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THE PHYTOGEOGRAPHY AND SYSTEMATICS OF *XANTHISMA TEXANUM* DC. (ASTERACEAE): PROPER USAGE OF INFRASPECIFIC CATEGORIES[1]

JOHN C. SEMPLE[2]

The monotypic genus *Xanthisma* DC. (Asteraceae) includes sufficient variation in its single species *X. texanum* DC. to illustrate the three levels of taxonomically recognized infraspecific variation: subspecific, varietal and formal. Proper usage of the three taxonomic ranks requires consideration of morphological and distributional data according to a consensus of international opinion. Although much has been published on the B-chromosome of the species (see Semple, 1972a), no modern systematic treatment of *X. texanum* has been published. Examination of some five hundred herbarium collections and experimental data indicate that a revision of Gray's 1852 treatment, which was based on only a few specimens, is necessary.

A detailed discussion of the distribution of the species as a whole and each of the infraspecific taxa is warranted for two reasons: first, to document the allopatric condition of the two subspecies, and second, to show that the distri-

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[1] The work was part of an NDEA Title IV Fellowship sponsored doctoral dissertation submitted to Washington University, St. Louis, Mo. Aug. 1972: Dr. Walter H. Lewis advisor.

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bution of the species is not predictable from the generalized vegetation distributions given by Gould (1962). The Edwards Plateau and its eroded portions are basic considerations in both cases. A taxonomic treatment considering all aspects of the problem is given at the end of the discussion of distribution and morphological variation.

All populations of a species ought to be interfertile to some degree. The validity of treating all the morphological forms of *Xanthisma* as a single species was tested by hybridization experiments involving greenhouse plants grown from fruiting material collected at wild populations. No barriers to fertilization were found and normal chromosome homologue pairing in meiotic prophase was observed in F_1 generation hybrids, which also set viable seed. Cross pollination was accomplished following the procedure of Smith & Parker (1971) and was facilitated by self-incompatibility. Selfing could be induced, but yielded progeny of low fitness. Clearly, Gray's combining all taxa of *Xanthisma* into a single species is acceptable.

DISTRIBUTION OF THE SPECIES

Xanthisma texanum grows in a portion of the central southwest of the United States: Texas, Oklahoma and eastern New Mexico. The known distribution of the species is illustrated in Figure 1 and is based on herbarium collections from GH, KSU, MO, NY, OKLA, SMU, TEX, TTC, US, WIS, and Arizona State University-Tempe.[3] Collections of subsp. *drummondii* (T. & G.) Semple and subsp. *texanum* are represented by dots and stars respectively; var. *texanum* and var. *orientalis* Semple of subsp. *texanum* are represented by encircled and unenclosed solid stars; putative hybrids between the two subspecies are represented by open stars. Treatment of Gray's (1852) varieties as subspecies, a term he did not use (Fernald, 1940), is based upon involucral bract morphology and the nearly allopatric distribution of the two taxa, while the distribution and bract morphology

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[3] The assistance of Frederick Utech and Timothy Love at the last two herbaria, respectively, is gratefully acknowledged.

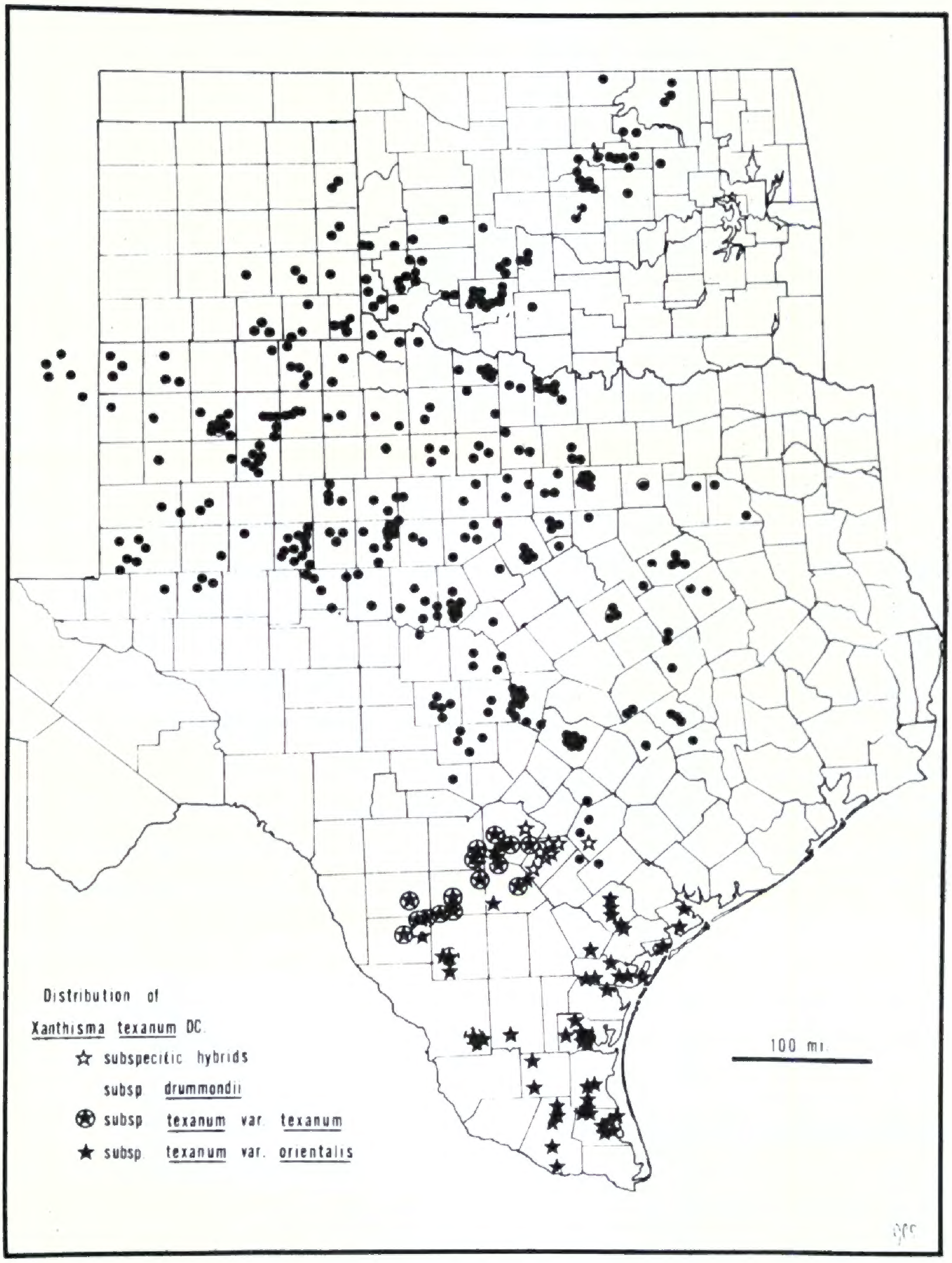


Figure 1. The distribution of *Xanthisma texanum* DC. Locations of collections have been determined from herbarium collections from eleven herbaria cited in the text. A key to the symbols used is given. Collections are plotted on a county outline map of Texas and Oklahoma.

variation within subsp. *texanum* is properly treated at the varietal level. Variation in environmental factors accounts for the species distribution.

Climatic factors determine the extent of the species' range in the east, northwest and south. Too much rain in the east and too little in the north and west are the apparent limiting factors, while increasingly tropical conditions become limiting to the south (Visher, 1954). Local variation in geological factors accounts for the distribution within the range and secondarily along the margins of the range. The western margin of the eastern deciduous forest (Bray, 1906; Tharp, 1926; Braun, 1950; and Gould, 1962) forms the eastern margin of the range of *X. texanum,* which is a member of the ecotone flora *sensu latu* between the forests and grasslands. Reasons for the present location of the forest-prairie ecotone are not appropriate for discussion in this paper.

A detailed treatment of geological influences on the species' range is given by Semple (1972b) and summarized for each taxon under each appropriate heading. The Rio Grande Valley supports a noticeably distinct vegetation community (Foscue, 1932). *Xanthisma texanum* is excluded from the community, which apparently forms a barrier to southward expansion of the range of *X. texanum,* since no collections have yet been made in Mexico. Either the Rio Grand Valley community is an impassible barrier or no inhabitable locations exist in Mexico for *X. texanum.*

DIAGNOSTIC MORPHOLOGY AND DISTRIBUTION OF THE TWO SUBSPECIES

A subspecies is characterized by all members exhibiting a particular morphology distinct from other individuals in the species and by the allopatric distribution of these members from the rest of the species (Du Reiz, 1930; Clausen, 1941; van Steenis, 1957; Valentine & Löve, 1958; and Ehrendorfer, 1968). Those morphologically intermediate individuals between the subspecies and the rest of the spe-

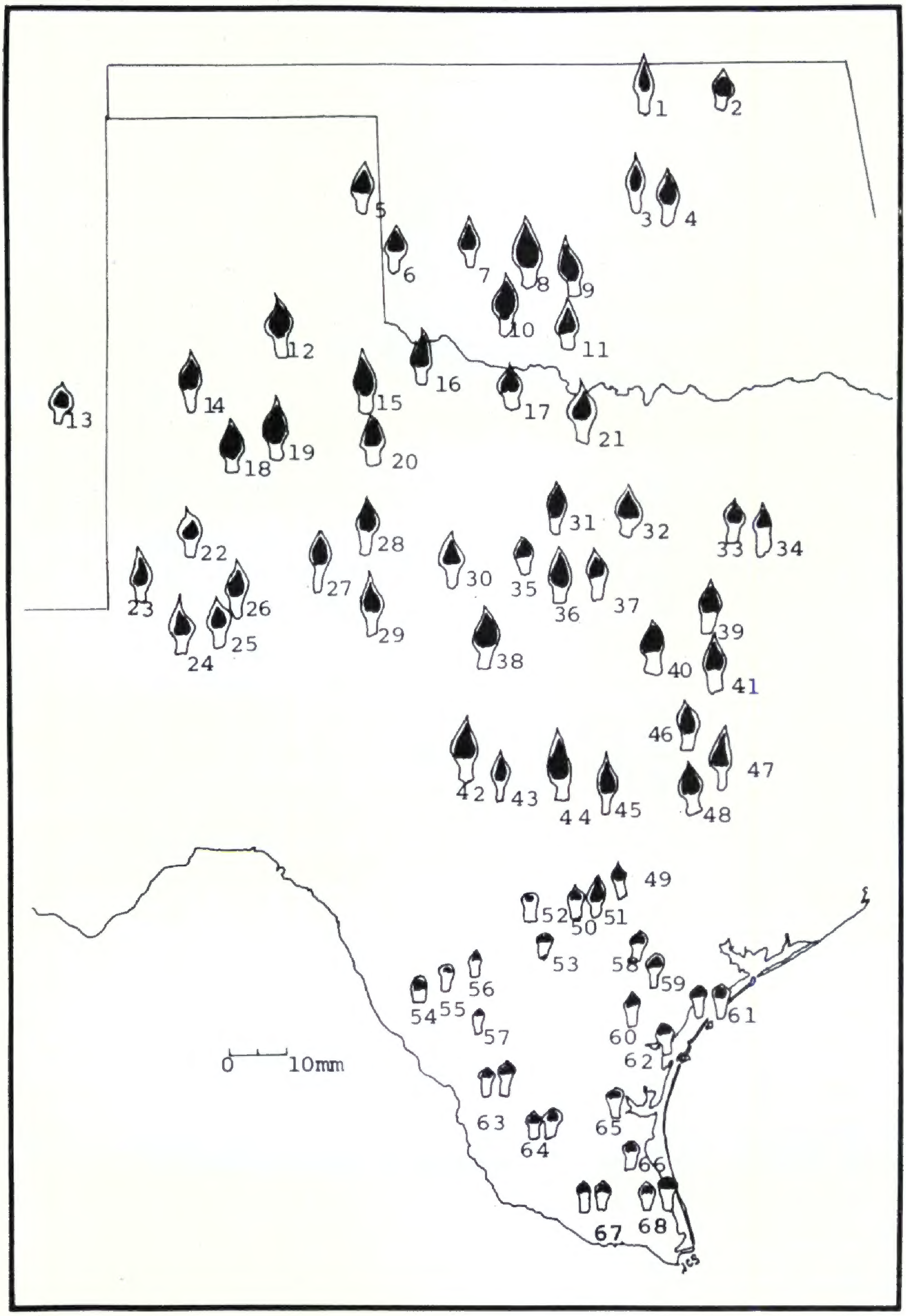


Figure 2. Geographic distribution of involucral bract variation of *Xanthisma texanum* DC. Bracts from plants from 68 populations are illustrated in outline on a map of Texas and Oklahoma. Bracts 1-48 are from individuals of subsp. *drummondii* (T. & G.) Semple; bracts 52-68 are from individuals of subsp. *texanum*; and bracts 49-51 are from putative hybrids between the two subspecies.

cies only occur in populations geographically located between the subspecies and the remainder of the species. Within *X. texanum* all members of subsp. *drummondii* (T. & G.) Semple are distinguished by involucral bracts that are lanceolate and taper to an acute apex. Subspecies *texanum* includes other members of the species and is characterized by involucral bracts that are depressed-ovate in shape and shorter than those of subsp. *drummondii.*

Diagrammatic representations (Figure 2) of involucral bracts typical of those occurring in the middle of the series forming the involucre are superimposed on an outline map of Texas and Oklahoma and were taken from plants occurring in wild populations at the locations indicated. Bracts 1-48 show the similarity that occurs within subsp. *drummondii* (see Figure 3.C for a detailed illustration of a typical involucral bract). Bracts 52-68 illustrate the range of variation in involucral bract shape found in subsp. *texanum* (Figures 3.A and 3.B). Bracts 49-51 illustrate involucral bracts from putative hybrids between the two subspecies and are the only bracts that are intermediate in shape.

The allopatric distribution of the two subspecies is due to the presence of the Edwards Plateau and the Blacklands Prairies between the two taxa. Geologically and topographically the Edwards Plateau is broken up into five regions (Fenneman, 1931; Oetking, 1959; and Raisz, 1957), although Gould (1962) included all the varied vegetation types within a single vegetation region. With a few exceptions, in part due to man's influences, subsp. *drummondii* does not grow in areas overlying uneroded portions of the Edwards Plateau, since the upper strata limit the amount of water available to the shallow rooted plants. Depending upon the extent of erosion and the nature of the underlying bedrock, subsp. *drummondii* grows in varying degrees of commonness in the areas of the eastern portion of the plateau (colloquial sense) in the following manner: common at the lower elevations of the Central Mining District, common throughout the Lampasas Cut Plains and rare on the more northeastern Comanche Plateau. Both subspecies are absent in the southeastern portion of the Edwards Plateau (the Texas Hill Country). Thus differences in geology account for the different numbers of collections in this well botanized area and also explain the means by which the two subspecies are isolated north and west of San Antonio, Texas.

The presence of the Blacklands Prairies isolates the two subspecies north and east of San Antonio. The prairies, which run from San Antonio to Dallas and further northeastward, are characterized by dark, high clay content soils (Sellards *et al.,* 1966) and are dry and rock hard in the summer. Typically, *Xanthisma* occurs on sandy, light brown or reddish soils. Field work in the central Texas region showed that *X. texanum* is very rare throughout the entire length of the prairies, except for a few individuals surviving on disturbed or introduced soils along highways and river banks. Clearly, Gray's varieties are exemplary of what are today treated as subspecies.

A narrow zone of isolated subsp. *drummondii* populations occurs in Caldwell, Gonzales and Wilson Counties, but the small populations only thrive in favorably moist years. Interestingly, *Heterotheca pilosa* (Nutt.) Shinners and *Bradburia hirtella* T. & G. are common in these counties and further east, the former being the most prevalent yellow flowered member of the Astereae. Similarity in superficial appearance of these two species with *X. texanum* undoubtedly explains confusion about the distribution of *X. texanum* in this critical region between the two subspecies.

DIAGNOSTIC MORPHOLOGY AND DISTRIBUTION OF THE TWO VARIETIES OF SUBSP. TEXANUM

A variety is characterized by all members of a population exhibiting a particular morphology distinct from other individuals in the species. The distribution of these populations is sympatric with populations whose members are not within the same variety, and also many populations of morphological intermediates exist (Du Reiz, 1930; Clausen, 1941; van Steenis, 1957; Valentine & Löve, 1958; and Ehrendorfer, 1968). By this definition varieties can be recognized within a species, which does not have subspecies. Furthermore, variation that is *not known* to be confined to an isolated group of populations can not be given subspecific status. Van Steenis (loc. cit.) described varietal level variation as being continuous with other varieties, although the continuum would have pronounced modes. The variation between subspecies can be described as discontinuous, except for the few hybrids. Figure 1 illustrates the sympatric condition of the two varieties of subsp. *texanum:* var. *texanum* with obtuse involucral bract apices (Figure 3.A) and var. *orientale* Semple with cuspidate involucral bract apices (Figure 3.B).

FORMAL LEVEL VARIATION IN VAR. ORIENTALIS

Formal level morphological variation is generally regarded as some phenotype possessed by only some members of a population, whereas the subspecific and varietal level phenotypes are possessed by all members of a population. Those individuals in populations of subsp. *texanum* var. *orientale* which exhibit red pigmentation along the lateral margins of the involucral bracts forming the middle and inner series of the involucre have been designated as forma *rubrum* Semple (Figure 3.B). Such individuals are rare, but do occur in populations throughout the range of var. *orientalis.*

GENETIC BASIS OF DIAGNOSTIC CHARACTERISTICS

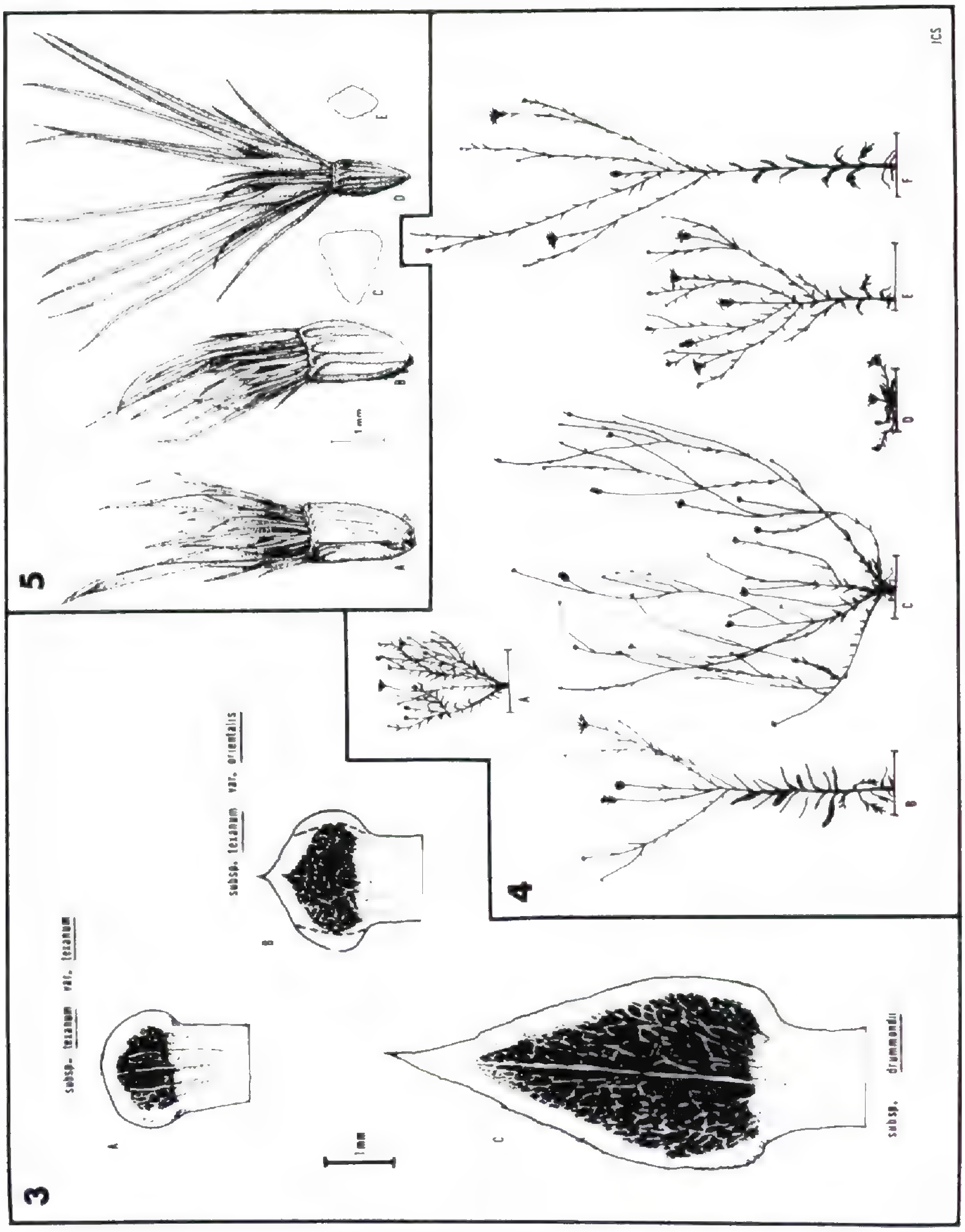
Experiments were conducted to show that all diagnostic characters have a genetic basis. Size but not general shape of the involucral bracts was found to be variable. Lack of sufficient light, available water, amount of soil or a high degree of crowding all resulted in smaller bracts being formed than those bracts formed by the individual when sufficient quantities of soil, light and water were provided.

The maximum size was determined by heredity and not the environment. Therefore size should be considered secondarily to shape in determining the proper identity of a particular collection.

The red pigment of f. *rubrum* was found to be passed from one generation to the next in var. *orientale,* but was never seen in var. *texanum* or in subsp. *drummondii.* Although the pigment is not always present in detectable quantities, its importance warrants some taxonomic status, since *Xanthisma* has always been previously described as monochromous. However, in some experimental plants heads were occasionally produced which manifested the red pigment in the distal portion of the ray straps on the adaxial surface and on the lobes of the disc florets, but only on the last day or two of disc anthesis. Most individuals produced enough pigment to give the rays an orange hue, but one plant produced rays that were deep rust red. Such variation in intensity of color does not occur on bract margins. No documentation of bicolor rays in wild plants exists.

HABIT AS AN EXAMPLE OF VARIATION NOT WARRANTING TAXONOMIC STATUS

Despite the great range of variation in habit occurring in the species, no one form was found to warrant taxonomic recognition. Within a single population long-stemmed and short-stemmed individuals were found in nature. The distribution patterns of the short-stemmed plants (Figure 4.C) and the stemless plants (Figure 4.D) suggest that these forms are ecotypes, since they have a genetic basis. The extremes of short-stemmedness and stemlessness only occur in populations of var. *orientale* and western populations of subsp. *drummondii,* respectively. The existence of a full range of intermediates between the extremes and the long-stemmed forms (Figures 4.B, 4.F and 4.G) in most populations makes taxonomic recognition unjustified.


3
subsp. texanum var. texanum
A
subsp. texanum var. orientalis
B
1mm
C
subsp. drummondii
4
A
B
C
D
E
F
JCS
5
A
B
1mm
C
D
E

A COMMENT ON CHEMICAL STUDIES

The taxonomic treatment that follows is based on morphology and distribution. Two dimensional paper chromatograms were run on leaf and flower extracts of specimens of each taxon. In general, subspecies *texanum* had fewer compounds than subspecies *drummondii,* and var. *orientale* has fewer compounds than var. *texanum.* In var. *orientale* individuals of forma *rubrum* had one compound, an unidentified anthocyanin (Semple, 1972b), not found in other individuals of the species. The full significance of the chemical studies can only be known upon complete identification of each compound. The preliminary results show that chemical data support the taxonomy. The chemical studies will have meaning in work on determining the evolution of the taxa described.

TAXONOMIC TREATMENT

The most recently published treatment of the genus *Xanthisma* is in Correll & Johnston (1970). The following detailed description of the genus is more complete and ac-

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Figure 3. Involucral Bracts of Infraspecific Taxa. Each bract shown is typical of those in the middle of the series forming the involucre: (A) subsp. *texanum* var. *texanum;* (B) subsp. *texanum* var. *orientale* Semple (dashed lines indicate the extent of red pigment on the margins of bracts of f. *rubrum* Semple); (C) subsp. *drummondii* (T. & G.) Semple.

Figure 4. Habit Variation of *Xanthisma texanum* DC. The baseline under each silhouette equals one decimeter. Each form shown illustrates the habits of experimental plants and represents naturally occurring forms. Plants were grown under similar conditions from fruiting material collected at wild populations. All plants were from different populations, except (B) and (C). See the text for a full discussion.

Figure 5. Heterocarpic Fruit of *Xanthisma texanum* DC. Ray and disc florets produce different kinds of fruit: (A), (B) and (C) are radial, tangential and diagrammatic cross-sectional views of a ray fruit; (D) and (E) are radial and diagrammatic cross-sectional views of a central disc fruit. Peripheral disc fruit are larger and angular ovate in cross-section.

curate in light of the findings of my investigations. The previously unreported heterocarpic fruit condition is also described (Figure 5). A complete list of specimens examined in the study is given in Semple (1972b) and only representative specimens are cited here.

Xanthisma DC., Prodr. 5:94-95. 1836.

Centauridium T. & G., Fl. N. Amer. 2:246. 1842.

Taprooted annuals, rarely biennial and flowering the second season; branches ascending, few to many. Leaves alternate, the upper sessile, the lower terminally serrate; basal leaves petioled, lobed or pinnatifid to bipinnatifid. Heads solitary; involucre turbinate to hemispheric or campanulate; involucral bracts broad in 3-4 series, imbricate, stiff, the margins pale; ray florets pistillate, fertile, yellow; disc florets perfect, fertile, yellow. Fruit heterocarpic with pappus bristly and margins finely serrate; both fruit kinds with fine ascending white hairs, straw-colored when mature and darkening with age. Receptacle slightly convex, with subulate chaff reticulately dispersed between the fruits.

The genus is monotypic and is endemic to the central southwestern areas of the United States.

Xanthisma texanum DC., Prod. 5:95. 1836.

Lectotype: Texas; Bexar County, in woods near Medina, May 1828, *Berlandier* 2039d (G!). Isolectotypes; G! (4), GH! (1), NY! (1), and US! (2).

Herbs 2-7 (rarely more) dm tall, branching near the middle to ground level from a main stem 0.1-3 dm long, or rarely acaulescent. Upper leaves 1-2 cm long, linear, entire; basal leaves 5-8 cm long, ovate to obovate in outline, intergrading above. Heads solitary, not crowded; involucre 5-10 mm high, involucral bracts 1.5-4 mm broad, rarely recurved, margins pale (the lateral margins very rarely red), the central portion green, reticulate venation pronounced, the inner-most bracts chartaceous, the outer-most linear grading into the peduncle bracts; ray florets 10-30, the straps 8-15 mm long, yellow adaxially, pale yellow abaxially (rarely red-tinted abaxially); disc florets many 40-150, slightly ampliate to tapering, the lobes short. Ray floret cypselas curved obpyramidal, triangulate in cross-section, the pappus grading from short linear to long basally broad scales; disc floret cypselas obovate radially and narrowly-so tangentially, the central fruits rhombic in cross-section, the outer obtrullate, the pappus in two whorls, the inner members ca. 6 mm long, linear, 8-15, the outer members 3 mm long or less many.

The species is characterized by the following combination of characters: heterocarpic fruit with a pappus of bristly scales only, fruit pubescence of long white ascending hairs, receptacle slightly convex with a persistent reticulate network of subulate scales.

The lectotype of the species was chosen from five specimens seen on microfilm only (IDC micro edition of Candolle Prodromi Herbarium). Since all five specimens are similar in quality, the specimen with the complete label giving collection number, date and location, and floral color (fourth from the left on the microfilm) is designated lectotype. Torrey (1859) first noted the typographic error in the Prodromus, which cited the type collection as *Berlandier* 2639 rather than *Berlandier* 2039.

Key to Infraspecific Taxa

I. Involucral bracts shorter than wide above the widest part, 1.5-3.5 mm wide and 1-2 mm long above the widest part. .... subsp. *texanum* (1)
    II. Involucral bracts rounded with little or no flare 1 mm from the apex, occasionally recurved. .... var. *texanum* (2)
    II. Involucral bracts obtusely pointed, the deltoid portion 2-3 mm wide and 1.5-2 mm long above the widest part. .... var. *orientale* (3)
        III. Lateral margins of bracts whitish. .... f. *orientale* (3a)
        III. Lateral margins of bracts red. f. *rubrum* (3b)

I. Involucral bracts longer than wide above the widest part; deltoid portion 2.5-5 mm wide and 3.5-8 mm long in bracts of the middle series. . . ssp. drummondii (4)

1. **Xanthisma texanum** spp. **texanum**

Xanthisma texanum var. *berlandieri* Gray, Smiths. Contrib. Knowl. 3(5) : 98. 1852.

Xanthisma berlandieri (Gray) Small, Fl. SE. U.S. p. 1184. 1903.

This subspecies includes the type collection of *X. texanum* and is distinguished by small involucral bracts with rounded or obtusely pointed apices. Two varieties are recognized within the subspecies.

2. **Xanthisma texanum** ssp. **texanum** var. **texanum**

The type variety of the species is distinguished by its small apically rounded involucral bracts 1.5-2 mm wide, appressed or rarely recurved; generally 30-35 bracts are visible without removing the outer series. The variety is endemic to the Nueces Plains of southern Texas from San Antonio to the south and west. East of San Antonio this variety forms hybrids with subspecies *drummondii*.

SOME REPRESENTATIVE SPECIMENS EXAMINED. TEXAS: Atascosa Co., Charlotte, 4 May 1919, *Schulz* 39 (US). Bexar Co., San Antonio, 4 June 1948, *Burr* 21 (NY, TEX), in woods near the Medina River, July 1829, *Berlandier* 629 (GH, MO, NY, US). Dimmit Co., Big Wells, 21 April 1945, *Shinners* 7,400 (NY, OKLA, SMU, TEX), in front of cemetery, 6 May 1964, *Turner* 4,996 (TEX). Frio Co., Dilley, 6 mi. W, 8 July 1970 *Lewis* 7,634 (MO). La Salle Co., Artesia Wells, 3 mi. W., 7 April 1963, *Dickey* 170 (SMU, TEX). Medina Co., Farm Rd. 1343, 4.4 mi S of U.S. Hwy. 90, 29 June 1972, *Semple & Shea* 720 (MO); Devine, 3 mi. SW, 1 May 1954, *Tharp & Turner* 3,439 (OKLA, TEX). Zavala Co., Batesville, 6 mi. E, 6 May 1964, *Turner* 5,002 (TEX).

3. **Xanthisma texanum** ssp. **texanum** var. **orientale** Semple, var. nov.

Involucri bracteae parvae manifeste depresse ovatae, apice obtuse, cuspidatae, interdum marginibus lateralibus rubris.

HOLOTYPE: Texas: Hidalgo Co.: 13.5 mi. N. of Edinburg on U. S. Hwy. 183, 8 July 1970, *W. Lewis* 7642 (MO). Isotypes: four, to be distributed.

The involucral bracts are small and pronouncedly shield-shaped, occasionally with red lateral margins. The apices are obtusely cuspidate.

This variety is distinguished by the 2-3.5 mm wide involucral bracts having obtuse, cuspidate apices. The short stem habit is also frequently encountered. Hybridization with var. *texanum* is common, but is unknown with ssp. *drummondii.* The name is taken from its distribution in the eastern half of the range of ssp. *texanum.* Two forms are recognized.

3a. **Xanthisma texanum** var. **orientale** Semple f. **orientale**

The type form is the most common form of the variety.

SOME REPRESENTATIVE SPECIMENS EXAMINED. TEXAS: Aransas Co., Aransas Refuge, 29 Sept. 1944, *Cory* 45, 895 (NY, TEX). Bee Co., Beeville, 21 June 1935, *Drushel* 9,941 (NY). Brooks Co., Hebbronville, 15 mi. E, 25 Nov. 1962, *Dohnke* 7 (SMU). Calhoun Co., Port Lavaca, 14 June 1953, *Johnston* 53.280.157 (OKLA, TEX). Goliad Co., Goliad, 15.9 mi. S, 9 July 1970, *Lewis* 7,655 (MO). Hidalgo Co., Rio Grande Valley, 8 Aug. 1942, *Walker* 70 (KSU, TEX). Jim Hogg Co., Hebbronville, 8 mi. E, 8 July 1970, *Lewis* 7,638 (MO). Jim Wells Co., Premont, 12 mi. N, 24 Nov. 1954, *Johnston* 542,144 (TEX). Kenedy Co., King Ranch, Norias Div., 24 Nov. 1953 *Johnston* 53.280.154 (OKLA, TEX.) Kleberg Co., Kingville, 1940, *Sinclair* s.n. (TEX). Refugio Co., 5 mi. S of county line on U. S. Hwy. 77A, 12 June 1971, *Semple* 581 (MO). San Patricio Co., Aransas Pass, 24 May 1922, *Schulz* 868 (TEX, US). Near San Patricio, May 1834, *Berlandier* 2573 (GH, MO, NY). Webb Co., Mirando City, 31 Aug. 1936, *Baird* s.n. (NY). Willacy Co., Yturria Station, 6 Aug. 1924, *Runyon* 664 (TEX, US).

3b. **Xanthisma texanum** var. **orientale** f. **rubrum** Semple, forma nov. Involucri bracteae cum marginibus lateralibus rubris.

HOLOTYPE: Texas: San Patricio Co., 0.5 mi. E. of Ingleside on Texas Hwy. 361, 13 June 1971, *Semple* 602 (MO). Isotype: one to be distributed.

This form is distinguished from the type form by having bracts with red lateral margins.

REPRESENTATIVE SPECIMENS EXAMINED. TEXAS: Aransas Co., Aransas Refuge, 29 Sept. 1944, *Cory* 45,895 (MO). Goliad Co., General Zaragoza State Park, 1 mi. S, 12 June 1971, *Semple* 579 (MO). Kenedy Co., Raymondville, 16 mi. N, 2 Dec. 1945, *Cory* 51,493 (US). Willacy Co., Port Mansfield, 0.5 mi. W of beach by garbage dump, 9 July 1970, *Lewis* 7,644 (MO).

4. **Xanthisma texanum** DC. ssp. **drummondii** (T. & G.) Semple, stat. nov.
Centauridium drummondii T. & G., Fl. N. Amer. 2: 462. 1842.

SYNTYPES: Texas, north of San Antonio, *Riddell* s.n. (NY!); Texas, exact locality unknown, Nov. 1835, *Drummond* 227 (GH!, NY!).

LECTOTYPE: *Drummond* 227 (GH). Isolectotypes: GH, NY.

Xanthisma texanum var. *drummondii* (T. & G.) Gray, Smiths. Contrib. Knowl. 3(5): 98. 1852.

Xanthisma drummondii (T. & G.) Hooker f., Curtis' Bot. Mag. 33: t. 6275. 1877.

Subspecies *drummondii* is distinguished by its involucral bracts, which are wider than those of ssp. *texanum* and are distinctly lanceolate. Populations occur in much of Texas north of San Antonio, and in Oklahoma and eastern New Mexico.

Drummond 227 (GH) was selected lectotype because it is the largest and most complete specimen. The Riddell collection cited by Torrey & Gray (1842) is fragmentary and a putative hybrid between the two subspecies.

SOME REPRESENTATIVE SPECIMENS EXAMINED. NEW MEXICO: Roosevelt Co., Elida, 5 mi. NE, 28 Sept. 1965, *Anderson* 3,004 (KSU). Lingo, 1.2 mi. N, *Semple & Shea* 705 (MO). OKLAHOMA: Beckham Co., Carter, 5 mi. S, 5 July 1965, *Thomas* 79 (OKLA). Caddo Co., Cement, 27 June 1936, *Demaree* 13, 133 (NY). Comanche Co., Cache, June 1927, *Ortenburger* s.n. (U.S.) Creek Co., Drumright, 10 June 1935, *Fry* 8 (OKLA). Custer Co., Clinton, 28 June 1966, *Ganz* s.n. (ARIZ. ST. U.). Grady Co., Verdun, 25 June 1963, *Pearce* 885 (OKLA, SMU). Greer Co., Granite, 17 June 1939, *Graumanns* 85 (OKLA). Harmon Co., Vinson, *Shinners* 31,644 (SMU). Jackson Co., Duke, 1.7 mi W. 15 July 1970, *Flyr* s.n. (MO). Kay Co.; 26 July 1898, *White* s.n. (US). Kiowa Co., Mt. Park, 23 June 1913, *Stevens* 1,293 (OKLA).

Lincoln, 23 Aug. 1895, *Blankenship* 17,334 (WIS). Logan Co., Guthrie, 12 July 1916, *Keyser* 6,036 (NY). Osage Co., 8 mi. S of Kans. state line on Okla. Hwy. 99, 24 June 1972, *Semple & Shea* 667 (MO). Oklahoma Co., Oklahoma City, 27 May 1937, *Waterfall* 582 (OKLA, NY). Pawnee Co., Pawnee, 8 mi. E, 8 June 1934, *Brodell* s.n. (TEX). Payne Co., Mulhall, 1.1 mi. N, 25 June 1972, *Semple & Shea* 674 (MO). Stephens Co., Duncan, 8 mi. N, 27 May 1960, *Waterfall* 15,911 (OKLA). Washita Co., 2.2 mi. E of county line on Okla. Hwy. 152, 20 Aug. 1970, *Semple & Love* 264 (MO). TEXAS: Andrews Co., Andrews, 4 mi. W, 28 May 1956, *Turner* 3,957 (TEX). Archer Co., Mankins, 2 mi. NE, 8 June 1956, *Shinners* 23,758 (SMU). Baylor Co., Seymour, 4 Aug. 1955, *Shinners* 20,776 (SMU). Blanco Co., Silverton, Farm Rd. 145, 26 June 1972, *Semple & Shea* 699 (MO). Burleson Co., Caldwell, 14 June 1971, *Semple* 625 (MO). Burnet, 8 mi. W, 19 May 1955 *Turner & Johnston* 2,480 (TEX). Callahan Co., Baird, Aug. 1882, *Letterman* 26 (MO, US). Childress Co., Childress, *Biology Class C. High School* 12 (TEX). Coke Co., Robert Lee, 3 mi. S, 4 Oct. 1968. *Gary* 192 (TTC). Comanche Co., Comyn, *Theney School* s.n. (TEX), Dallas Co., Dallas, near Comanche Peak, Aug. 1877, *Reverchon* s.n. (US). Dewitt Co., western part of Co., 20 July 1941, *Reidel* s.n. (TEX). Erath Co., 1922, *Gaugh* 29 (US). Fisher Co., Rotan, 10 Sept. 1933, *Brooker* s.n. (TEX). Gaines Co., Lamesa, 15.1 mi. W, 14 Sept. 1946, *Whitehouse* 16,788 (NY, SMU). Gillespie Co., Cherry Spring, 18??, *Jermy* 639 (MO). Gonzales Co., Cost, 11.5 mi. SW, 29 June 1972, *Semple & Shea* 730 (MO). Hall Co., Turkey, 5 mi. S, 12 June 1950, *Tilton* T.550.604 (TTC). Hood Co., 6 Aug. 1877, *Reverchon* 1368 (KSU, NY, US). Howard Co., Big Spring, 22 mi. S, 27 April 1963, *Dallas* 64 (OKLA). Kerr Co., 6 June 1929, *Whitehouse* 7.056 (TEX). Limestone Co., Kosse, 3.5 mi. N, 14 June 1971, *Semple* 626 (MO). Lubbock Co., Lubbock, *Demaree* 7,715 (MO, TEX, TTC, US). McCullogh Co., 1 mi. S of Colorado R., 28 June 1972, *Semple & Shea* 716 (MO). Navarro Co., Corsicana, 21 June 1872, *Hall* 311 (GH, MO, NY, US). Robertson Co., Calvert, 8 May 1904, *Tyler* s.n. (US). Tarrant Co., Lake Fort Worth, 16 July 1923, *Ruth* 742 (GH, KSU, US, WIS). Travis Co., Austin, 9 June 1908, *Biltmore* s.n. (US). Van Zandt Co., Edom, 3 July 1939, *Ball* 7 (SMU). Washington Co., 20 May 1938, *Brackett* s.n. (TEX). Young Co., Belknap, 6 May 1858, *Hayes* 397 (NY).

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A WHITE-FLOWERED FORM OF UTRICULARIA PURPUREA FROM NEW HAMPSHIRE. A white-flowered form of *Utricularia purpurea* Walter was found while conducting research in a small pond in New Hampshire. This form was extremely abundant forming extensive mats on the surface of this shallow pond. None of the normal purple-flowered plants were observed. Plants commonly associated with the white form were *Utricularia vulgaris* L., *Utricularia intermedia* Hayne and *Najas flexilis* Rostk. & Schmidt. The pond had a pH of 6.5 and methyl orange alkalinity reading of 8.0 mg/1.

The following form is described. *Utricularia purpurea* Walter forma **alba** Hellquist, forma nova. differt forma purpurea quantum flores albos non purpureos habet. TYPE: NEW HAMPSHIRE: CARROLL COUNTY: small unnamed pond southeast of Dorr Pond on N.H. Route 153 at the settlement of Woodman, Town of Wakefield (U.S.G.S. quadrangle Newfield, Me.-N.H.), *C. B. Hellquist* 8935 (NHA).

The holotype has been placed at the University of New Hampshire Herbarium (NHA). Isotypes are in the herbarium of the New England Botanical Club (NEBC) and Boston State College Herbarium.

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ON THE SCIENTIFIC NAME OF THE LONGLEAF PINE[1]

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The Longleaf Pine of the southeastern United States has been spared the numerous changes in scientific name that have cast confusion over many of our other tree species. From pioneer days the dominant practice, both among botanists and foresters, has been to apply the name *Pinus palustris* Mill. to the Longleaf. Prior to the 1940's the only author of significance to do otherwise was J. K. Small (1933) who interpreted *P. palustris* Mill. to be the northern variety of slash pine, *P. elliottii* Engelm. Small's *Manual of the Southeastern Flora*, however, achieved only regional impact, and his use of *P. australis* Michx. f. for the Longleaf did not gain a wide following.

A much stronger impetus for associating the Longleaf with *Pinus australis* was generated in 1948 by M. L. Fernald who advocated this name in two detailed and strongly worded articles (Fernald & Schubert, 1948; Fernald, 1948). Fernald's position was reinforced by the publication of his monumental reworking of *Gray's Manual of Botany* (1950), and was further entrenched when the independent H. A. Gleason adopted the same name in his *New Britton and Brown Illustrated Flora* (1952) as did A. Cronquist in their companion field guide, the *Manual of Vascular Plants of Northeastern United States and Adjacent Canada* (Gleason & Cronquist, 1963). These three publications totally dominate the field of regional floras in the Northeast, and their consistent use of *Pinus australis* inevitably suggests that this name is supported by general professional agreement and by nomenclatural legitimacy.

Yet in publications other than these or their derivatives, the Longleaf remains known by the name *Pinus palustris*

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Mill. This is the name found in state or district floras such as the *Manual of the Vascular Flora of the Carolinas* (Radford et al., 1968), the *Manual of the Vascular Plants of Texas* (Correll & Johnston, 1970), and *A Flora of Tropical Florida* (Long & Lakela, 1971), as well as in the more basic modern treatments of the genus by Mirov (1967) and by Little & Critchfield (1969). The U. S. Forest Service, following the guidance of its dendrologist, E. L. Little, has remained steadfast with *P. palustris*, and the state forest services have done likewise.

The rationale behind Fernald's heterodox displacement of *Pinus palustris* was his view that Philip Miller (1768), superintendent of the Chelsea Physic Garden and British author of a series of widely used and authoritative horticultural dictionaries, did not have the Longleaf when he described an American tree under this name. The original description contained phrases that do not apply to the stately and versatile Longleaf: "I have been informed that they grow to a height of twenty-five or thirty feet. . . . I have not heard the wood was of any use but for fuel." However, Miller reported these statements as hearsay, not as observed fact, while his description also contained such passages as "Pine-tree with the longest leaves growing by threes out of each sheath" and "Their leaves are a foot or more in length, growing in tufts at the end of the branches, so have a singular appearance." These phrases were given without qualification and form a brief but unmistakable description of the Longleaf.

Fernald further relied on the habitat of *Pinus palustris* reported by Miller, "swamps in many parts of North America," as excluding the Longleaf. He proposed instead that Miller may have had the Loblolly Pine, *P. taeda* L. Actually however, although the Longleaf usually occurs on dry well-drained soils, it not uncommonly is found associated with the Slash Pine in the extensive level undrained swamps known as flatwoods and throughout its range probably occurs as frequently in wet soils as Fernald's proposed substitute, the Loblolly. Of couse, Miller's use of an epithet meaning "swampy", even if it were totally unsuitable, would not be justification for discarding his *P. palustris;* Article 62 of the International Code of Botanical Nomenclature (Stafleu, 1972) provides that: "a legitimate name or epithet must not be rejected merely because it is inappropriate . . ."

No information is available from specimens preserved by Miller; Dr. Schubert examined the Miller collections of the British Museum and was unable to find a specimen that could be considered a type. Fernald, by correspondence, did locate a specimen he presumed to be of *P. taeda* that Miller may have seen and that someone, possibly Miller, had noted as "palustris." It seems improbable that Miller would have so misidentified *P. taeda* since this species was well known to him and was treated in some detail in the several editions of his "Dictionary."

Fernald did demonstrate at some length that the name *Pinus palustris* was not clearly understood and was even misused by Miller's contemporaries and other early workers, but this again does not provide justification for discarding the name. There seems to be essentially no sound rationale for interpreting this name to mean anything other than, in the conventional usage, the Longleaf Pine.

In the event, moreover, that Miller's brief but clear diagnosis should be considered ambiguous, no alternative name is available. *Pinus lutea* Walter, whimsically suggested by Fernald, is probably *P. taeda. Pinus australis* Michx. f. is unmistakably the Longleaf, and was selected as the correct name for this species by Small and by Fernald. Little (1948), however, accurately pointed out prior to the publication of Fernald's first paper on the subject, that Article 63 (then Article 60) of the International Code makes this name illegitimate since it was superfluous when published. Not only did Michaux (1810) cite *P. palustris* as a synonym, but he specifically explained that he was replacing this name with *P. australis,* using an epithet ("southern") that he thought more appropriate. It is precisely such actions as this that Article 63 is designed to prevent, and Fernald's protestations that Michaux was "definitely defining a new species" are contradicted by Michaux' own words, in translation: "I have thought likewise that the specific name 'australis' was preferable to that of 'palustris', under which this species has been described by botanists; for this last gives an absolutely false idea of the nature of the soil where this tree grows."

The only other specific name apparently ever given the Longleaf was *Pinus longifolia* Salisb., but here again the epithet used was superfluous, for Salisbury (1796) was unabashedly providing a substitute name for *P. palustris* and thereby formed an illegitimate and unusable combination.

The person who would apply a scientific name to the Longleaf Pine, therefore, has the choice, should he wish to follow the Code, of either accepting Miller's brief description of *Pinus palustris* as adequate, or of discarding it as confused and coining and publishing a name of his own creation. Neither *P. australis* Michx. f. nor *P. longifolia* Salisb. may be legitimately used for this tree, and prudence and practicality, as well as historical precedent, indicate strongly the advisability of retaining the Longleaf Pine under the name *Pinus palustris* Mill.

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THE OCCURRENCE OF BALD CYPRESS (TAXODIUM DISTICHUM (L.) RICHARD) IN SUFFOLK COUNTY, LONG ISLAND, NEW YORK. In October, 1972, Mr. Richard Fackovec, a student in an aquatic botany course at Southampton College, brought to our attention a specimen of *Taxodium distichum* that he collected along the shore of Long Pond in Sag Harbor, New York. We returned to investigate the region in November and found eight bald cypress seedlings, ranging in height from one to 2½ meters and growing close to shore in 0.5-0.7 meters of water. The four smallest trees (approximately one meter tall) are growing close together at the southern end of the pond at the edge of a large marsh. The other cypress trees are located at the southern end of the pond also, but along the western shore. The two largest trees (2½ and 1½ meters tall) are at the edge of a large stand of *Typha latifolia.* Most of the remaining shoreline of Long Pond consists of very dense vegetation composed primarily of shrubs and small trees (e.g., *Myrica gale, Decodon verticillata, Cassandra calyculata, Vaccinium corymbosum, Nyssa sylvatica, Acer rubrum*). It is within this shrub zone that we found two additional bald cypress seedlings. One had become encompassed so completely by encroaching shoreline vegetation that we removed it; subsequently, it has been replanted along the shore of a pond in the Morton Wildlife Refuge, a Federal Wildlife Preserve in Noyac, New York.

We have communicated with Dr. Richard Stalter, plant taxonomist at St. Johns University in Jamaica, New York, regarding the northern distribution of *Taxodium distichum.* As far as we have been able to determine, this is the first record of a natural population of bald cypress in New York State. The closest naturally-occurring populations of *Taxodium* are in Delaware, where there are a few large colonies (Stalter, personal communication). There was, at one time, a colony in New Jersey, but it has been unknown in that state for several years (Stalter, personal communication).

Accompanied by Dr. Stalter, we returned to Long Pond in December in an unsuccessful effort to locate mature bald cypress trees. We share the opinion with Dr. Statler that this colony of *Taxodium distichum* represents a naturalized population. The presence of a few bald cypress seedlings in relatively inaccessible portions of the shoreline strongly suggests that they were not planted. The apparent absence of large bald cypress in the area leaves unanswered the question as to how the seedlings became established; hopefully, further investigation will afford us an answer.

The voucher specimen collected by Mr. Fackovec is deposited in the Southampton College Herbarium.

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STUDIES ON THE BRYOPHYTES OF SOUTHERN MANITOBA
III. COLLECTIONS FROM GRAND BEACH PROVINCIAL PARK

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Grand Beach Provincial Park lies approximately 57 miles north of Winnipeg. The entire park, which covers 59,000 acres, is in the Manitoba Lowlands Section of the Boreal Forest Region (Rowe, 1959). Three miles of the area fronts on Lake Winnipeg. The underlying bedrock is palaeozoic limestone, and the overlying beds are modified till, or lacustrine clays deposited in glacial Lake Agassiz. Most soils have a high lime content.

On the flat, poorly drained areas, black spruce (*Picea mariana* (Mill.) BSP.) and tamarack (*Larix laricina* (Du Roi) K. Kich) forest prevail, while on the better drained alluvial strips bordering the rivers and creeks, white spruce (*Picea glauca* (Moench) Voss), aspen (*Populus tremuloides* Michx.) and balsam poplar (*Populus balsamifera* L.) predominate. On the low, well-drained ridges, jack pine (*Pinus banksiana* Lamb.) is dominant, with aspen, paper birch (*Betula papyrifera* Marsh.) and some bur oak (*Quercus macrocarpa* Michx.) present.

No bryophytes have previously been reported for the park. In the present study, several sites were visited, mostly in the vicinity of 96°35′W and 50°33′N. The sites were chosen as representative of the major vegetation types in the area, and the following seven, visited in July, 1972, are reported as representative of the area studied. Several of the vascular collections could be determined to genus only, because of lack of flowering or fruiting material.

1. Sand dunes and dune slacks behind the East Beach. Dominant shrubs were *Salix* spp., especially in the slacks, with *Prunus pumila* L. conspicuous on the drier areas. Other prominent vascular plants on the dry areas included *Carex* spp., *Rhus radicans* L. var. *rydbergii* (Small)

Rehder, and *Artemisia* spp. Total plant cover was rather thin (about 20%) except in the slacks, and most bryophyte cover was on wet litter in the slacks. Small turf mosses such as *Bryum* spp. were, however, common in dry habitats.

2. Aspen-dominated forest just s. of the parking lot at the East Beach. Most mosses were from tree bases.
3. Mixed mature aspen — jack pine forest on w. side of the road n. of main park entrance.
4. Black spruce bog with some tamarack and white cedar (*Thuja occidentalis* L.). The understory was dominated by *Ledum groenlandicum* Oeder and the terrain consisted of pools and *Carex* hummocks. Just s. of Highway 12, ½ mile from its junction with Highway 59.
5. Open jack pine with some birch, on s. side of Highway 12, 2 miles from its junction with Highway 59.
6. Tamarack — black spruce bog on e. side of Highway 59, 2 miles n. of its junction with Highway 12. Drier than site 4, and with a tall shrub layer of *Alnus* sp., as well as a short shrub layer dominated by *Ledum groenlandicum*. Deadfall was abundant.
7. Mature, open jack pine forest on w. side of Highway 59 4 miles n. of its junction with Highway 12. There was an open short shrub and herb layer dominated by *Vaccinium angustifolium* Ait., *Chimaphila umbellata* (L.) Bart. and *Amelanchier alnifolia* Nutt., with *Linnaea borealis* L. and *Vicia americana* Muhl. prominent. The forest floor was dominated by *Pleurozium schreberi* and *Dicranum* spp., especially *D. polysetum*. The many large humus-covered boulders present all had an extensive, species-rich bryophyte cover. Numbers in the species list refer to the sites described above.

Taxonomic and field work were shared equally by both authors. Voucher specimens have been deposited in the authors' own herbarium and at the University of Winnipeg. Nomenclature for Sphagnobrya and Eubrya follows Crum, Steere, and Anderson (1965) with modification according to Crum (1971). Hepatic nomenclature follows Schuster

(1969), supplemented by Schuster (1953) with abbreviations of authorities amended to conform with the list of Sayre, Bonner and Culberson (1964). Vascular plant nomenclature follows Scoggan (1957).

Hepaticae

Calypogeia muelleriana (Schiffn.) K. Müll. (6). Three collections, two on humus mixed with well-rotted wood, and one on a rotten stump with *Lophocolea heterophylla, Cephalozia media* and *Hypnum pallescens.* Only once previously recorded for the province (Longton, 1972).

Cephalozia media Lindb. (6). One collection, on a rotten stump.

Cephaloziella rubella (Nees) Douin (4). On humus over rotten wood, with *Amblystegium juratzkanum, Chiloscyphus pallescens* and *Thuidium recognitum.*

Chiloscyphus pallescens (Ehrh.) Dum. (4). Only once previously recorded for the province, in Spruce Woods Provincial Park (Stringer & Stringer, *a,* in preparation).

Chiloscyphus polyanthus (L.) Corda (3, 4). On bark at the base of an aspen tree (3) with *Hypnum pallescens,* and on humus with *Distichium inclinatum.* Recorded previously only in Spruce Woods Provincial Park (Stringer & Stringer, in preparation).

Lophocolea heterophylla (Schrad.) Dum. (3, 6, 7,). On humus or rotten wood, often with *Pohlia nutans* or *Hypnum pallescens.* Previously recorded only in the Spruce Woods area by Bird (1969) and by Stringer & Stringer (in preparation).

Lophocolea minor Nees (6). On thick humus (dead *Aulacomnium palustre*), with *Pohlia nutans* and *Eurhynchium pulchellum.* Not previously recorded for the province.

Ptilidium ciliare (L.) Nees (5, 6, 7,). On loose humus or litter with *Dicranum* spp. and *Pleurozium schreberi.* One collection (7) on loose conifer needles over rock, with *Hedwigia ciliata.*

Ptilidium pulcherrimum (Web.) Hampe (7). One collection, on fallen birch bark.

Radula complanata (L.) Dum. (7) One collection, on packed humus at the base of a jack pine tree.

Riccardia pinguis (L.) S. Gray (4). On thick, moist humus mixed with silt, with *Myurella julacea, Amblystegium juratzkanum* and *Platydictya jungermannoides.* Previously recorded only in the Spruce Woods area by Bird (1969) and Stringer & Stringer (in preparation).

Sphagnobrya

Sphagnum capillaceum (Weiss) Schrank (6). In deep hummocks, with *Pleurozium schreberi.*

Eubrya

Amblystegium juratzkanum Schimp. (1, 2, 4, 5, 6, 7). On rotten wood or humus, especially at tree bases, where it was often found with *Pylaisiella polyantha* and *Brachythecium salebrosum.*

Amblystegium varium (Hedw.) Lindb. (1, 2, 6). On thick humus and rotten wood, with *Brachythecium* spp. and *Mnium cuspidatum.*

Aulacomnium palustre (Hedw.) Schwaegr. (4, 5, 6). On thick humus, in deep pure sods, or with *Pleurozium schreberi.* One collection (5) on rotting birch bark.

Brachythecium campestre (C. Müll.) B. S. G. (5, 6, 7). On humus, usually over well-drained sandy soil. Previously recorded in Manitoba only in the Winnipeg and Spruce Woods areas by Stringer & Stringer (1973) and Stringer & Stringer (in preparation).

Brachythecium rutabulum (Hedw.) B. S. G. (1, 2, 5, 6, 7). On humus or rotten wood in moist habitats. Previously recorded only by Mueller-Dombois (1964), Longton (1972), and by Stringer & Stringer (in preparation), in the Spruce Woods area.

Brachythecium salebrosum (Web. and Mohr) B. S. G. (1, 2, 3, 5, 6, 7). Common in many habitats, especially on tree bases.

Bryoerythrophyllum recurvirostrum (Hedw.) Chen (4). On thick humus, with *Amblystegium juratzkanum, Myurella julacea* and *Platydictya jungermannoides.*

Bryum angustirete Kindb. ex Mac. (1). On humus over sand, alone, and with *Encalypta procera*.

Bryum argenteum Hedw. (1, 3). On dry humus and sand. Often with *Funaria hygrometrica*.

Bryum creberrimum Tayl. (3, 5). On humus mixed with sand. Often with *Ceratodon purpureus*.

Bryum pallescens Schleich. ex Schwaegr. (1, 2, 3). On humus in moist habitats.

Bryum pseudotriquetrum (Hedw.) Gaertn., Meyer and Scherb. (2, 4). On thick, moist humus with *Campylium stellatum* and *Brachythecium rutabulum*.

Callicladium haldanianum (Grev.) Crum (5, 6, 7). On humus and moist rotten wood. Previously reported only in the Winnipeg and Spruce Woods areas by Bird (1969) and by Stringer & Stringer (*a*, in preparation).

Calliergon giganteum (Schimp.) Kindb. (4). On waterlogged litter, in large masses mixed with *Campylium stellatum*.

Campylium chrysophyllum (Brid.) J. Lange (4). On well-rotted wood and humus.

Campylium hispidulum (Brid.) Mitt. (4). One collection, on humus. with *Amblystegium juratzkanum*.

Campylium stellatum (Hedw.) C. Jens. (4, 6). On wet humus or litter, often with *Mnium affine* or *Thuidium delicatulum* var. *radicans*.

Ceratodon purpureus (Hedw.) Brid. (1, 3, 4, 5, 7). On humus over dry sand, with *Bryum* spp., *Funaria hygrometrica*, or *Polytrichum juniperinum*.

Dicranum bonjeanii De Not. ex Lisa (7). On thick humus over rotten wood, with *D. polysetum* and *Ptilidium ciliare*.

Dicranum drummondii C. Müll. (6, 7). In thick, deep, pure clumps on humus, or as small plants on rotten wood with such typical species of decayed wood as *Pohlia nutans* and *Tetraphis pellucida*.

Dicranum fuscescens Turn. (5, 7). On humus or rotten wood, usually in pure tufts.

Dicranun polysetum Sw. (4, 5, 6, 7). Common, especially in jack pine forests of the area. Forms deep pure tufts. Often found also with *Pleurozium schreberi.*

Distichium inclinatum (Hedw.) B. S. G. (4). Common in this collecting area and most often found with *Myurella julacea, Amblystegium juratzkanum,* and *Platydictya jungermannoides.* Several of the collections had mature capsules, and the large warty spores (35μ-40μ) distinguish this species from the closely related *Distichium capillaceum* (Grout, 1936).

Drepanocladus aduncus (Hedw.) Warnst. (1). On wet litter under willows.

Drepanocladus aduncus (Hedw.) Warnst. var. *polycarpus* (Bland. ex Voit) Roth (1, 2). More commonly found than the preceding, this variety occurred on moist humus or litter, often with *Leptodictyum riparium.*

Drepanocladus revolvens (Sw.) Warnst. (4). Several collections made on wet litter or humus, in pure mats or with *Pleurozium schreberi* and *Thuidium recognitum.*

Drepanocladus uncinatus (Hedw.) Warnst. (4, 5, 6, 7). On rotten wood or humus, in drier habitats than other members of the genus. With *Brachythecium* spp. and *Bryum* spp.

Encalypta procera Bruch (1). One collection, on thin humus over dry sand.

Eurhynchium pulchellum (Hedw.) Jenn. (4, 6, 7). On thick humus or litter in both wet and dry habitats.

Fissidens adianthoides Hedw. (4). One small collection, with *Campylium stellatum,* on loose, moist humus. Not previously recorded for the province.

Funaria hygrometrica Hedw. (1, 4, 5, 7). Frequent on sandy soil, often mixed with ashes of old fires. Commonly with *Bryum* spp., *Ceratodon purpureus,* and *Leptobryum pyriforme.*

Haplocladium microphyllum (Hedw.) Broth. (2, 3, 6, 7). Almost all collections on rotten wood but one collection (7) on humus.

Hedwigia ciliata (Hedw.) P. Beauv. (7). Several collections, all on humus over rock or loose conifer needles over rock.

Hylocomium splendens (Hedw.) B. S. G. (4, 6, 7). On litter and loose humus, often with *Pleurozium schreberi.*

Hypnum lindbergii Mitt. (4, 5, 6). Usually on wet, well-rotted wood or wet humus.

Hypnum pallescens (Hedw.) P. Beauv. (3, 5, 6, 7). Common on live and fallen bark of both conifers and hardwoods. Often associated with *Pylaisiella polyantha.*

Hypnum pratense Koch ex Spruce (1). One collection, on wet rotten bark with *Drepanocladus aduncus* var. *polycarpus.*

Isopterygium turfaceum (Lindb.) Lindb. (7). One collection, on thick humus over granite rock, with *Pohlia nutans* and *Brachythecium rutabulum.*

Leptobryum pyriforme (Hedw.) Wils. (1, 2, 4, 7). Common on a wide variety of substrates and with a wide range of associated species.

Leptodictyum riparium (Hedw.) Warnst. (1, 2). On wet humus or litter, often with *Drepanocladus aduncus* or *Amblystegium varium.*

Leptodictyum trichopodium (Schultz) Warnst. var. *kochii* (B. S. G.) Broth. (1, 2). On deadfall or humus in moist habitats.

Leskea polycarpa Hedw. (1, 2, 5). On bark or humus, found most often with *Amblystegium varium* or *Leptodictyum trichopodium* var. *kochii.*

Mnium affine Bland. ex Funck (4, 6). On wet humus or disintegrated rotten wood.

Mnium cuspidatum Hedw. (1, 2, 3, 5, 6). On humus, rotten wood or litter in drier habitats than *M. affine,* often alone, or with *Brachythecium salebrosum.*

Myurella julacea (Schwaegr.) B. S. G. (4). Common in wet habitats in this collecting area and often found with *Campylium stellatum* and *Aulacomnium palustre.*

Orthotrichum obtusifolium Brid. (3). One collection, on poplar bark, with *Hypnum pallescens.*

Orthotrichum speciosum Nees ex Sturm (3, 7). On live poplar bark, often with *Pylaisiella polyantha,* but persisting on deadfall even in advanced stages of decay where it often occurs with *Haplocladium microphyllum.*

Platydictya jungermannioides (Brid.) Crum (4). Fairly common in this collecting area, with *Myurella* and *Distichium.* Recorded only once previously for the province, as *Amblystegiella sprucei* (Bruch) Loeske, by Crum and Schofield (1959).

Pleurozium schreberi (Brid.) Mitt. (3, 4, 5, 6, 7). Common, and often forming large pure colonies in both wet and dry coniferous forests.

Pohlia nutans (Hedw.) Lindb. (5, 6, 7). Usually on well-rotted wood but sometimes (7) on humus.

Polytrichum juniperinum Hedw. (5, 6, 7). Usually on humus over sand in drier habitats.

Polytrichum piliferum Hedw. (7). One collection on humus over sand.

Ptilium crista-castrensis (Hedw.) De Not. (5, 7). Usually a forest floor species of dry coniferous forests in the area, occurring on loose humus or needle litter over sand.

Pylaisiella polyantha (Hedw.) Grout (2, 3, 5, 6, 7). Common with *Orthotrichum speciosum,* especially on bark of live hardwoods, but also on humus (6, 7) or at the base of jack pine (5).

Tetraphis pellucida Hedw. (6). On well-rotted wood, with *Pohlia nutans* and *Drepanocladus uncinatus.*

Thuidium delicatulum (Hedw.) B. S. G. var. *radicans* Crum, Steere & Anderson (4). On loose wet humus and litter with *Hypnum lindbergii, Campylium stellatum* and *Tomenthypnum nitens.*

Thuidium recognitum (Hedw.) Lindb. (4, 6). On loose humus and needle litter in wet or moist habitats.

Tomenthypnum nitens (Hedw.) Loeske (4). On loose, wet humus and litter.

Tortula ruralis (Hedw.) Gaertn., Meyer & Scherb. (7). On thin humus over sand.

DISCUSSION

A search of the literature reveals that little work has been done on the bryophytes of Manitoba. Bird (1966), who gives a comprehensive list of the recordings for the province, lists only 289 taxa of bryophytes for the whole of Manitoba. This list has been somewhat augmented by Bird (1969) and Longton (1972), but published work on the bryophyte flora of the province is still greatly lacking. This situation is especially unfortunate as Manitoba is particularly interesting from a phytogeographic point of view, lying as it does at a "crossroads of floral elements, from both north and south, east and west" (Löve, 1959).

Approximately half of the species recorded in the present study are pan-North American in distribution, according to the designations given by Bird (1969) and Bird and Won Shic Hong (1969). However, the Boreal element is represented by species such as *Dicranum fuscescens, D. polysetum, Tetraphis pellucida, Myurella julacea, Thuidium delicatulum* var. *radicans, Thuidium recognitum, Pleurozium schreberi, Ptilium crista-castrensis,* and *Pylaisiella polyantha.* The Arctic Boreal element is represented by *Dicranum bonjeanii, Bryoerythrophyllum recurvirostrum, Bryum pallescens, Orthotrichum speciosum, Calliergon giganteum, Campylium stellatum, Eurhynchium pulchellum, Tomenthypnum nitens, Hylocomium splendens, Polytrichum juniperinum,* and *Polytrichum piliferum.* A few Eastern Boreal species are also present, i.e. *Dicranum drummondii, Leptodictyum trichopodium* var. *kochii* and *Callicladium haldanianum.*

The hepatics are largely pan-North American species. *Cephaloziella rubella,* however, is Boreal and *Ptilidium ciliare* is Arctic Boreal (Bird & Won Shic Hong, 1969). *Calypogeia muelleriana* and *Cephalozia media* have been previously recorded only from the north-east part of the province, from Churchill and York Factory respectively (Longton, 1972). The only previous record of *Cephaloziella rubella* was from Spruce Woods Provincial Park (Stringer

& Stringer, in preparation). *Lophocolea minor,* recorded from Grand Beach as new to the province, has since been found at several stations in Birds Hill and Whiteshell Provincial Parks, where *Radula complanata* is also quite frequent. *Riccardia pinguis* has only two previous records, both from Spruce Woods Provincial Park, although subsequent work by the authors shows that it is common on the calcareous clays of the southern part of the province. All of these liverworts are probably much more widely distributed throughout the province than the scant records indicate.

Several moss species which, according to the literature, should have a wide distribution have few records in Manitoba. This is especially true of *Brachythecium* spp., perhaps because of the apparent scarcity of fertile material and the consequent difficulty in making a positive identification. *Brachythecium rutabulum,* common in the Grand Beach area studied, was reported as new to the province by Longton (1972), although Mueller-Dombois (1964) described it as one of the mosses forming the typically continuous carpet in one of the jack pine — black spruce forest types in southeastern Manitoba. The only other records of *Brachythecium campestre* are also from the southern part of the province (Stringer & Stringer, in preparation, 1973) although this species appears to have a pan-North American distribution.

Callicladium haldanianum, reported for the first time in the province by Bird (1969) as *Heterophyllium haldanianum* (Grev.) Kindb., reaches its western limit in Manitoba. The Grand Beach record is further north than either of the Bird records.

Fissidens adianthoides, a new record for Manitoba, appears to be rare in western Canada (Bird 1966), although Grout (1936) gives its distribution as from Cape Breton Island to Vancouver Island and south to California and Florida.

It is intended that the information presented in this study should, in conjunction with information presented in further papers in this series, assist in describing the bryophyte flora of Manitoba and its relationships with the floras of adjacent regions.

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SOME NEW OR NOTEWORTHY VASCULAR PLANT RECORDS FROM NORTHWESTERN SASKATCHEWAN

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During the course of recent botanical studies in northwestern Saskatchewan, several new or otherwise interesting plant records were collected. Most of these were collected from along the Green Lake-La Loche Road during a study supported by the Institute for Northern Studies, University of Saskatchewan, or from the Lake Athabasca area. The purpose of this paper is to comment on these records in order to make this information generally available to taxonomists and phytogeographers. The collection numbers are those of the senior author unless otherwise indicated. All specimens cited have been deposited in the Fraser Herbarium, University of Saskatchewan (SASK).

SPARGANIUM CHLOROCARPUM Rydb. 7 mi. s.-s.e. of La Loche, Mile 60 Buffalo Narrows-La Loche Road, *Harms* 17635; McAneely Creek, 2 mi. s.w. of Turnor Lake village, *Harms* 18390; Bear Creek, Mile 41 Buffalo Narrows-La Loche Road, *Harms* 19661.

This species has never been listed for Saskatchewan by Fraser and Russell (1937), Fraser and Russell (revised by Russell, Ledingham and Coupland (1954)), or Breitung (1957). The specimens of the species were for the most part confused with *Sparganium multipedunculatum.* While a taxonomic problem exists between the two taxa, and evenually both of them, together with *S. angustifolium,* may be merged as varieties under an enlarged *S. simplex,* there is no question that many of our specimens best fit *S. chlorocarpum* as it is now recognized. Other specimens in the Fraser Herbarium now identified as *S. chlorocarpum* include the following:

Melfort, *J. B. Millar* 64-163, 64-12; Saskatoon, *J. H. Hudson* 2488, 2548, *J. B. Millar* 65-217, *W. P. Fraser* 1930;

Pike Lake, 20 mi. s. of Saskatoon, *W. P. Fraser* 1 Sept. 1937, *R. C. Russell, et al.*, 4 August 1937; St. Denis, *J. B. Millar* 62-72; W. of Whitefox, *W. P. Fraser & G. F. Ledingham* 28 July 1936; Swift Current, *J. L. Bolton* 8 July 1936; Dahlton, *W. P. Fraser and G. F. Ledingham* 20 July 1937; Egg Creek, s. of Cumberland House, *G. H. Townsend* 55; Waskesiu, *W. P. Fraser* 24 July 1938; Lake Waskesiu Road, *W. P. Fraser* July 1932; Mile 23 Waskesiu Road to Prince Albert, *W. P. Fraser* 24 August 1934; Meadow Lake Provincial Park, Waterhen River, *J. H. Hudson* 2427; Sylvan Lake, Candle Lake Road, *J. K. Jeglum* 18 July 1964; 1.7 mi. n. of forks at Candle Lake, *J. K. Jeglum* 9 July 1964.

CALAMAGROSTIS LAPPONICA (Wahl.) Hartm. 3 mi. s. of La Loche, Mile 64 Buffalo Narrows-La Loche Road, *Harms* 17532, 17565; 2 mi. s. of La Loche, Mile 65 Buffalo Narrows-La Loche Road, *Harms* 17547, 17543; Island in William River, south shore Lake Athabasca, *R. Hermesh* 485; Thompson Bay, south shore of Lake Athabasca, *R. Hermesh* 582.

This northern species has never been previously reported for Saskatchewan. There seems to be intergradation between *Calamagrostis lapponica* and *C. neglecta* (Ehrh.) Gaertn. as indicated by an intermediate collection from Taylor Lake, Mile 19 Buffalo Narrows-LaLoche Road (18160), and between *C. lapponica* and both *C. neglecta* and *C. inexpansa* A. Gray as indicated by intermediate specimens from the same area (18142, 18147). The whole *C. lapponica, C. neglecta,* and *C. inexpansa* complex appears in need of careful taxonomic study.

CAREX ADUSTA Boott. Turnor Lake, *Harms* 18364-B, 18361-A.

In the Fraser Herbarium, there are three specimens from the Waskesiu area or the road to Montreal Lake, Prince Albert National Park (*W. P. Fraser* July 8, 1939, June 25, 1940, June 22, 1941). This species has been collected by J. H. Hudson at Flin Flon, Manitoba, near the Saskatchewan border. Breitung (1957) reports it also from Meadow

Lake but a substantiating voucher is missing from the Fraser Herbarium. The above record represents a considerable northwestward range extension in Saskatchewan.

CAREX RUFINA Drej. Beach at Thomson Bay, south shore Lake Athabasca, *R. Hermesh* 421.

This represents the first report for this species in Saskatchewan. Characteristic material of this species comes from Greenland and Iceland. Scoggan (1957, p. 179) relates that A. E. Porsild collected typical material from southern Keewatin, Northwest Territories, while Baldwin found abberrant material at Nueltin Lake, northern Manitoba, about 125 miles south of Porsild's station. Porsild has annotated Baldwin's sheet as follows: "Differs from typical *C. rufina* by paler scales having more prominent midveins, paler and more prominently nerved perigynia, and by terminal spikelets being not so strictly gynaecandrous (in some even androgynous). Perigynia only rarely with a few teeth in the upper part." The present Lake Athabasca material agrees well with the characters mentioned in these statements. This collection represents about a 350 mile westward range extension for the species.

HABENARIA ORBICULATA (Pursh) Torr. Lac La Plonge, 5 mi. e. of Beauval, *Harms* 17959-B.

In the Fraser Herbarium there are specimens of this species from Big Sandy Lake, Hansen Lake Road (*G. W. Argus* 4237), from La Ronge (*J. S. Maini* 611), and from Pinkney Lake, 35 mi. n.e. of Candle Lake (*J. M. A. Swan* 65-45). Breitung (1957) also reports it from Torch River and Amisk Lake, the latter based on a collection by J. H. Hudson. The present record is the first one from the western part of the province and represents a considerable westward extension of the main species range. It is disjunctly present in British Columbia.

SPIRANTHES GRACILIS (Bigel) Beck. (*S. lacera* Raf.). Little Amyot Lake area, Mile 69 Green Lake-Buffalo Narrows Road, *Harms* 17736; 2 mi. e. of Beauval, *Harms*

17776; Taylor Lake, Mile 19 Buffalo Narrows-La Loche Road, *Harms* 18139-B.

There are specimens of this species in the Fraser Herbarium from Lake Waskesiu, Prince Albert National Park (*Anonymous* July 1932) and from 20 miles south of Meadow Lake (*A. J. Breitung* 8164). The above records amplify the known range of the species and extend it to northwestern Saskatchewan.

SPERGULA ARVENSIS L. 2 mi. w. of Beauval, *Harms* 17846.

Breitung (1957) does not report this plant for Saskatchewan, and Scoggan (1957) does not report it for Manitoba. Boivin (1968) listed this species as doubtful for Saskatchewan. Hudson (1972) reported it as new to Saskatchewan on the basis of a collection from Gronlid (*B. Zuk* 1971, DAO). Boivin, in personal correspondence to J. H. Hudson, indicated the presence of an earlier collection from Sylvania (*K. Drake* July 26, 1966, DAS). Mrs. H. D. Bobier recently sent a collection of the species from Rapid View (west of Meadow Lake) to J. H. Hudson. A map by J. F. Alex indicates two infestations of this weed near Outlook, Saskatchewan but these are not substantiated by voucher specimens. Thus the above record represents only the fourth report for Saskatchewan and the only one from this far northwest in the province.

CALTHA NATANS Pallas. 7 mi. s.-s.e. of La Loche, Mile 60 Buffalo Narrows-La Loche Road, *Harms* 17633.

There are no Saskatchewan specimens of this species in the Fraser Herbarium. Breitung (1957) reported it from Windrum Lake (56°02′N, 104°W) and Amisk Lake, the latter based on a collection by J. H. Hudson. The present collection presumably represents the third report for Saskatchewan.

RANUNCULUS HYPERBOREUS Rottb. Open beach, William's Point, south shore Lake Athabasca, *R. Hermesh* 415.

This represents the first record of this northern buttercup species in Saskatchewan.

MYRIOPHYLLUM ALTERNIFLORUM DC. Little Amyot Lake, Mile 70 Green Lake-Buffalo Narrows Road.

Breitung (1957) omits this species from his list of Saskatchewan plants. Boivin (1968) reports only 3 collections from the prairie provinces: Cochrane River, Reindeer Lake, and Lake Axis. The present collection would therefore represent only the second Saskatchewan record for the species.

EUPHRASIA ARCTICA Lane var. DOLOSA Boivin (*E. subarctica* Raup, *E. disjuncta* Fern. & Wieg. var. *dolosa* Boivin). 2 mi. s. of La Loche, Mile 65 Buffalo Narrows-La Loche Road, *Harms* 17550.

In the Fraser Herbarium, the only Saskatchewan specimen of this species is from Stony Rapids, north of Fond-du-lac River (*J. S. Maini & M. Swan* Aug. 3, 1961). Breitung (1957) cites a Raup report from Lake Athabasca. The above record represents about a 200 mile southward range extension for the species in Saskatchewan.

LOBELIA DORTMANNA L. Little Amyot Lake, Mile 70 Green Lake-La Loche Road, *Harms* 16972.

In the Fraser Herbarium we have specimens of this species from Little Gull Lake, south shore Lake Athabasca (*G. W. Argus* 553-63) and Carswell Lake, 40 mi. south of Lake Athabasca (*G. W. Argus* 628-62). Breitung (1957) reports the species also from Windrum Lake, north of the Churchill River, 56°02′N, 104°W. Therefore, the above record represents the third general locality for the species in Saskatchewan.

ADOXA MOSCHATELLINA L. 17 mi. n. of Meadow Lake, *J. H. Hudson* 2729 (SASK).

Boivin (1972, p. 5) reports this species in Saskatchewan from Pasquia Hills and Candle Lake; the latter specimen, which he collected, was the first record for Saskatchewan. The present material is evidently the third record of the species for the province and represents more than a 100 mile westward range extension in the province.

ANAPHALIS MARGARITACEA (L.) B. & H. 3 mi. s. of Buffalo Narrows, Mile 124 Green Lake-Buffalo Narrows Road, *Harms* 18244.

There are various specimens of this species in the Fraser Herbarium from the Cypress Hills area of Saskachewan. Breitung (1957) reports it also from Cut Knife but a substantiating voucher has not been found. Therefore the above record represents at least a 200 mile, if not a 300 mile northward range extension.

BIDENS BECKII Torr. Little Amyot Lake, Mile 70 Green Lake-Buffalo Narrows Road, *Harms* 16978.

There are two specimens of this species in the Fraser Herbarium from the Cumberland House area on the Saskatchewan River (*A. E. Etter* Aug. 8, 1934; *D. Dabbs* 126-66) in east-central Saskatchewan. The above report therefore represents the second known Saskatchewan locality for the species and is a considerable westward range extension in the province.

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PARASITIC WITCHWEED: STRIGA ASIATICA VERSUS S. LUTEA (SCROPHULARIACEAE)

F. N. HEPPER

When plants of a witchweed were discovered in 1956 parasitizing *Zea mays* L. in North and South Carolina, specimens were sent to Kew for identification. I determined them as *Striga asiatica* (L.) O. Kuntze and communicated the name to Dr. S. F. Blake and other authorities in the United States, who used it until a paper by Dr. C. J. Saldanha (1963) proposed the rejection of that name in favour of *S. lutea* Lour. (Smith 1966). The purpose of this paper is to reinstate *S. asiatica* on the basis of typification of the Linnean basionym *Buchnera asiatica,* rather than on the opinions of other taxonomists.

Linnaeus' description of *Buchnera asiatica* in 'Species Plantarum' (1753) is unusually full for that work and entirely devoid of any references to literature. This indicates that he had before him a specimen, or specimens, from which he drew up his description. Examination of his herbarium at the Linnean Society, London, revealed six sheets bearing the name *'Buchnera asiatica'* in Linnaeus' hand and now numbered according to Savage's Catalogue as 790/10, 11, 12, 13, 14, & 15.

Sheets 13, 14 and 15 can be discounted, since they are annotated as having been collected by Thunberg (13) sometime after 1772, and by Koenig (14 & 15) in 1777 according to the date on the sheet. They are referable to *Striga bilabiata* (Thunb.) O. Kuntze (syn. *S. thunbergii* Benth.) and *S. euphrasioides* Benth., respectively.

Sheet 12 bears a single simple plant with pale flowers that would be known in India as *Striga lutea.* The only annotation on the sheet is 'Indica,' indicating its country of origin. The specimen does not fit Linnaeus' description, and it can be ruled out as the type.

Five specimens are glued to sheet 10, including a well-branched plant with dark-coloured flowers that fits the original description admirably. Two other specimens match it except for their simple habit. The remaining two are only the inflorescences of *Striga densiflora* Benth. The specimen on sheet 11 is very similar to the large branched one on sheet 10, but there is no annotation apart from the name. On sheet 10, however, Linnaeus has added the locality "ins. Johan.," and although the 'Species Plantarum' cites the distribution as "Habitat in Zeylona, China" this reference to "ins. Johan." provides a clear indication of the provenance and history of what must be regarded as the type material of *Buchnera asiatica*. Where, then, is "ins. Johan." and who collected the specimen?

Several voyages to China were undertaken before 1753, including one by Peter Osbeck who wrote an account of it in Swedish (1757) which was translated into German (1765) and from the German edition into English, and published in 1771 under the title 'A voyage to China and the East Indies, together with a voyage to Suratte by Olof Toreen in a series of letters to Doctor Linnaeus.' Toreen (or Torén), in fact, continued his voyage as far as China and it is his letters, and not Osbeck's text, which are of particular interest since he tells (p.166) how, on 16 August 1750, he landed at the island of "St. Joanna" in the Comoros near Madagascar. It is evident that Linnaeus worked out the collections made by Toreen and Osbeck, attributing them all to China in the appendix to Osbeck and Toreen's travels entitled 'Flora Sinensis.' There, on p. 356, is listed *Buchnera asiatica* with the reference to 'Species Plantarum.' It is interesting to note that the same island was visited by Koenig in 1768 where he gathered the plant Linnaeus (1771) described as *Baccharis arborea* (which Brenan (1968) identified as *Vernonia grandis* (DC.) Humbert var. *comorensis* Humbert), yet Linnaeus gave the occurrence as the "East Indies."

Striga asiatica (L.) O. Kuntze, Rev. Gen. Pl. 2: 466. 1891. Type. Comoro Islands, St. Joanna, *Toreen* LINN. (Savage Cat. No. 790/10 partly).

Buchnera asiatica L., Sp. Pl. 630. 1753.
Striga lutea Lour., Fl. Cochinch. 22. 1740.
Buchnera hirsuta Benth., Scroph. Ind. 41. 1835.
Striga hirsuta (Benth.) Benth. in Hook., Comp. Bot. Mag. 1: 363. 1836.

Bentham's work was completed long before an international code of botanical nomenclature had been agreed, and certainly his concepts of typification were not in accord with modern attitudes. Hence, he coined the new names to replace *Buchnera asiatica* which seemed to him, as to Saldanha, to apply to a number of different species. The more so since he considered *S. lutea* Lour. to be a distinct species.

Saldanha considered *Striga asiatica* and its basionym as *nomena rejicienda* under Art. 69 since "any attempt to decide a lectotype is bound to be arbitrary and open to question." On the contrary, this species is one of the few Linnean species that may be typified and localized with certainty.

I am grateful to my colleague Mr. R. D. Meikle for his helpful advice and assistance.

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CACALIA RUGELIA: A NEW COMBINATION FOR A NORTH AMERICAN SENECIONOID*

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The problematic taxon long-called *Senecio rugelia* (Shuttl. ex Chapman) A. Gray (Compositae) is a distinctive species occurring in coniferous associations along the higher ridges of the Great Smokies astride the North Carolina-Tennessee border. It is a tall, coarse herb with several conspicuous discoid heads and dull, dirty-white corollas. The species was introduced to science as *Rugelia nudicaulis* Shuttl. ex Chapman in 1860, but in 1883 Asa Gray transferred it to *Senecio*, where it has remained.

Many botanists have recognized the incongruity of including this entity in *Senecio*, but the morphological tolerances of *Senecio* have been usually treated as very wide, and so the matter has not been pursued. However, Greenman (1901) and Alexander (1937) noted the possible relationship to *Cacalia*.

The species referable to *Cacalia* have had their systematic woes, being variously regarded as constituting several genera, or as members of the single genus *Cacalia*, or as a part of *Senecio*. Compounding these difficulties has been a disagreement concerning the typification of the name *Cacalia*. A review of these matters is beyond the scope of this paper, but we are treating *Cacalia* in the expanded sense, and we accept *Cacalia hastata* L. as the generic type (Vuilleumier & Wood, 1969).

In general, *Cacalia* differs from *Senecio* by the two floral features of discoid heads and white to creamy corollas. Both are features which occur independently as evolutionary tendencies in other alliances within *Senecio*. In *Cacalia*, however, the two occur together, presumably defining a natural assemblage.

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Cacalia is here regarded as a derivative of *Senecio* section *Palmatinervii* of Mexico, a group of coarse herbs strongly resembling *Cacalia* in aspect. Nearly all species of the *Palmatinervii* for which chromosome counts are reported have $n=30$ (Gibson, 1969). *Cacalia* has $n=30$, and a reduction series of $n=28$, 27, 26, 25, and 20 (Ornduff et al., 1963, 1967). The species here offered as *Cacalia rugelia* has $n=28$, a number unreported for *Senecio* (Fedorov, 1969).

In a recent study of Mexican cacalioids, Pippen (1968) recognizes four genera, but he offers a table summarizing the distinctions between these "Cacalioid genera" and *Senecio* (table 2, p. 371). Incorporated into the table are the cacalioid features of discoid heads and white or creamy florets. The table also shows that the "Cacalioid genera" characteristically have deeply lobed disk corollas, a feature which we find in *Cacalia rugelia* as well. Furthermore, in Pippen's key the present species falls into the assemblage treated as the Mexican segregate-genus *Odontotrichum*, and it is morphologically compatible with that group. The floristic relationships between the Southern Appalachian region and some of the mountains of Mexico have been noted by other authors (e.g. Sharp, 1946).

In the light of the foregoing considerations, the following transfer is proposed:

Cacalia rugelia (Shuttl. ex Chapman) Barkley & Cronquist, comb. nov.

Type: "Smoky Mountains, Tennessee. *Rugel, Buckley.*" Paratype: *Buckley*, NY!

Senecio rugelia A. Gray, Proc. Am. Acad. **19**: 54. 1883.

Rugelia nudicaulis Shuttleworth ex Chapman, Fl. S. U. S. 246. 1860.

non *Cacalia nudicaulis* (Less.) O. Kuntze, 1891.

non *Senecio nudicaulis* Buck.-Ham. ex D. Don, 1825.

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TYPIFICATION AND APPLICATION OF THE NAMES SCIRPUS AMERICANUS PERS., S. OLNEYI GRAY, AND S. PUNGENS VAHL

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The names *Scirpus americanus* Pers. (Syn. Pl. 1: 68. 1805) and *Scirpus pungens* Vahl (Enum. Pl. 2: 255. 1805) are usually applied to the same species by Cyperologists (Beetle, 1947; Koyama, 1963). The former name for plants commonly known as Three-square in North America presently receives widespread usage because of priority. Data from type specimens and original descriptions now make it apparent that these names should be applied to different species. The type of *S. americanus* (Hab. in Carolinâ inferiore, Herb. Michx., P) is conspecific with plants usually treated (Beetle, 1947; Koyama, 1963) as *S. olneyi* Gray (Bost. Journ. Nat. Hist. 5: 238. 1845). The type of *S. pungens* (Erhart misit, Herb. Vahl, C) is conspecific with plants usually treated (op. cit.) as *S. americanus*.

In his original description of *Scirpus americanus*, Persoon cites Michaux's description of *S. triqueter* L. (Fl. Bor.-Am. 1: 30. 1803.) and gives the habitat as "in Carolina inferiore." The specimens on the sheet thus named and labeled in Michaux's herbarium at P have strongly winged culms, short involucral bracts, shallowly cleft scales, small achenes, and broad bristles characteristic of plants resembling the type of *S. olneyi* (Rhode Island, Providence, *Olney*, GH). Thus the correct name for plants usually treated as *S. olneyi* is *S. americanus*.

In the original description of *Scirpus pungens*, Martin Vahl gave the habitat as, "in Europa, in insula Borboniae. Commerson." The specimen from Vahl's herbarium designated as the type probably was collected in Europe and also contains the word "pungens Vahl" presumably in the handwriting of Jens Vahl, son of Martin Vahl. No specimen labeled, "in insula Borboniae," or collected by Commerson has been located. The triangular culms, long involucral bracts, deeply cleft scales, and narrow bristles are characteristics of plants usually but incorrectly treated as *S. americanus*. *Scirpus pungens* is the earliest available name for these plants.

The literature cited by Vahl is also in accordance with his description and the designated type specimen. The cited illustrations of Morrison (Pl. Hist. Univ. Oxon. s. 8, t. 10, f. 20. 1699.) and Plukenet (Algm. Bot. t. 40, f. 1. 1696.) closely resemble the type specimen of *Scirpus pungens*. Roth's descriptions of *S. mucronatus* L. (Tent. Fl. Germ. 1: 23. 1788, and 2: 60. 1789.) and *S. triqueter* L. (Neue Beytr. 1: 91. 1802.) cited by Vahl best apply to plants resembling the type specimen of *S. pungens*. Apparently Roth was confused about the identity of *S. mucronatus* and *S. triqueter*, and incorrectly applied the names to plants of *S. pungens*.

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I am grateful to H. Heine (P), J. Raynal (P), and A. Skovsted (C) for courtesies enabling me to examine critical specimens and data at their respective institutions, and to John Braxton (PH) and Helena Greenwood (PH) for their assistance. Abbreviations of institutions are those given by Lanjouw and Stafleu (1964).

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THE CORRECT AUTHORITY FOR CARDAMINE CLEMATITIS (CRUCIFERAE)

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The most recent entry in the literature of *Cardamine clematitis* appears on page 508 of the *Manual of the Vascular Flora of the Carolinas* by Radford, Ahles and Bell (1968). They cite "Shuttlew." as the authority for this taxon. This authority refers to Robert James Shuttleworth, a famed naturalist and collector who was the sponsor of Ferdinand Rugel, a prolific plant collector in eastern North America from 1840 and for many years thereafter until his death in 1879.

The various references in the literature to *Cardamine clematitis* have consistently overlooked the fact that Shuttleworth cannot be cited as the sole publishing authority for the specific epithet, *clematitis.* In addition to Radford, Ahles and Bell (1968), several other earlier North American references also provided descriptions and occasionally illustrations of *C. clematitis,* and all accepted Shuttleworth as the sole publishing authority. These include: Chapman, *Flora of the Southeastern United States,* ed. 2, Supplement p. 605. 1887; *ibid.,* ed. 3, p. 25. 1897; Britton & Brown, *Illust. Flora of the Northern United States and Canada,* ed. 1. 2: 130. *fig. 1730.* 1897; *ibid.,* ed. 2. 2: 185. *fig. 2088.* 1913; Small, *Flora of the Southeastern United States,* ed. 1, p. 482. 1903; *ibid.,* ed. 2, p. 568. 1933; Fernald in Gray's *Manual of Botany,* p. 721. 1950; Gleason and Cronquist *in* Britton and Brown, *Illust. Flora of the Northeastern United States and Adjacent Canada* 2: 230, *fig. p. 231.* 1952; Gleason & Cronquist, *Manual of Vascular Plants of Northeastern United States and Adjacent Canada,* p. 340. 1963; and Radford, Ahles and Bell, *Guide to the Vascular Flora of the Carolinas,* p. 173. 1964.

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In the course of evaluating the Ferdinand Rugel collections in the Isaac C. Martindale Herbarium at the U.S. National Arboretum, F. G. Meyer called my attention to an unidentified specimen of *Cardamine* collected by Rugel and accompanied by a signed holograph label that reads "Top of Smoky Mts. on the first Branch Nord Carolina Side. May 1866." Although this Rugel specimen clearly represents *C. clematitis,* it is not a part of the type.

The first published reference to *Cardamine clematitis* is on page 53 of Sereno Watson's *Bibliographic Index to North American Botany* (Smithsonian Miscellaneous Collections No. 258, 1878) that reads as follows: "*C. clematitis* Shuttl. in Herb. Gray, ined." It is evident that Watson took the name from Shuttleworth's printed herbarium *exsiccata* label which reads "*Cardamine clematitis* Shuttle. n. sp." and that name was used only as a *nomen nudum.* Watson's reference does not incorporate a validating description. On this basis alone, *clematitis* cannot be used as a valid specific epithet. It is listed, however, in *Index Kewensis* 1: 421. 1895 as: "*Clematitis* Shuttle. ex S. Watson"!

Later, in a paper by Asa Gray entitled "Some New North American Genera, Species, &c." (Proc. Am. Acad. Arts Sci. n.s., 7:45. 1880, a valid Latin description is provided. Gray precisely identified the plant as "*Cardamine clematitis* Shuttleworth in coll. distrib. Rugel," and explains that the original collection was from "wet ground along streamlets in the higher Iron or Smoky Mountains of North Carolina and Tennessee, collected in 1844 by Rugel . . ."

When dealing with nomenclatural problems of this nature, we are guided by Article 46 and its accompanying recommendations (particularly Recommendation 46C) in the *International Code of Botanical Nomenclature,* p. 46. 1972. The correct authority citation for *Cardamine clematitis* is *C. clematitis* Shuttleworth ex A. Gray, although it may be shortened, particularly in floristic treatments, to cite only the publishing author. Under no circumstances can Shuttleworth be assigned solitary authorship. The correct citation of the name is:

Cardamine clematitis Shuttleworth ex A. Gray, Proc. Amer. Acad. Arts Sci., new series, 7: 45. 1880 — non Shuttl. ex Watson, *Bibliog. Index North American Bot.*, p. 53, 1878.

The original collection and designated type of *Cardamine clematitis* is Rugel No. 19 collected in 1844 in the Smoky Mts. of Tennessee. The holotype is deposited at GH, and cited duplicates (isotypes) are to be found at G-Herb. Boissier and W.

TYPE: Tennessee, Smoky Mountains ["in locis humidis et ad regionis super. montium Smoky Ms., Tennessee, Mai 1884."] May 1844, *Ferdinand Rugel* No. 19 (holotype, GH; isotypes BM, G, W).

The most complete set of Rugel's material, purchased from Shuttleworth, is at the British Museum; however, reference to the existence of such a specimen has not previously appeared in the literature. N. K. B. Robson of the British Museum (Natural History) assures me that a duplicate is retained at BM.

The one Rugel collection of *Cardamine clematitis* not previously reported in the literature is a specimen collected, probably a unicate, after Rugel's professional contacts with Shuttleworth had ceased. The specimen was maintained in Rugel's personal herbarium until that herbarium was purchased in 1881 from Rugel's heirs by Isaac C. Martindale: North Carolina: "Top of Smoky Mts. on first Branch, Nord Carolina Side", *Ferdinand Rugel,* May 1866 (NA — from herbarium of Isaac C. Martindale).

The astute monographer of *Cardamine* and indefatigable expert on the Cruciferae, D. E. Schulz, in "Monographie der Gattung *Cardamine*" (Bot. Jahrb. 32: 440. 1903.) recognized Shuttleworth as responsible for the epithet *clematitis,* but also recorded that Asa Gray provided a description of the species in Proc. Am. Acad. Arts Sci., n.s. 7: 45. 1880. Schulz examined the original 1844 material of *C. clematitis* collected by Rugel (GH, G & W — but not BM), which was annotated and distributed by Shuttleworth; he also cited numerous additional collections made by J. K. Small, N. L.

& E. G. Britton & A. M. Vail, S. B. Buckley, J. K. Small & A. A. Heller, W. M. Canby, M. E. Hyams and J. W. Chickering.

SYNONYMS OF CARDAMINE CLEMATITIS

A point should also be discussed that concerns the synonomy of *Cardamine clematitis* Shuttleworth ex A. Gray as presented by the Radford, Ahles and Bell publications (1964 & 1968). These works refer *"C. flagellaris"* (= *C. flagellifera* Schulz, Bot. Jahrb. 32: 405. 1903.) into synonomy under *C. clematitis*. Although the type specimen of *C. flagellifera* (*Biltmore Herbarium* 7756) was originally annotated as *C. clematitis*, it is not conspecific with *C. clematitis*. Not only does *C. flagellifera* stand morphologically and ecologically distinct from *C. clematitis*, but it was also assigned by Schulz within *Cardamine* to Sect. Macrophyllum, whereas *C. clematitis* was referred by Schulz to the typical section. Small (1903) described *C. hugeri* that Radford, Ahles & Bell (1964 and 1968) sank under *C. clematitis*. However, if referrable into synonomy at all, *C. hugeri*, a low altitude plant, more logically pertains to *C. flagellifera*.

In Watson's reference (*loc. cit.*) to *Cardamine clematitis*, he cites as a synonym a *"Nasturtium officinale"* that appeared in the Supplement to Torrey and Gray, *A Flora of North America* **1**: 666. 1843. In addition to validating, describing and typifying *C. clematitis*, Gray (*loc. cit.*) explains Watson's confusion in incorrectly citing this *"Nasturtium officinale"* as a synonym of *C. clematitis*. The original Rugel material, annotated and distributed from Switzerland by Shuttleworth, was a mixed collection. A part representing *C. clematitis* "was mixed up with a Florida species intermediate between *Cardamine* and *Nasturtium*, first received from Leavenworth without fruit, and referred in the supplement to the first volume of Torrey and Gray's Flora to *N. officinale*." This element of *"Nasturtium officinale"*, according to Gray, was later received from S. B.

Buckley; again later received from Shuttleworth's distributed collections of Rugel as *Cardamine curvisiliqua* Shuttleworth; and yet again received from Shuttleworth as *Nasturtium stylosum* Shuttleworth! The current fate of Leavenworth's *"Nasturtium officinale"* is not within the scope of this paper; however, both Chapman (1887) and Small (1903) equate Leavenworth's *"Nasturtium officinale"* with *Cardamine curvisiliqua* Shuttleworth.

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A NEW FORM OF DIGITARIA SANGUINALIS. As a result of extensive field work in east-central Illinois an unusual form of the common crabgrass was found. This form differs from typical *Digitaria sanguinalis* (L.) Scop. in that long, spreading, papillose-based hairs are found scattered along both sides of the flattened rachis. These colorless hairs are 3-6 mm long (rarely 1 cm long) and on the specimens examined usually 1 to 5 hairs are found on each cm of rachis length. As a result of this difference the following form is described.

Digitaria sanguinalis (L.) Scop. forma **illinoensis** Ebinger forma nova.

A forma *sanguinalis* differt pilis base papillosis in rhachidi. TYPE: ILLINOIS: DOUGLAS CO.: 4 miles east of Hindsboro, Sargent Twp. (NE¼, Sect. 3, R10E, T14N), in open field at edge of road, *J. E. Ebinger* 6845 (EIU). This area was revisited on 9 October 1969 and a second collection (*J. E. Ebinger* 9282) was made at that time (EIU, ISM).

Long, papillose-based hairs are known in a few species of *Digitaria*. The presence of these hairs is an important diagnostic characteristic used by Hitchcock (1935), Henrard (1950), and many others to separate the tropical *Digitaria horizontalis* Willd. from other members of the genus. The hairs in this species are similar in all respects to those found in *D. sanguinalis* f. *illinoensis*. The two taxa are easily separated however, since in *D. horizontalis* the nearly glabrous spikelets are usually less than 2.4 mm long, extremely narrow and with an acuminate apex while *D. sanguinalis* has pubescent spikelets that are longer (2.5-3.5 mm long) and broader and with an acute apex. The only other closely related taxon in which these hairs have been reported is *D. adscendens* (HBK) Henrard var. *rhachiseta* Henrard. The differences between this taxon and *D. sanguinalis* have been studied by Ebinger (1962, 1965).

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THE GROWTH OF SOME NEW ENGLAND PERENNIAL SEAWEEDS

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Growth studies on *Fucus vesiculosus* L., *Ascophyllum nodosum* (L.) LeJolis, *Rhodymenia palmata* (L.) Greville, *Laminaria digitata* (L.) Lamouroux and *Laminaria saccharina* (L.) Lamouroux were initiated at Dover Point, Dover, New Hampshire and Jaffrey Point (Fort Stark), Newcastle Island, Portsmouth, New Hampshire in July 1968. Dover Point is an estuarine tidal rapid area whereas Jaffrey Point is a semi-exposed open coastal location. Both areas have been studied extensively and much is known of their flora and ecology (Mathieson, Hehre & Reynolds, in press; Mathieson, Reynolds & Hehre, in press; Reynolds, 1971).

Approximately 20 plants of each species were tagged at both locations with plastic forester's tape and small white tags. The monthly growth of *F. vesiculosus*, *A. nodosum* and *R. palmata* was recorded by measuring their total length, while in *L. digitata* and *L. saccharina* growth was recorded by determining the monthly increase in distance between the intercalary meristem and paired holes (Sundene, 1964). The holes were made with a cork borer 1 inch above the meristem. New holes were made every 2 months, because the terminal portions of the lamina sloughed off continuously. Specimens of *L. saccharina*, *L. digitata* and *R. palmata* were transplanted from the high to the low current areas at Dover Point, and their growth and longevity was recorded. During the 16 months of the experiment, nearly all the initial plants were lost due to human interference, grazing of snails, wave action or degeneration. Consequently, it was necessary to continuously tag and measure new plants.

The growth of *Rhodymenia palmata* was sporadic in the areas of low and high currents at Dover Point. Fragmentation occurred extensively during the late winter. The area of low currents was not suitable for the sustained growth of *R. palmata,* for when plants were transplanted there they died in a few months. All specimens of *R. palmata* grew at least one inch during June 1968.

The best growth of *Fucus vesiculosus* and *Ascophyllum nodosum* occurred during the summer while the poorest growth occurred during cold weather. The growth of *F. vesiculosus* and *A. nodosum* at Jaffrey Point was consistently lower than at Dover Point. The maximum growth of *F. vesiculosus* was 2 inches per month, and it occurred from May 15 to August 15, 1968, in the area of low currents at Dover Point.

Figures 1 and 2 show the growth of *Laminaria digitata* and *L. saccharina.* Because of the extreme variability in growth rates between individual plants, these rates are described only in relative terms as follows:

(1) good growth = over 3 inches/month
(2) average growth = 2-3 inches/month
(3) poor growth = up to 2 inches/month.

The growth of *Laminaria digitata* in the low current areas at Dover Point was quite variable. When transplants were made from the high to the low current areas, the growth was initially high, but the plants eventually degenerated. The probable cause is siltation and the physiological decrease of oxygen and nutrients due to the decreased currents. Good growth of *L. digitata* occurred in the spring and summer at Jaffrey Point and in the area of high currents at Dover Point. Poor growth was particularly evident in the winter at the same locations. In general, *L. digitata* had a higher rate of growth and it was sustained for a longer time in the high current areas at Dover Point than at Jaffrey Point.

An interesting phenomenon was observed when *L. digitata* was transplanted from the high to the low current areas at Dover Point. No dissection of the newly formed parts of the blades took place, and in a few months it was difficult to distinguish the plants from *L. saccharina,* except for the identification tags. The mechanical force of

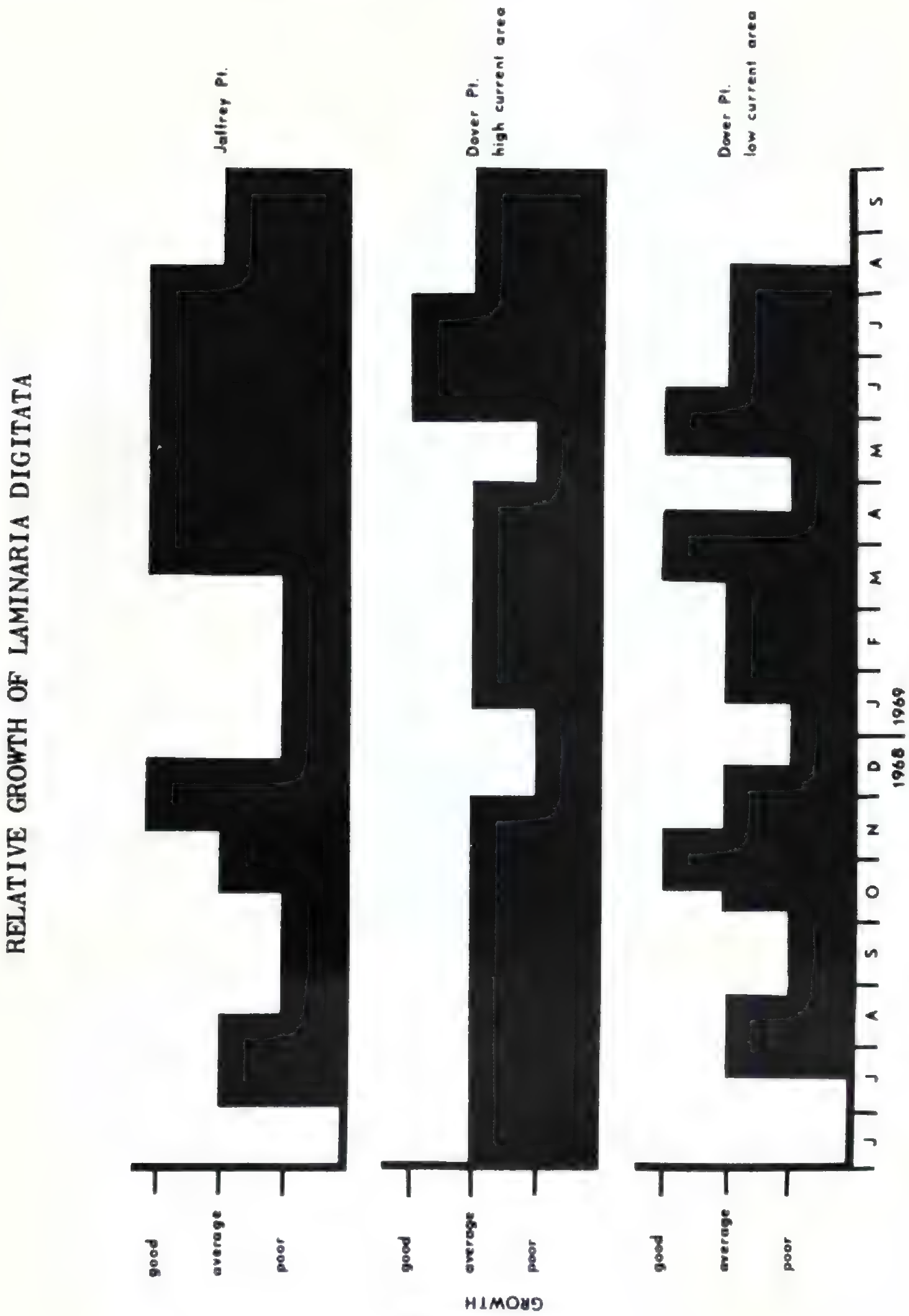

Figure 1
RELATIVE GROWTH OF *Laminaria digitata*

LEGEND:

Poor Growth	0-2 inches per month
Average Growth	2-3 inches per month
Good Growth	3-5½ inches per month

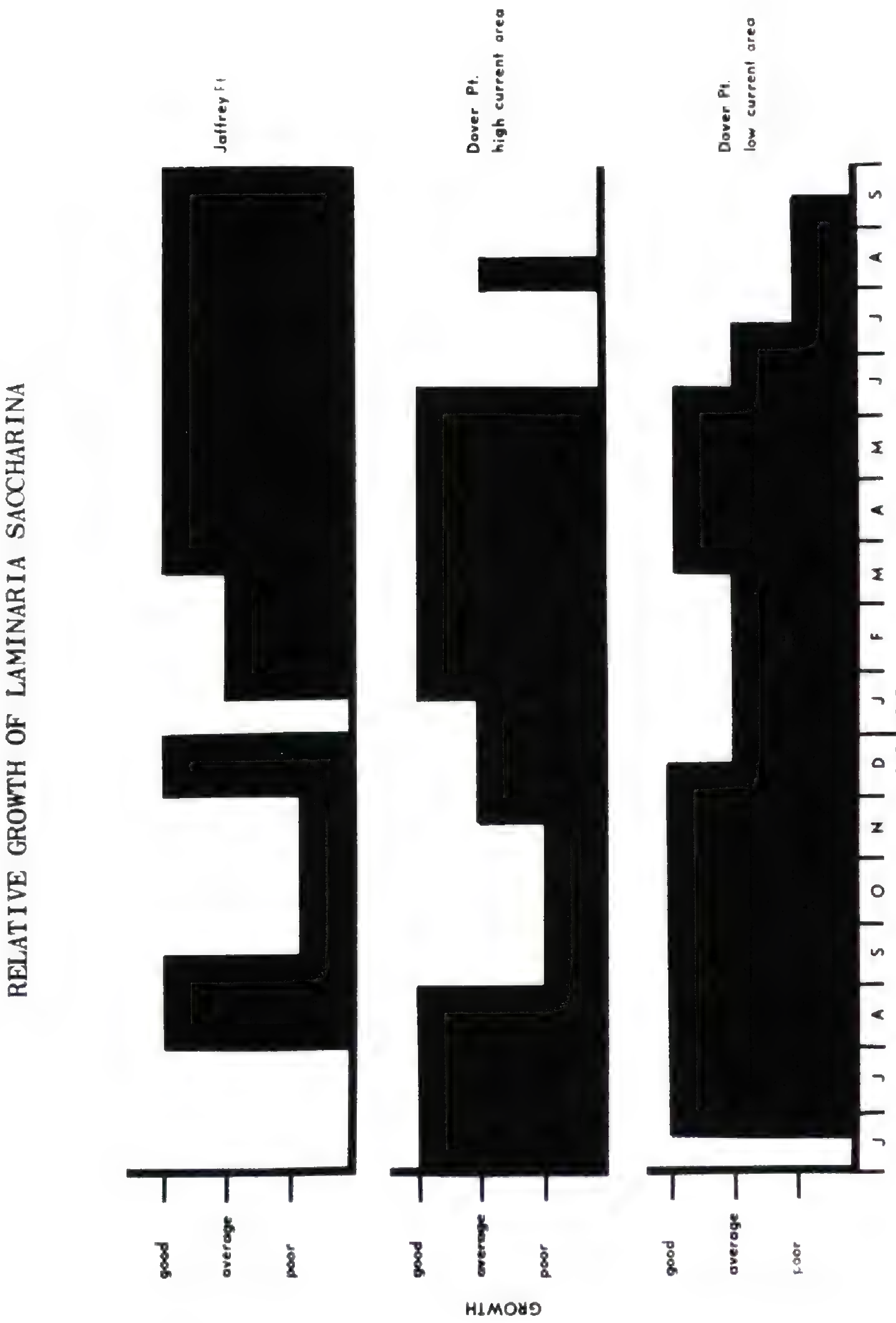

Figure 2

RELATIVE GROWTH OF *Laminaria saccharina*

LEGEND:

Poor Growth	0-2 inches per month
Average Growth	2-3 inches per month
Good Growth	3-5 ½ inches per month

the current was not high enough to cause the final separation of the frond segments.

The growth rate of *L. saccharina* was good for most of the year in the low current areas at Dover Point. A slight decrease in growth occurred during the winter. Good growth of *L. saccharina* occurred during the summer and early fall at Jaffrey Point and in the high current areas at Dover Point. Poor growth was evident during the late fall and early winter.

Laminaria saccharina exhibited good growth at all areas during the summer. *Laminaria saccharina* dominated the kelp beds at Dover Point during the winter, but *L. digitata* was dominant the rest of the year. It can be concluded that *L. saccharina* is better adapted to the estuarine environment than is *L. digitata*. The penetration of *L. saccharina* into the estuary is dependent on the presence of currents to compensate for the reduced salinities.

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CHROMOSOME NUMBERS IN KOSTELETZKYA PRESL (MALVACEAE)

ORLAND J. BLANCHARD, JR.

Heretofore, knowledge of the cytology of *Kosteletzkya* Presl has consisted of a single chromosome count from *K. hastata* Presl (Skovsted, 1941). This note corrects the number erroneously reported by Skovsted and adds counts from two African species, *K. adoensis* (Hochst. ex A. Rich.) Mast., and *K. buettneri* Gürke, and four American species, *K. coulteri* A. Gray, *K. pentasperma* (Bertero ex DC.) Griseb. *K. paniculata* Benth., and K. *virginica* (L.) Presl ex A. Gray (Table 1).

Counts were made from pollen mother cells of buds collected in the wild or taken from plants grown from seeds collected in the wild. Methods of fixation, preparation, and documentation are those reported by Bates and Blanchard (1970). Voucher specimens have been deposited in the L. H. Bailey Hortorium (BH).

The species counted represent a rather wide range of morphological diversity in the genus as well as a considerable geographical range. *Kosteletzkya paniculata* belongs to the specialized sect. *Orthopetalum* Benth. of western Mexico, which is notable in its convolute, tubular corolla and its exserted staminal column. The remaining species, both African and American, belong to the widespread sect. *Kosteletzkya,* but within that section represent a diversity of forms. The fact that counts made from all these species are the same, $n = 19$, suggests that the number in the genus may be constant. At variance with this conclusion is Skovsted's report of $2n = 34$ in *K. hastata,* a species closely related to *K. pentasperma.* However, an examination of the illustration by Skovsted (1941, fig. 99) shows 38 chromosomes rather than the reported 34. It may therefore be assumed that the gametic chromosome number of *K. hastata* is also $n = 19$.

The error that entered Skovsted's paper is of further interest because he used the erroneous count to support Hochreutiner's suggestion (1900) that *Kosteletzkya* could be related to *Hibiscus* sect. *Pterocarpus* Garcke ex Hochreutiner, a section known cytologically only from *H. vitifolius* L. with a chromosome number of $n = 17$ (Skovsted, 1935, 1941). There are ample reasons on morphological grounds for relating *Kosteletzkya* and *Hibiscus* sect. *Pterocarpus*, e.g., they share depressed, pentagonal, 5-crested capsules, the valves of which fall away completely from the floral axis at maturity, as well as similarities in calyx, involucre, and vegetative characters. Now, however, any proposal to unite the two taxa must take into account the difference in chromosome numbers.

Acknowledgments

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Table 1. Chromosome counts in *Kosteletzkya*

Species	*n-number*	*Locality and Collector*
K. adoensis	19	Cultivated, BH-69:555. Seed source — Angola: Huambo Distr., *Instituto de Investigação Agronómica de Angola*
K. buettneri	19	Cultivated, BH-72:100. Seed source — Zambia: "C Province," *Robinson* 6706
K. coulteri	19	Mexico: Sinaloa, *Fryxell, Bates & Blanchard* 1544
K. pentasperma	19	Mexico: Jalisco, *Fryxell, Bates & Blanchard* 1610
	19	Mexico: Michoacan, *Fryxell, Bates & Blanchard* 1650
	19	Mexico: Nayarit, *Fryxell, Bates & Blanchard* 1563
K. paniculata	19	Cultivated, BH-71:119. Seed source — Mexico: Jalisco, *Fryxell, Bates & Blanchard* 1590
K. virginica	19	USA: Florida, Collier Co., *Blanchard & Blanchard* 303
	19	USA: New Jersey, Ocean Co., *Blanchard & Blanchard* 284
	19	Cultivated, BH-69:430. Seed source — USA: Texas, Jefferson Co., *Knight* 88

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NAME CHANGES FOR THE SEED PLANTS IN THE BAHAMA FLORA

WILLIAM T. GILLIS

The author has been working in collaboration with Richard A. Howard of the Arnold Arboretum and George R. Proctor of the Institute of Jamaica towards a revision of Britton and Millspaugh's "Bahama Flora," published first in 1920 and reprinted without changes in 1962. A recent paper by the three of us (Gillis, Howard, and Proctor, 1973) has reported additions to the flora of the Bahamas based on personal collections, new collections available to us, and reports from the literature.

The present paper offers updated annotations on the correct scientific names to be applied to the species listed by Britton and Millspaugh whose work was completed under the provisions of the American Code of Botanical Nomenclature. We encourage others to use this list and its supporting bibliography, and to report additional changes or additions to me. We would particularly value contributions which specialists in non-vascular plants could make to the listings in Britton and Millspaugh for mosses and liverworts, algae, fungi, slime molds, and lichens. Our efforts will consider only the flowering plants and pteridophytes. We therefore encourage workers in these other fields of botany to update knowledge of their disciplines in the Bahamas too.

The value of lists of nomenclatural corrections has been evident to us in the work of Alain (1965) on the flora of Puerto Rico and the Virgin Islands. Additional nomenclatural changes have been obtained from monographs or the recent floras of Jamaica (Adams, 1971) and Barbados (Gooding et al., 1965). In all of these, however, the reasons for the changes of names are not always explained, requiring the curious or careful worker to reinvestigate each and every problem. I believe the explanations which accompany the changes reported here will be of value to other workers in subtropical New World floras and particularly in the West Indies. Reasons given for changes are usually: use of an earlier epithet, avoidance of a tautonym, replacement of a later homonym, correct application of a name, etc. When name changes have been made by others than myself, I have cited the publication upon which this information was based. Conversely, when I have had reason not to accept a particular treatment, then reasons have been stated.

The listing is by no means complete. Certain groups within the Boraginaceae, Rubiaceae, Loranthaceae, and Asclepiadaceae need intensive study and many more observations in the field, especially in such genera as *Heliotropium, Borreria, Dendropemon, Phthirusa,* and *Cynanchum.* A new look must be given to the genus *Agave* for the West Indies, inasmuch as the most recent treatment is now 60 years old (Trelease, 1913). Other groups including the ferns are being studied by others at the present time and we await publication of the conclusions of these investigators.

The Turks and Caicos Islands are politically a separate Crown Colony from the newly independent Commonwealth of the Bahama Islands. Britton and Millspaugh included all within the Bahama Flora and such is the geographical sense employed here in that it includes the Turks and Caicos Islands as well.

For ease of reference this paper will follow the order of species presented in Britton and Millspaugh's Bahama Flora, which will be Monocotyledons first, followed by the Dicotyledons, and then the Gymnosperms. Again for brevity, Britton and Millspaugh's flora is referred to by the expression B&M in the text of this paper. The figure in the left margin refers to the page in B&M on which the taxon in question is discussed. The name following the arrow (→) is the name considered to be correct. These names are not necessarily nomenclatural or taxonomic equivalents, hence the reason for not employing an equals sign (=). In some instances, B&M misidentified the plant or used a binomial incorrectly. Where monographs or significant studies support the use of names as they were employed in B&M, such references are cited under the generic name, e.g., *Guaiacum* (Porter, 1972).

In a few instances where the name changes have involved closely allied genera, or where the existing keys in B&M are wholly inadequate, particularly for use in the field, I have provided new keys. They are designed to employ characters of the floral, fruiting, and vegetative portions of the plant so that they can be of optimum use in working with specimens, whether living or in the herbarium, and whether reproductive or vegetative.

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This study was made while the author was a Research Fellow at the Arnold Arboretum and I express my gratitude for this opportunity. A generous gift from an anonymous donor interested in the work on the Bahama flora made this study possible.

PAGE
IN
B&M

TYPHACEAE

4 *Typha angustifolia* → **Typha domingensis** (Pers.) Kunth. These are two different valid species according to Hotchkiss and Dozier (1949) with only *Typha domingensis* occurring in the Bahamas.

POTAMOGETONACEAE (ZANNICHELLIACEAE)

5 *Potamogeton heterophyllus* → **Potamogeton gramineus** L. var. **gramineus.** On the basis of both herbarium specimens and abundant fresh material from a pond on San Salvador Island (*Gillis 8864*), I have considered all the *Potamogeton* material on the Islands to be the same (see Ogden, 1943).

5 The question of good characters, reliable under all conditions, for separating *Ruppia maritima* from *R. cirrhosa,* is still open. Various treatments have been consulted (Fernald and Wiegand, 1914; Hagstrom, 1916; McCann, 1945; Setchell, 1946; Reese, 1962a and b; Gamerro, 1968; and Schwanitz, 1967) for specimens collected in the Bahamas. For the moment, it appears that both species seem to be present. Therefore, *R. cirrhosa* is an addition to the flora, rather than merely a different name for the species in B&M. Collectors are urged to look for *R. cirrhosa* inasmuch as flowering and fruiting material are as yet unknown in the Bahamas. An adaptation of Gamerro's key follows:

Peduncle of inflorescence more than 10 cm. (8-60 cm.), coiled until anthesis; anther sacs reniform, 1.7 mm. long; fruits rounded at apex; leaves 1 mm. broad; leaf epidermal cells 16-19μ; $2n = 40$ . . . . *Ruppia cirrhosa* (Petagna) Grande.

Peduncle of inflorescence less than 5 cm., not coiled in spiral until anthesis; anther sacs elliptic, 0.6-0.7 mm. long; fruits irregularly pointed; leaves 0.5

mm. broad; epidermal cells of leaves 12.5-16.0μ; $2n = 20$ .... *Ruppia maritima* L.

ZANNICHELLIACEAE (CYMODOCEACEAE)

6 *Cymodocea manatorum* → **Syringodium filiforme** Kütz. This change of name follows Dandy and Tandy (1939) and den Hartog (1970).

6 *Halodule wrightii* Aschers. is indeed in the Bahamas, but so is *H. beaudettei* (den Hartog) den Hartog (1964). These two species can be separated as follows:

Leaf tips bicuspidate; leaf blades 1/3-4/5 mm. wide; leaves with linear teeth, concave on the inner side ... *Halodule wrightii* Aschers.

Leaf tips tricuspidate; leaf blades 2/3-1¼ mm. wide; leaves with linear lateral teeth ... *Halodule beaudettei* (den Hartog) den Hartog.

HYDROCHARITACEAE (ELODEACEAE)

8 *Halophila* — consult Hartog (1959).

ALISMATACEAE

7 *Echinodorus cordifolius* → **Echinodorus berteroi** (Spreng.) Fass. (See Fassett, 1955).

GRAMINEAE

13 There is some question among agrostologists whether *Schizachyrium* should be segregated from *Andropogon* as it was in B&M. Chase (1951) joins the two genera. For the moment, however, I shall follow treatments by Gould in maintaining them as separate genera (see Gould, 1967, 1968, and 1969).

14 *Nazia aliena* → **Tragus berteronianus** Schult. *Tragus* is conserved over *Nazia*. The species epithet changed from *aliena* to *berteronianus* because the type of *Lappago alienus* Spreng., the basionym, is referred to *Pseudechinolaena polystachya* (H.B.K.) Stapf, and not to this Bahamian plant (Chase, 1951).

15 *Syntherisma filiformis* → **Digitaria panicea** (Sw.) Urb. The species on which the epithet *filiformis* is based is a different species from the one of concern here. The earliest name for this species is *Milium panicea* Sw. which was transferred to *Digitaria* by Urban. The combination was made twice in the same year (1920), by Urban in February and by Fernald in June. The Urban combination obviously has priority. *Digitaria* is an earlier generic name than *Syntherisma*.

16 *Syntherisma digitata* → **Digitaria horizontalis** Willd. *Milium digitatum* Sw. (1788) is the earliest basionym, but is is preoccupied in *Digitaria* by *D. digitata* Buse (1854). The next earliest name available is *D. horizontalis* Willd. (1809).

16 *Syntherisma sanguinalis* → **Digitaria sanguinalis** (L.) Scop.

16 *Valota insularis* → **Trichachne insularis** (L.) Nees. *Valota* is inadequately published (Chase, 1951).

18 *Paspalum poiretii* **R.** et S. → **Paspalum sagetii** Chase. *Paspalum caespitosum* → **Paspalum poiretii** R. et S. The work of Chase (1929) sorts out the names of these *Paspalum* species by typifying them. It is thus apparent that, although the name *P. poiretii* is still used in the Bahama flora, it must be applied to a different species from the one to which it was assigned by B&M.

18 *Paspalum portoricense* → **Paspalum molle** Poir. in Lam. The change is required because of an earlier epithet (Chase, 1951).

18 *Paspalum simpsonii* → **Paspalum blodgettii** Chapm. *Paspalum blodgetti* is an earlier name for *P. simpsonii* Nash, and not a synonym of *P. caespitosum* Chase, 1951).

19 *Paspalum glabrum* → **Paspalum laxum** Lam. The change is required because of an earlier epithet (Chase, 1951).

20 *Paspalum distichum* L. is attributed by B&M to the

Pugil. Pl. Jam., one of the dissertations of Linnaeus (1759). It actually appeared earlier in the same year in the Systema Naturae, ed 10, and should be so attributed.

22 *Panicum barbinode* → **Panicum purpurascens** Raddi. The change is required because of an earlier epithet (Hitchcock, 1936).

22 *Panicum distantiflorum* → **Setaria distantiflorum** (A. Rich. in Sagra) Pilger.

22 *Panicum chapmani* → **Setaria chapmanii** (Vasey) Pilger. Rominger (1962) has shown that these two species properly belong in *Setaria.*

24 *Panicum dichotomiflorum* → **Panicum bartowense** Scribn. et Merr. These names were treated as synonymous by B&M. Hitchcock (1935) and Chase (1951) felt that they are separate species and that the Bahamian plant is *P. bartowense.* Fernald (1934) treated the taxon as *P. dichotomiflorum* var. *bartowense* Schribn. et Merr.) Fern.

24 *Panicum coerulescens* → **Panicum coerulescens** Hack. ex Hitchc. This change is simply a corrected spelling.

27 *Oplismenus hirtellus* (L.) R. & S. 1817 → **Oplismenus hirtellus** (L.) Beauv., Ess. Agrost. 54, 168. 1812. An author change is needed for this earlier publication of the binomial.

27 *Chaetochloa geniculata* → **Setaria geniculata** (Lam.) Beauv.

28 *Chaetochloa setosa* → **Setaria setosa** (Sw.) Beauv.

28 *Chaetochloa macrosperma* → **Setaria macrosperma** (Scribn. et Merr.) K. Schum. *Setaria* is the older and preferred name over *Chaetochloa. Setaria* Beauv. is conserved over *Setaria* Michx.

28 *Cenchropsis mysuroides* → **Cenchrus mysuroides** H.B.K. *Cenchropsis* is not now considered distinct from *Cenchrus* (Chase, 1936 and Delisle, 1963).

29 *Cenchrus carolinianus* → **Cenchrus incertus** M. A. Curtis. The use of *Cenchrus carolinianus* in B&M was a misapplication of the name. That name is

now considered a synonym of *C. longispinus*, but is correctly used for a plant not found in the Bahamas. The plant in question is *C. incertus* which is widespread in the Bahamas (DeLisle, 1963).

29 *Cenchrus microcephalus* → **Cenchrus incertus** M. A. Curtis. DeLisle (ibid.) felt that there was so little difference between the "endemic" race of *Cenchrus* with small fruits and the more widespread species that he treated them as conspecific. The small fruited form should be considered an insular form.

29 *Cenchrus viridis* → **Cenchrus brownii** R. et S. This name change is required because of an earlier epithet (DeLisle, ibid.).

30 *Stenotaphrum* — Consult Sauer, 1972.

31 *Aristida gyrans* → **Aristida vilfifolia** Henr. After publication of B&M, *Aristida vilfifolia* was segregated as a distinct species from *A. gyrans* which was the name in B&M (Henrard, 1926-33; 1929-33). It is the segregate which indeed is the one in the Bahama flora.

31 *Aristida scabra* → **Aristida ternipes** Cav. This change is required because of an earlier epithet.

32 *Sporobolus indicus* → **Sporobolus jacquemontii** Kunth.

33 *Sporobolus berteroanus* → **Sporobolus indicus** (L.) R. Br. In the *Sporobolus indicus* complex, there are two Caribbean species which are often confused: *S. jacquemontii*, which has an obtuse upper glume and is a fully tropical species, and *S. indicus*, which has an acute upper glume and is a more subtropical species. According to the description in B&M, these taxa have been confused (Clayton, 1964 and personal communication).

33 *Sporobolus atrovirens* → **Sporobolus bahamensis** Hack. *Sporobolus atrovirens* is a different plant from the one in the Bahamas; it is a Mexican plant, is a perennial, and has smaller spikelets and glumes than *S. bahamensis*. The latter is a Bahamian endemic and an annual.

33 *Sporobolus argutus* → **Sporobolus pyramidatus** (Lam.) Hitchc. This name change is required because of an earlier basionym. The citation for Domingan dropseed-grass should be *Sporobolus domingensis* (Trin.) Kunth, Rév. Gram. 1, Suppl.; xvii. 1830, a citation three years earlier than that cited in B&M.

34 *Capriola dactylon* → **Cynodon dactylon** (L.) Pers. *Cynodon* is conserved over *Capriola.*

36 *Chloris polydactyla* → **Chloris dandyana** Adams. Adams (1971) published a new name for this plant without giving the background reasons for the illegitimacy of the original name. The background is as follows: There is a Jamaican plant with the legitimate name *Andropogon barbatus* L. Some time after describing this Jamaican grass, Linnaeus applied the same binomial to an East Indian grass. The epithet *barbatus* (referring to the East Indian species) was transferred to *Chloris* by Swartz, an act which prevents the transfer of the Jamaican species epithet to *Chloris*. In the meantime, Linnaeus proposed a superfluous name for the first *Andropogon barbatus,* i.e., *A. polydactylos.* Swartz's transfer of this superfluous name to *Chloris* is illegitimate; hence Adams's publication of a new name for the species in the West Indies. (I should like to acknowledge personal communication from C. D. Adams and J. E. Dandy for the historical background on this matter.)

39 *Phragmites phragmites* → **Phragmites australis** (Cav.) Trin. ex Steud. Clayton (1968) pointed out that the correct name for the pan-tropical reed is the combination used above.

39 *Diplachne fascicularis* → **Leptochloa fascicularis** (Lam.) A. Gray. Current views of agrostologists suggest that *Diplachne* should be contained within *Leptochloa.*

41 *Eragrostis cilaris* (L.) Link 1827 → **Eragrostis ciliaris** (L.) R.Br. in Tuckey, 1818. Chase (1951) recorded the earlier publication of this combination.

42 *Uniola virgata* → **Leptochloöpsis virgata** (Poir.) Yates. Yates (1966) has subdivided *Uniola* into *Uniola, Chasmanthium,* and *Leptochloöpsis* on the basis of a number of anatomical, cytological, morphological, and embryological characters. Because this species of spike-grass is considered close to *Leptochloa,* Yates erected *Leptochloöpsis* to contain it and another species from Ecuador.

CYPERACEAE

44 *Cyperus paniculatus* → **Cyperus polydactylos** Rottb. These names originate from the same date and are considered to be synonymous. Corcoran (1941) chose *C. polydactylos* to be the inclusive name. The Bahama populations might be designated as *C. polydactylos* var. *texensis* (Torr.) Fern. (McLaughlin, 1944).

45 *Cyperus cuspidatus* → **Cyperus aristatus** Rottb. True *C. cuspidatus* does not occur in the Bahamas, but in Cuba. (See Horvat, 1941; McLaughlin, 1944).

Cyperus pseudovegetus → **Cyperus distinctus** Steud. *Cyperus pseudovegetus* was a name misapplied to the plant of the Bahamas (O'Neill, 1939).

46 *Cyperus brunneus* → **Cyperus planifolius** L. C. Rich. This name change is required by an earlier epithet (McGivney, 1938; McLaughlin, 1944).

47 *Cyperus ferax* → **Cyperus odoratus** L. var. **odoratus.** O'Neill (1940) demonstrated that these two names apply to the same species, and that *C. odoratus* is the earlier name. He further thought that the typical variety was the one found in the Bahamas.

According to the treatment by McLaughlin (1944), the populations of *Cyperus filiformis* Sw. in the Bahamas are of the typical variety (var. *filiformis*).

49 *Stenophyllus wilsonii* → **Bulbostylis floccosa** (Griseb.) Clark in Urb. *Stenophyllus* is merged with *Bulbostylis* in the treatment by Kral (1971). *Bulbostylis floccosa* is the earliest name. It is not endemic to the

Bahamas as stated in B&M, but also is found in Cuba and Hispaniola.

50 *Fimbristylis diphylla* → **Fimbristylis dichotoma** (L.) Vahl. This change is required because of an earlier basionym.

51 According to B&M, the record of *Fimbristylis hirta* in the Bahamas is very tenuous. Neither Kral nor I have seen any material from the Bahamas. If indeed it does occur there, its more appropriate name should be *F. squarrosa* Vahl (see Kral, 1971).

52 *Abildgaardia monostachya* → **Abildgaardia ovata** (Burm. f.) Kral. This change is required because of an earlier epithet (Kral, ibid.).

53 There are cyperologists who wish to merge *Dichromena* with *Rhynchospora*. On the basis of the striking white bracts and insect pollination characteristic of *Dichromena,* I am, for the moment at least, retaining it as distinct.

54 *Rhynchospora cyperoides* → **R. cyperoides** (Sw.) Mart. var. **cyperoides.**

54 *Rhynchospora tracyi* → **Rhynchospora cyperoides** var. **triceps** (Vahl) Bock. This treatment follows that of Kükenthal (1949).

55 *Rhynchospora perplexa* → **Rhynchospora microcarpa** Baldw. ex Gray. Gale (1944) maintained that true *R. perplexa* was not in the Bahamas and that all the material which Britton and Millspaugh called by this name was misdetermined.

55 *Rhynchospora bahamensis* Britt. → **Rhynchospora lindeniana** var. **bahamensis** (Britt.) Gale. Gale's treatment (ibid.) of the West Indian *Rhynchospora* species reduced Britton's species to a variety of the more widespread *R. lindeniana.*

56 *Rhynchospora marisculus* → **Rhynchospora odorata** C. Wright ex Griseb. Gale (ibid.), in examining the same material which Britton and Millspaugh did, determined that the use of *R. marisculus* in B&M was a misapplication of the name.

56 *Mariscus jamaicensis* → **Cladium jamaicense** Crantz. Most treatments now segregate *Cladium* from *Mariscus*.

57 *Scleria*. Consult Jackson, 1949.

PALMAE (ARECACEAE)

59 *Thrinax parviflora* → **Thrinax floridana** Sarg. *Thrinax parviflora* is an endemic species of Jamaica. Furthurmore, the treatment of *Thrinax* by Read in Adams (1971) will be superseded now that additional type material has been examined. The correct name for the small thatch of South Florida and the northern West Indies with leaf segments broadest at the point of fusion, with scattered, fimbriate, centrally translucent scales, and glabrous axes should be *T. floridana* (Read, personal communication).

59 *Thrinax parviflora* → **Thrinax floridana** Sarg. *Thri-* (Jacq.) L. H. Bailey. True *C. argentea* may exist in the southern Bahamas, but this has yet to be demonstrated. It is now treated as being indigenous to Hispaniola. (See Moore, 1963).

60 *Paurotis wrightii* → **Acoelorrhaphe wrightii** (Griseb. ex H. Wendl.) H. Wendl. ex Becc. The preferred name for the Paurotis palm, Spanish-top, or Everglades palm is now *Acoelorrhaphe* (Moore, 1963).

61 *Pseudophoenix vinifera* → **Pseudophoenix sargentii** subsp. **saonae** (Cook) Read. True *P. vinifera* is indigenous to Hispaniola and is not known from the Bahamas. (Read, 1968).

COMMELINACEAE

67 *Commelina longicaulis* → **Commelina diffusa** Burm. f.

67 *Commelina elegans* → **Commelina virginica** L. Name changes are made here in accord with the treatment by Brashier (1969). The following key may be more easily used than that in B&M:

Plant annual, trailing; spathes not united at the base, margins ciliate; internodes glabrous; sta-

minodes 2 .... *Commelina diffusa* Burm. f.
Plant perennial, tufted and erect; spathes united at the base, margins membranous; internodes puberulent; staminodes 3 ...... *Commelina virginica* L.

68 *Rhoeo discolor* → **Rhoeo spathacea** (Sw.) Stearn. This name change follows Stearn (1957) who discovered that the earlier epithet of Swartz applies to this plant.

AGAVACEAE (LILIACEAE)

69 *Cordyline guineensis* → **Sansevieria hyacinthoides** (L.) Druce. This change follows Wijnands (1973).

SMILACACEAE

71 *Smilax*. Consult Coker, 1944.

AMARYLLIDACEAE

78 *Atamosco rosea* → **Zephranthes rosea** Lindl.

78 *Atamosco cardinalis* → **Zephyranthes cardinalis** C. Wright. *Zephyranthes* is conserved over *Atamosco*.

79 *Hymenocallis caymanensis* → **Hymenocallis latifolia** (Mill.) Roemer. This change follows the treatment by Sealy (1954).

ORCHIDACEAE

83 *Carteria corallicola* → **Basiphyllaea corallicola** (Small) Ames. *Carteria* is a later homonym for a genus of algae. *Basiphyllaea* was erected as a genus to correct this situation.

83 *Vanilla eggersii* → **Vanilla dilloniana** Correll.

84 *Vanilla articulata* → **Vanilla barbellata** Reichb. f. This treatment of *Vanilla* in the Bahamas follows Correll (1950).

84 *Pelexia adnata* → **Spiranthes adnata** (Sw.) Benth. Although *Pelexia* is a conserved name, it is also a generic synonym of *Spiranthes* (Garay and Sweet, 1972).

84 *Pelexia setacea* → **Eltroplectris calcarata** (Sw.) Garay

et Sweet. Luer (1972) changed *Pelexia setacea* to *Centrogenium setaceum* but Garay and Sweet (1972) maintained that this combination is based on an illegitimate name and therefore should be *Eltroplectris calcarata* (Sw.) Garay et Sweet.

85 *Ibidium tortile* → **Spiranthes tortilis** (Sw.) L. C. Rich. *Ibidium* is considered to be a generic synonym of *Spiranthes.* (Garay & Sweet, 1972).

85 *Ibidium lucayanum* → **Spiranthes polyantha** Reichb. f. These names are considered synonymous by Luer (1972).

86 *Stenorrhynchus lanceolatus* → **Spiranthes lanceolata** (Aubl.) Léon. *Stenorrhynchus* is now treated as a generic synonym of *Spiranthes.* (See Dunsterville and Garay, 1965).

87 *Ponthieva brittonae* → **Ponthieva racemosa** var. **brittonae** (Ames) Luer. Two varieties of *Ponthieva racemosa* occur in the Bahamas. One is the typical variety (var. *racemosa*) as treated by Luer (1972) and reported by him as new to the flora. Var. *brittonae* is the reduction made by Luer of the name in B&M.

87 *Physurus querceticola* → **Erythodes querceticola** (Lindl.) Ames. *Physurus* is considered to be a generic synonym of *Erythodes* (Garay and Sweet, 1972).

89 *Polystachya minuta* → **Polystachya flavescens** (Lindl.) J. J. Smith. Although the epithet *minuta* (from *Epidendrum minutum* Aubl.) is the oldest name available, it is preoccupied in *Polystachya*, and hence, *P. flavescens* must be used.

89 *Spathiger rigidus* → **Epidendrum rigidum** Jacq. *Spathiger* is considered a generic synonym of *Epidendrum.*

90 *Auliza nocturna* → **Epidendrum nocturnum** Jacq. *Auliza* is considered a generic synonymn of *Epidendrum* (Dunsterville and Garay, 1965; Luer, 1972).

91 There is much discussion among orchid taxonomists whether *Encyclia* should be segregated from *Epiden-*

drum or not. For the moment, I accept the treatment of Dressler (1961; 1966) and Beckner (1970) in maintaining *Encyclia* at the generic level as in B&M.

91 *Encyclia rufa* → **Encyclia bahamensis** (Griseb.) Britt. et Millsp. Specimens labeled *E. rufa* from the Bahamas are now all best considered *E. bahamensis. Encyclia rufa* is, as B&M suspected, still not known from the archipelago.

92 *Encyclia diurna* → **Encyclia hodgeana** (A. D. Hawkes) Beckner. This name change is required because of more complete understanding of the taxa involved. The species previously called *E. diurna* or *E. gracilis* is, in fact, a hybrid between *E. hodgeana* and *E. tampensis.* (See Beckner, 1970).

93 *Epicladium boothianum* → **Encyclia boothiana** var. **erythronioides** (Small) Luer. *Epicladium* is a generic synonym of *Encyclia.*

93 *Anacheilium cochleatum* → **Encyclia cochleata** var. **triandra** (Ames) Dressler. *Anacheilium* is a generic synonym of *Encyclia.*

95 *Laeliopsis domingensis* → **Broughtonia lindenii** (Lindl.) Dressler. This change is made in accord with the treatment by Dressler (1961).

95 *Limodorum simpsoni* → **Calopogon tuberosus** (L.) Britten, Stearns, and Poggenberg. This treatment follows Luer, 1972.

PICRODENDRACEAE

103 *Picrodendron macrocarpum* → **Picrodendron baccatum** (L.) Krug et Urb. in Engl. I presently have *Picrodendron* under study. It appears that this genus should be placed within the Euphorbiaceae. There is likely only one species, which would be the typical one, *P. baccatum.*

ULMACEAE

104 *Trema lamarckiana* → **Trema lamarckianum** (R. et S.) Blume. The gender of *Trema* should be neuter.

MORACEAE

105 *Ficus jacquinifolia* → **Ficus perforata** L.

Ficus brevifolia → **Ficus citrifolia** Mill. Recent treatments of *Ficus* (DeWolf, 1969 and Condit, 1969) have equated *F. perforata* with *F. jacquinifolia* A. Rich. in Sagra. Moreover, they have also equated *F. brevifolia* and *F. citrifolia.* B&M's *F. brevifolia* Nutt. (lectotype at BM) must become *F. citrifolia* Mill., the earlier name (lectotype at BM, chosen by Dandy). I have further studied *F. perforata* which DeWolf and Condit have given as the correct name for *F. jacquinifolia* (which itself should be written *jacquiniifolia*). The Linnaean name must be typified by an illustration in Plumier associated with the dissertation on the plants of Surinam (1775). Although there is a specimen of *F. perforata* at LINN (Savage Catalog No. 1240: 9), the only reference in the Dissertation (and the later Amoenitates) in this context is that to Plumier. The specimen at LINN appears to be of the tree of Central America and northern South America, *F. pertusa* L. f. I should like to acknowledge the consultation and discussion with Dr. Gordon DeWolf which proved very valuable in application of names in *Ficus.* A key to the Bahama material follows:

1. Syconia sessile .... *Ficus aurea* Nutt.
1. Sycania stalked .... 2.
    2. Syconia 7-10 mm. in diameter; petioles less than 1 cm.; blades obovate; lateral veins flush with lower surface; leaf base cuneate .... *Ficus perforata* L.
    2. Syconia 8-18 mm. in diameter; petioles longer than 1 cm.; blades ovate; lateral veins ± prominent, somewhat elevated on lower surface; leaf blade base rounded .... *Ficus citrifolia* Mill.

LORANTHACEAE

108 Generic study of *Dendropemon, Phthirusa,* and *Phoradendron* is needed before good species concepts and correct nomenclature emerge.

ARISTOLOCHIACEAE

113 *Aristolochia passifloraefolia* → **Aristolochia passiflorifolia** A. Rich. in Sagra. With the exception of the orthograhic change (above) made in accord with rules adopted at the Seattle Congress, the names for *Aristolochia* species in the Bahamas remain as they were in B&M (Pfeifer, 1966; 1970).

POLYGONACEAE

114 *Persicaria hydropiperoides* → **Polygonum hydropiperoides** Michx.

114 *Persicaria punctata* → **Polygonum punctatum** Ell.

115 *Persicaria portoricensis* **Polygonum densiflorum** Meissn. *Persicaria* is treated by Graham and Wood (1955) as a section of *Polygonum.*

115 *Fagopyrum fagopyrum* → **Fagopyrum esculentum** Moench. This change is necessary in order to avoid a tautonym.

117 *Coccolobis laurifolia* → **Coccoloba diversifolia** Jacq.

117 *Coccolobis bahamensis* → **Coccoloba tenuifolia** L.

117 *Coccolobis diversifolia* → **Coccoloba swartzii** Meisn. *Coccoloba* is conserved over *Coccolobis.* All *Coccoloba* species therefore should change spelling to conform. The 3 species mentioned above are changed further in accord with Howard (1957). From Howard's treatment also comes the change of citation for *Coccoloba uvifera* (L.) L., Syst. Nat., ed. 10, p. 1007. 1759.

CHENOPODIACEAE

121 *Dondia linearis* → **Suaeda linearis** (Ell.) Moq.

121 *Dondia fruticosa* → **Suaeda fruticosa** (L.) Forsk.

121 *Dondia insularis* → **Suaeda insularis** (Britt.) Urb. et Ekm. *Dondia* is considered to be a taxonomic synonym

of *Suaeda*. *Suaeda* Forsk. ex Scopoli remains in the list of conserved names even though the reason for its inclusion is no longer valid.

AMARANTHACEAE

124 *Amaranthus gracilis* → **Amaranthus viridis** L. Reed (1968) and Merrill (1936) considered these species to be taxonomic synonyms. *Amaranthus viridis* L. is the earlier name.

126 *Centrostachys indica* → **Achyranthes aspera** var. **indica** L. *Centrostachys* seems better treated as a generic synonym *Achyranthes*.

126 *Achyranthes maritima* → **Alternanthera maritima** St. Hil.

126 *Achyranthes polygonoides* → **Alternanthera polygonoides (L.)** R. Br.

127 *Achyranthes repens* → **Alternanthera pungens** H.B.K. This treatment follows Reed, 1968. The epithet *pungens* is used for the last species rather than the earlier epithet *repens* because *Achyranthes repens* is a *nomen confusum* according to Reed.

128 *Philoxerus* remains the same except for citing an earlier date of publication: *Philoxerus vermicularis* (L.) R. Br. Prodr. Fl. Nov. Holl. 416. 1810.

128 *Iresine celosia* → **Iresine diffusa** Humb. et Bonpl. ex Willd. (Sp. Pl., ed. 4, 4: 765. 1806). *Iresine celosia* is an illegitimate name.

NYCTAGINACEAE

130 *Boerhaavea coccinea* Mill. → **Boerhavia coccinea** Mill. *Boerhaavea erecta* L. → **Boerhavia erecta** L. *Boerhavia* is the original spelling.

131 *Torrubia obtusata* → **Guapira obtusata** (Jacq.) Little.

131 *Torrubia cokeri* → **Guapira obtusata** (Jacq.) Little.

132 *Torrubia longifolia* → **Guapira longifolia** (Heimerl) Little.

132 *Torrubia bracei* → **Guapira bracei** (Britt.) Little. If one considers that blollies are similar to *Pisonia*

species, then *Torrubia* merges with *Pisonia.* If one wishes to recognize both as distinct genera, then one must take up *Guapira,* an earlier name than *Torrubia.* The Committee for Spermatophytes rejected a proposal to conserve *Torrubia,* hence a paper by Little (1968) which made the appropriate transfers to *Guapira.* It is currently felt that *Torrubia cokeri* is synonymous with *Guapira obtusata;* it has been so treated here. This is an exceedingly variable species with different forms having been named in the past.

PORTULACACEAE

138 *Portulaca phaeosperma* → **Portulaca rubricaulis** H.B.K. Legrand (1952) chose the earlier name for this species.

NYMPHAEACEAE

139 *Castalia pulchella* → **Nymphaea pulchella** DC. Wood (1959) has treated *Castalia* as a subgenus of *Nymphaea.*

LAURACEAE

143 *Ocotea coriacea* → **Nectandra coriacea** (Sw.) Griseb. Recent treatments have merged *Ocotea* and *Nectandra* (Wood, 1958; Allen, 1966).

144 *Persea pubescens* → **Persea palustris** (Raf.) Sarg. Kopp (1966) pointed out that *palustris* is an earlier epithet than *pubescens* for this species.

CASSYTHACEAE

144 *Cassytha americana* → **Cassytha filiformis** L. This change is necessitated because *filiformis* is the earlier epithet.

CRUCIFERAE (BRASSICACEAE)

146 Hitchcock (1945) recognized several varieties of *Lepidium virginicum.* If this treatment is followed, the Bahama one is var. *virginicum.*

147 *Sinapis arvensis* → **Brassica kaber** (DC.) L. C. Wheeler. Wheeler (1938) thought that *Sinapis* should

properly be considered a part of *Brassica*. *Sinapis arvensis* of B&M cannot be transferred to *Brassica* because there is already a *B. arvensis*. *Brassica kaber* appears to be an older combination than *B. willdenovii* Boiss., as attributed to the Bahamas in Adams, 1972.

148 *Radicula brevipes* → **Rorippa portoricensis** var. **pumila** (O. E. Schulz) Stuckey. The name used in B&M and its synonyms are misapplied to the Bahamian taxon, according to Stuckey (1972). Stuckey inadvertently maintained a neuter ending for the varietal epithet in his treatment; this is corrected above.

148 *Canara didyma* → **Coronopus didymus** J. E. Smith. *Coronopus* (1757) is an older name than *Canara* (1792). *Coronopus* Zinn. (1757) is conserved over *Coronopus* Miller (1754), a genus of Plantaginaceae.

MORINGACEAE

151 *Moringa moringa* → **Moringa oleifera** Lam. In avoiding the tautonym, *Moringa moringa*, Ernst (1963) has picked up *Moringa oleifera* for the horseradish-tree.

CRASSULACEAE

152 *Bryophyllum pinnatum* → **Kalanchoë pinnata** (Lam.) Pers. Treatments of *Kalanchoë* and *Bryophyllum* (Baldwin, 1938; Hamet, 1907) have recognized *Kalanchoë* as the inclusive genus.

ROSACEAE (AMYGDALACEAE)

153 *Laurocerasus myrtifolia* → **Prunus myrtifolia** (L.) Urb. The cherry-laurel is best considered in the larger genus *Prunus* especially in view of other recent floras which have so placed it.

CHRYSOBALANACEAE (AMYGDALACEAE)

154 *Chrysobalanus pellocarpus* → **Chrysobalanus icaco** L. Prance (1972) thought that there were insufficient means to separate *C. pellocarpus* from *C. icaco* and has treated them as taxonomic synonyms.

LEGUMINOSAE (MIMOSACEAE)

155 *Pithecellobium* is conserved over *Pithecolobium*, and hence all species change to this orthography. The ram's horn has been a source of confusion for a number of years. *Pithecellobium keyense* Britt. ex Coker in Shattuck was proposed to replace *P. guadalupense* because the latter name was not applicable. Britton did not state why he considered the name inapplicable. In creating the new name, Britton (actually Coker) had no description and hence, created a *nomen nudum*. This situation was rectified in 1928 by Britton and Rose. Although the type of *Mimosa guadalupensis* Pers., the basionym, cannot be found at present in the Jussieu Herbarium at P, there appears to be no valid reason why this name cannot be taken up, pending proof that this plant does *not* represent the concept of the species known as "ram's horn" in the West Indies and South Florida. Isely (1972) referred to specimens at the Delessert Herbarium and at Leiden which should be "critical," but inasmuch as the basionym is linked by Persoon with "Hab ad Guadalupam (Herb. Juss.)," the lectotype material should be sought in the Jussieu Herbarium. Why Britton and Rose indicated that this species was "not *Inga guadalupensis* Desv." (which is based on the same basionym) is unknown. The only *Pithecellobium* which occurs on Guadaloupe is this one. I am therefore retaining the name in B&M, but adding the parenthetical reference to the author of the basionym which was omitted in B&M: *Pithecellobium guadalupense* (Pers.) Chapm.

158 The *Lysiloma* species remain as in B&M (Gillis and Stearn, in press), except for correcting gender to neuter.

159 *Anneslia haematostoma* → **Calliandra haematomma** (Bert.) Benth.

159 *Anneslia formosa* → **Calliandra formosa** (Kunth) Benth. *Calliandra* is conserved over *Anneslia*. The

specific epithet *haematostoma* in B&M appears to be a misprint, judging from the basionym they cite.

160 Despite efforts of Britton and Rose (1928) to fractionate *Acacia* into *Bahamia* and *Lucaya*, it seems best to maintain the three species of *Acacia* in B&M under the same names as in the flora: **Acacia acuifera, A. choriophylla,** and **A. macracantha.**

161 *Vachellia farnesiana* → **Acacia farnesiana** (L.) Willd. *Vachellia* is best considered a generic synonym of *Acacia.*

162 *Leucaena glauca* → **Leucaena latisiliqua** (L.) Gillis et Stearn. Based on typification of an earlier name than either the epithet *glauca* or *leucocephala* (deWit, 1961). Gillis and Stearn (in press) have shown that *latisiliqua* should be taken up.

163 *Acuan virgatum* → **Desmanthus virgatus** (L.) Willd. var. **virgatus.**

163 *Acuan depressum* → **Desmanthus virgatus** var. **depressus** (Willd.) Turner. *Desmanthus* is conserved over *Acuan.* The two Bahama plants probably are best considered distinct only at the infraspecific level; therefore the treatment of Isely (1970) is followed.

164 *Neptunia* — consult Windler (1966).

164 *Prosopis* — consult Johnston (1962).

LEGUMINOSAE (CAESALPINIACEAE)

166 *Cassia tora* → **Cassia obtusifolia** L. B&M suggest that *Cassia tora* and *C. obtusifolia* are synonyms and chose the former as the name to be used in the Bahama flora. Typification shows that such is not the case. DeWit (1955) selected a specimen in the Linnaean Herbarium as the type of *C. tora* L., but Brenan (1958) objected to this choice and selected a specimen in the Hermann Herbarium (at BM) as the type. Based on the position of the petiolar gland, length of flowering and fruiting pedicels, anther shape, and presence of a 1.2-2 mm. areole on both

sides of the seed, Brenan distinguished these two as distinct species. There is probably no *Cassia tora* in the New World according to Brenan.

168 *Chamaecrista chamaecrista* → **Cassia nictitans** L. Despite the efforts of Britton and Rose to fractionate *Cassia* into segregate genera *Chamaecrista, Ditremexa, Peiranisia,* etc., I maintain *Cassia* as an inclusive genus. This necessitates different names for the six species placed in *Chamaecrista* in B&M. *Cassia chamaecrista* L. is based on a composite collection according to Pennell (1917). Therefore the correct name for the annual plant that is distributed throughout Eastern United States is generally accepted as *C. fasciculata* Michx. "*Chamaecrista chamaecrista*" of B&M should be rather the perennial species, *Cassia nictitans* L. I believe it is necessary to retypify all the names used in this complex in order to apply these names properly.

169 *Chamaecrista riparia* → **Cassia caymanensis** C. D. Adams. Adams (1970) has shown that *Cassia riparia* is an illegitimate name, and therefore this plant must have a new epithet in *Cassia*.

169 *Chamaecrista lucayana* → **Cassia lucayana** Britt.

169 *Chamaecrista caribaea* → **Cassia caribaea** Northrop.

170 *Chamaecrista inaguensis* → **Cassia inaguensis** Britt.

170 *Chamaecrista lineata* → **Cassia lineata** Sw. These species revert to their original names in *Cassia*.

172 *Guilandina crista* → **Caesalpinia bonduc** (L.) R. Br. Gray nickerbean has been shown by Dandy and Exell (1938) to be *Caesalpinia* (or *Guilandina*) *bonduc.* The epithet *crista* as used by Linnaeus refers to an Old World species.

172 *Guilandina bonduc* → **Caesalpinia divergens** Urb.

172 *Guilandina ovalifolia* → **Caesalpinia ovalifolia** Urb. Current thought among those working with this group of scrambling shrubs of the coastal regions of the West Indies is to treat them as a section of *Caesalpinia,* rather than a separate genus *Guilandina.*

For some long period of time, *G. bonduc* was used to refer to the yellow-seeded nickerbean. As we have seen, proper typification by Dandy and Exell has shown that the name *bonduc* is misapplied when used thus. Among the synonyms given by B&M for this species, most apply to still other species. *Caesalpinia divergens* seems to be the earliest name available for this species. The yellow-seeded nickerbeans in the Bahamas (with the exception of a new species to be described by Gillis and Proctor from Inagua) can be separated as follows:

1. Seeds spherical, yellow; leaflets elliptic to suborbicular, obtuse or emarginate .... *Caesalpinia ovalifolia* (Urb.) Britt.
1. Seeds oblong, bronze-brown; leaflets ovate, acute or acuminate .... *Caesalpinia divergens* Urb.

173 I accept B&M's treatment of 1920 instead of the later treatment of Britton and Rose (1928) which recognized the segregate genus *Vicarago*. I see no reason to separate this taxon from *Caesalpinia*.

LEGUMINOSAE (FABACEAE)

177 *Ateleia cubensis* → **Ateleia gummifera** (Bert. ex DC.) Dietr. The epithet *gummifera* is an earlier epithet for this species (Rudd, 1968).

178 Yakovlev (1967 a and b) has recognized a number of subspecific units in *Sophora tomentosa* L. For the moment, these seem difficult to accept as other than insular forms, and therefore I consider the taxon to be the single, variable *S. tomentosa* throughout the archipelago as in B&M.

181 *Cracca cinerea* → **Tephrosia cinerea** (L.) Pers.

181 *Cracca cathartica* → **Tephrosia senna** H.B.K. Although *Cracca* Benth. in Benth. et Oersted is conserved over *Cracca* L., *Tephrosia* Pers. is conserved over *Cracca* L., *Needhamia* Scopoli, and *Reineria* Moench. The

correct generic name for the plants in the Bahamas is *Tephrosia*. Because the key to species in B&M is somewhat inadequate, a revised one follows:

1. Leaflets 9-15; racemes opposite the leaves; pod 2.5-4 mm. broad . . *Tephrosia cinerea* (L.) Pers.
1. Leaflets 5-9; racemes terminal and opposite the leaves; pod 4-5 mm. broad .... *Tephrosia senna* H.B.K.

182 *Sesban sericea* → **Sesbania sericea** (Willd.) DC.

182 *Sesban occidentalis* → **Sesbania emerus** (Aubl.) Urb.

182 *Agati grandiflora* → **Sesbania grandiflora** (L.) Pers. *Sesbania* is conserved over *Sesban* and *Agati*. The second of the species mentioned above was known only from fruit at the time of the writing of B&M. From collections made recently from the same population, I have determined it to be *S. emerus*.

183 *Stylosanthes* — consult Mohlenbrock (1957).

184 *Meibomia supina* → **Desmodium canum** (Gmel.) Schinz et Thell.

184 *Meibomia tortuosa* → **Desmodium tortuosum** (Mill.) DC.

184 *Meibomia mollis* → **Desmodium glabrum** (Mill.) DC. *Desmodium* is conserved over *Meibomia*. *Supina* cannot be used as an epithet for the first species above because it is based on a name which is a later homonym (*Hedysarum supinum* Sw. non *H. supinum* Chaix ex Villars). *Incanum* has often been taken up as a specific epithet for this plant also (based on *Hedysarum incanum* Sw.), but the basionym is a later homonym for *H. incanum* Thunb. *Desmodium canum* is based on the earliest available legitimate epithet. *Desmodium glabrum* is based on an earlier basionym than *Meibomia mollis* of B&M.

185 *Alysicarpus nummularifolius* → **Alysicarpus vaginalis** (L.) DC. *Alysicarpus vaginalis* has been used for the false moneywort rather than a combination based on *Hedysarum nummularifolium* L. Schindler (1926)

interprets the Linnaean material as being *Indigofera echinata,* in part, and *Alysicarpus monilifer,* in part, hence the choice of *Hedysarum vaginale* L. as the basionym rather than the earlier one.

186 *Ecastophyllum ecastophyllum* → **Dalbergia ecastophyllum** (L.) Taub. *Dalbergia*'s having been conserved over *Ecastophyllum* eliminates the problem of the tautonym in B&M.

186 *Ichthyomethia piscipula* → **Piscidia piscipula** (L.) Sarg. *Piscidia* has been conserved over *Ichthyomethia.* (See Rudd, 1969).

187 *Abrus abrus* → **Abrus precatorius** L. The later epithet of Linnaeus is used to avoid the tautonym.

188 *Bradburya floridana* → **Centrosema floridanum** (Britt.) Lakela.

188 *Bradburya virginiana* → **Centrosema virginianum** (L.) Benth. *Bradburia* has been conserved for a genus of Compositae over *Bradburya* of the Leguminosae. See also Lakela (1963).

191 *Canavali lineata* → **Canavalia rosea** (Sw.) DC.

192 *Canavali bahamensis* → **Canavalia nitida** (Cav.) Piper. *Canavalia* is conserved over *Canavali.* Sauer (1964) revised species of *Canavalia,* but apparently overlooked Johnston's note (1949b) on publication of names referring to *C. maritima.* The basionym of this oft-used binomial has been treated as *Dolichos maritima* Aubl., but Thouars, in making the combination *Canavalia maritima,* did not in fact cite the Aublet name; hence it is not a new combination, but a new name dating from 1813. Aublet's name cannot then be transferred to *Canavalia* because it is preëmpted by the Thouars combination, albeit for the same species. Alas, another name proposed in the interval is the oldest which must be used, *Canavalia rosea* (Sw.) DC. Species 2 of B&M (*Canavali gladiata*) is probably not in the Bahamas. All specimens bearing this determination by either Britton or Mills-

paugh have been annotated by Sauer as *C. maritima* (=*C. rosea*).

192 *Cajan cajan* → **Cajanus cajan** (L.) Millsp. *Cajanus* is conserved over *Cajan.* The tautonym of B&M can thus be avoided.

193 *Dolicholus reticulatus* → **Rhynchosia reticulata** (Sw.) DC.

193 *Dolicholus swartzii* → **Rhynchosia swartzii** (Vail) Urb.

193 *Dolicholus minima* → **Rhynchosia minima** (L.) DC. *Rhynchosia* is conserved over *Dolicholus.* Dr. John Grear indicates (personal communication) that *Rhynchosia caribaea* based on *Glycine caribaea* Jacq. is not in the flora, thus agreeing with B&M. The latter is ironically not native to the New World, but is restricted to South Africa.

194 *Phaseolus lathyroides* → **Macroptilium lathyroides** (L.) Urb. On the basis of having five calyx teeth rather than four, *Macroptilium* is segregated from the large genus *Phaseolus.*

195 *Dolichos lablab* → **Lablab purpureus** L. Many workers (including Adams, 1972) use the generic segregate *Lablab* in preference to *Dolichos.* If one follows this trend, then the change above is indicated. Otherwise, *Dolichos lablab* may continue to be used.

Dolichos insularis → **Oxyrhynchus volubilis** Brandegee. This change follows studies by Rudd (1967).

195 *Vigna repens* → **Vigna luteola** (Jacq.) Benth. in Mart. Although the epithet *repens* is the oldest name, it is invalidated in *Vigna* by *V. repens* Baker, published in 1876 (Merrill, 1910).

OXALIDACEAE

197 *Inoxalis intermedia* → **Oxalis intermedia** A. Rich.

197 *Xanthoxalis corniculata* → **Oxalis corniculata** L. Modern treatment of Oxalidaceae would merge *Inoxalis* and *Xanthoxalis* into *Oxalis* (Eiten, 1963).

LINACEAE

200 *Cathartolinum curtissii* → **Linum medium** var. **texanum** (Planch.) Fern.

200 *Cathartolinum corallicola* → **Linum bahamense** var. **corallicola** (Small) Rogers.

200 *Cathartolinum bahamense* → **Linum bahamense** Northrop var. **bahamense.**

201 *Cathartolinum bracei* → **Linum bahamense** var. **bracei** (Small) Rogers.

201 *Cathartolinum lignosum* → **Linum bahamense** Northrop. var. **bahamense.** Rogers (1963; 1968) has restored *Linum* as the correct name for the yellow-flowered species in the West Indies. I have followed his 1963 treatment chiefly.

ZYGOPHYLLACEAE

202 *Guaiacum* — consult Porter (1972).

MALPIGHIACEAE

205 *Byrsonima cuneata* → **Byrsonima lucida** (Mill.) DC. It is generally agreed that the plum-berry or locust-berry should be *Byrsonima lucida,* based on *Malpighia lucida,* an earlier epithet than *cuneata.* But upon whose *M. lucida?* Most authors attribute the name to Swartz, but his *M. lucida* is a later homonym for *M. lucida* Mill. Both names can be typified by material at BM. DeCandolle (1824) specifically indicated the Swartz material as basionym, but it is illegitimate as a later homonym. Kunth (1923) indicated that he thought that *M. lucida* should be a *Byrsonima* but did not make the transfer in accord with the Code. Rather than presume to make a new combination at this date myself, I interpret this situation in the light of history. Swartz undoubtedly knew of Miller's name and probably even examined herbarium material from the Chelsea Physic Garden upon which the lectotype of *M. lucida* Mill. (chosen by Gillis) has been selected. That he (Swartz) did not specifically indicate that

he was taking up Miller's name is not important, it seems to me. There is ample precedent with Jacquin and Linnaeus, for instance, in assuming that the later author knew of the earlier work but did not, under existing convention, always cite the author of the earlier binomial, or place of publication. With this assumption, I shall follow Robertson (1971), in attributing the combination to DeCandolle with a lectotype of Miller's name at BM.

SIMAROUBACEAE

211 Cronquist's treatment of *Alvaradoa* (1944) would make the Bahamian populations *Alvaradoa amorphoides* subp. *psilophylla* (Urb.) Cronq.

BURSERACEAE

212 *Elaphrium inaguense* → **Bursera inaguensis** Britt.

212 *Elaphrium simaruba* → **Bursera simaruba** (L.) Sarg. *Bursera* is conserved over *Elaphrium.*

POLYGALACEAE

216 *Badiera oblongata* → **Polygala oblongata** (Britt.) Blake. It seems desirable not to segregate the woody species of *Polygala* into the genus *Badiera.*

EUPHORBIACEAE

219 *Cicca disticha* → **Phyllanthus acidus** (L.) Skeels. This name change follows Webster (1956-58).

220 *Margaritaria bahamensis* → **Margaritaria tetracocca** (Baill.) Webster. Webster (1956-58: J. Arnold Arbor. 38: 66) found that an earlier epithet applied to this species.

220 *Xylophylla epiphyllanthus* → **Phyllanthus epiphyllanthus** L. This treatment follows Webster (1967).

221 *Phyllanthus pruinosus* → **Phyllanthus caroliniensis** subsp. **saxicola** (Small) Webster.

221 *Phyllanthus pentaphyllus* → **Phyllanthus pentaphyllus** C. Wright subsp. **pentaphyllus.** This treatment follows Webster (1970).

223 *Croton flocculosus* Geisl. → **Croton flavens** var. **balsamiferus** (Jacq.) Muell.-Arg. It appears to me that *Croton flocculosus* is best treated as a variety of the widespread *Croton flavens.* It matches well the lectotype of *Croton balsamiferus* Jacq. (lectotype from Martinique at BM), the basionym.

225 *Curcas curcas* → **Jatropha curcas** L. Placement of the physic-nut in *Jatropha* seems to be the best placement taxonomically, and also avoids a tautonym.

225 *Adenoropium gossypifolium* → **Jatropha gossypifolia** L. *Adenoropium* is best treated as a subdivision of *Jatropha.*

225 *Argythamnia* — consult Ingram (1967).

228 The place of publication of *Acalypha alopecuroidea* Jacq. should be Collect. 3: 196. 1790.

229 *Acalypha ostryaefolia* → **Acalypha ostryifolia** Ridd.

229 *Pera bumeliaefolia* → **Pera bumeliifolia** Griseb. These orthographic changes are required by the Seattle Code.

230 *Manihot manihot* → **Manihot esculenta** Crantz. This name is the earliest available to replace the tautonym used in B&M.

232 *Gymnanthes lucida* → **Ateramnus lucidus** (Sw.) Rothm. Rothmaler (1944) and Dandy (1967) have resurrected *Ateramnus* P. Browne to replace the later *Gymnanthes* Sw. Although I am of the opinion that *Gymnanthes* should be conserved over *Ateramnus,* conservation was already rejected once by the Special Committee for Pteridophyta and Phanerogamae (Taxon 3: 241. 1954). There appears to be no choice but to adopt the new combination in *Ateramnus.*

234 *Adenorima gymnonota* → **Euphorbia gymnonota** Urb. *Adenorima* is treated as a section of *Euphorbia* by Webster (1967) and that treatment is followed here.

235 *Arthrothamnus cassythoides* → **Euphorbia cassythoides** Boiss. *Arthrothamnus* differs too little from other forms of *Euphorbia* to be segregated from it.

235 *Tithymalus trichotomus* → **Euphorbia trichotoma** H.B.K. *Tithymalus* is treated by Webster (1967) as a section of *Euphorbia.*

236 *Aklema petiolaris* → **Euphorbia petiolaris** Sims. *Aklema* differs too little from other forms of *Euphorbia* to be segregated from it.

238 *Chamaesyce wilsonii* → **Chamaesyce lecheoides** var. **wilsonii** (Millsp.) Burch.

238 *Chamaesyce lecheoides* → **Chamaesyce lecheoides** Millsp. var. **lecheoides.**

238 *Chamaesyce insulae-salis* → **Chamaesyce centunculoides** (HBK.) Millsp.

238 *Chamaesyce exumensis* → **Chamaesyce lecheoides** var. **exumensis** (Millsp.) Burch. These name changes follow the treatment by Burch (1966).

BUXACEAE

243 *Tricera bahamensis* → **Buxus bahamensis** Baker in Hook. *Tricera* is best treated by the earlier name *Buxus* (Howard, 1962).

ANACARDIACEAE

244 Poison-ivy in the Bahamas is the typical subspecies: **Toxicodendron radicans** (L.) Kuntze subsp. **radicans** (see Gillis, 1971).

CELASTRACEAE

247 *Rhacoma coriacea* → **Crossopetalum coriaceum** Northrop.

248 *Rhacoma crossopetalum* → **Crossopetalum rhacoma** (Sw.) Hitchc.

248 *Rhacoma aquifolia* → **Crossopetalum aquifolium** (Griseb.) Hitchc.

248 *Rhacoma ilicifolia* → **Crossopetalum ilicifolium** (Poir.) Kuntze. *Crossopetalum* was revived by Brizicky (1964) as the earliest name for this genus.

249 Although several recent rorkers have accepted *Cassine* as a widespread genus that would include *Elaeodendron* (Adams, 1972 and Ding Hou, 1963),

I have chosen to follow Robson (1965) to recognize the segregate genus *Elaeodendron* for the Bahamas, thus leaving *Cassine sensu stricto* for a small African genus.

SAPINDACEAE

252 *Thyana discolor* → **Thouinia discolor** Griseb. *Thouinia* Poit. is an earlier name than *Thyana* Hamilt. and is conserved over *Thouinia* Thunb. ex L.f.

253 *Allophylus cominia* → **Allophylus cobbe** (L.) Raeusch. Leenhouts (1967) makes a strong case for recognizing only one worldwide species in this genus. He has found no morphological gaps which can be used to distinguish separate populations in any geographical sense. Having chosen to recognize only one species, Leenhouts chose *A. cobbe* as the all-encompassing name from two Linnaean names of the same date.

253 *Melicocca bijuga* → **Melicoccus bijugatus** (L.) Jacq. The correct spelling of this name was worked out by Brizicky (1963).

RHAMNACEAE

257 *Sarcomphalus taylori* → **Ziziphus taylori** (Britt.) M. C. Johnston. Johnston's treatment (1964) merges *Sarcomphalus* with *Ziziphus.*

257 *Colubrina reclinata* → **Colubrina elliptica** (Sw.) Briz. et Stern.

258 *Colubrina cubensis* → **Colubrina cubensis** var. **floridana** M. C. Johnston.

258 *Colubrina colubrina* → **Colubrina arborescens** (Mill.) Sarg. These changes follow the monographic treatment by Johnston (1971).

TILIACEAE

263 *Triumfetta* — consult Ko Ko Lay, 1950.

MALVACEAE

264 *Phymosia* — consult Fryxell (1971).

266 *Gayoides crispum* → **Herissantia crispa** (L.) Brizicky.

The earliest generic name available for this segregate of *Abutilon* is *Herissantia* (See Brizicky, 1968).

267 *Sida ciliaris* → **Sida ciliaris** L. var. **ciliaris.**

268 *Sida carpinifolia* → **Sida acuta** subsp. **carpinifolia** (L.f.) Borss.

268 *Sida spinosa* → **Sida spinosa** var. **angustifolia** (Lam.) Griseb.

268 *Sida hederaefolia* → **Sida javanensis** Cav. emend. Borss. Recent treatments of *Sida* (Kearney, 1954b; Clement, 1957; Borssum Waalkes, 1966) do not all agree on treatment of the species in the Bahamas. I have followed Clement and Borssum Waalkes here.

271 *Malache scabra* → **Pavonia spicata** Cav. var. **spicata.**

271 *Malache bahamensis* → **Pavonia bahamensis** Hitchc. *Pavonia* is conserved over *Malache.* Kearney's (1954a) treatment is followed here except for one point. He overlooked the fact that *Pavonia scabra* (B. Vogel) Juble et Quentin is a later homonym of *P. scabra* Presl. It must be replaced by *P. spicata* var. *spicata.*

271 *Malvaviscus sagraeanus* → **Malvaviscus arboreus** var. **mexicanus** Schlecht. Schery (1942) has found an older name than the one given in B&M.

272 *Hibiscus bahamensis* → **Hibiscus brittonianus** Kearney. Because *H. bahamensis* Britt. is a later homonym, Kearney (1954c) published a new name.

272 Although a number of recent publications place okra in the genus *Hibiscus* as *H. esculentus,* Bates (1965) and Borssum Waalkes (1966) retained it in *Abelmoschus,* as in B&M, on the basis of the spathelike calyces which are basically adnate to the staminal tube and corolla, and which are circumscissilely deciduous.

273 *Pariti tiliaceus* → **Hibiscus tiliaceus** L. subsp. **elatus** (Hochr.) Borss. Borssum Waalkes (1966) is followed in his treatment of this taxon.

274 *Gossypium barbadense* → **Gossypium arborescens** var. **nadam** (Watt.) Prockh.

274 *Gossypium punctatum* → **Gossypium hirsutum** var. **punctatum** (Schum.) Hutch. Hutchinson (1943) is followed for the treatment of indigenous cotton species.

STERCULIACEAE

276 The use of names in *Melochia* has been thoroughly considered by Goldberg (1967) who considered *Moluchia* and *Melochia* synonymous. The only changes from B&M therefore are orthographic. Because the keys in B&M are inadequate, a new key to the Bahama species is given here:

1. Flowers in sessile glomerules, many per cluster; sinus between calyx teeth acute; fruit a 5-parted coccus less than 3.5 mm. in diameter .... *Melochia nodiflora* Sw.
1. Flowers pedicelled, 3-10 per cluster; sinus between calyx teeth rounded to truncate; fruit a 5-angled capsule, greater than 5 mm. in diameter .... 2.
    2. Capsule with rounded angles and unbranched hairs; inflorescences mostly in axillary cymes or appearing terminal; foliage leaves glabrous or with scattered, simple hairs; leaves only slightly lighter in color on lower surface than on upper .... *Melochia pyramidata* L.
    2. Capsule sharply angled, with dense stellate hairs; inflorescences mostly opposite the leaves, never terminal; foliage leaves densely stellate; leaves tending toward being discolorous, much lighter on the lower surface than upper due to dense pubescence .... *Melochia tomentosa* L.

278 *Waltheria americana* → **Waltheria indica** L. An examination of Linnaean material and resultant lectotypification has resolved the question of a name for

the common *Waltheria* in accord with Brizicky (1966) and the example used in the International Code (Art. 57). The lectotype (chosen by Gillis) of *Waltheria indica* L. is in the Hermann Herbarium at BM. The lectotype of *Waltheria americana* L. is at LINN (Savage Catalog No. 852: 1). They represent the same taxon; both names originate from the same date (1753). Robert Brown (in Tuckey, Narr. Exp. River Zaire 484. 1818) appears to be the first to adopt the name *W. indica* L. for the combined species, and therefore should be followed.

The descriptions and separation of the two species of *Waltheria* in B&M are ambiguous. The foliage of *W. bahamensis* is decidedly bronze in the field; herbarium specimens do not show this character well, but it is useful as a field character. The following key should assist in making determinations:

Foliage green; branches of stellate hairs 2-4 mm. long .... *Waltheria indica* L.

Foliage bronze; pubescence in small tufts, branches of stellate hairs less than 1 mm. .... *Waltheria bahamensis* Britt.

278 *Ayenia pusilla* → **Ayenia insulicola** Cristobal. Except for an orthographic change necessitated by the Seattle Code, the *Ayenia* species should be named according to Cristobal (1960).

HYPERICACEAE

280 *Ascyrum linifolium* → **Hypericum hypericoides** (L.) Crantz. The nomenclature of *Ascyrum* has undergone much discussion (Adams, 1957; Adams and Robson, 1961). The treatment of Adams and Robson (ibid.) has been followed here.

FLACOURTIACEAE

284 *Myroxylon ilicifolium* → **Xylosma ilicifolia** Northrop.

284 *Myroxylon bahamense* → **Xylosma bahamensis** (Britt.) Standl. *Xylosma* G. Forst. has been conserved over

Myroxylon J. R. et G. Forst. as a genus of Flacourtiaceae (*Myroxylon* L. has been conserved in the Leguminosae). The question of whether these two species are, in fact, distinct still needs to be explored further.

PASSIFLORACEAE

288 *Passiflora pallida* → **Passiflora suberosa** L. The two names above are synonyms of the same date; they were united by Killip (1938). See also Brizicky, 1961. *Passiflora* species in the Bahamas will be evaluated in a separate paper.

LOASACEAE

290 *Mentzelia* — consult Darlington (1934).

LYTHRACEAE

300 *Parsonsia parsonsia* → **Cuphea parsonsia** (L.) R. Br. *Parsonsia* is conserved for a genus of Apocynaceae; it therefore cannot be used for a genus of Lythraceae.

COMBRETACEAE (TERMINALIACEAE)

302 *Conocarpus erecta* → **Conocarpus erectus** L. The generic name *Conocarpus* should be treated as masculine in accordance with the International Code (Recommendation 75A). In Stearn (1966) the substantive termination *-carpus* is consistently treated as masculine. Stearn (personal communication) suggests that Linnaeus may have treated *Conocarpus* as feminine by analogy with many classical second-declension names of trees.

MYRTACEAE

303 *Eugenia buxifolia* → **Eugenia foetida** Pers. The Myrtaceae need to be reworked in the light of McVaugh's generic guidelines and definitions (1956; 1968). The change indicated above is made in accord with his analysis of types (McVaugh, 1973).

305 *Pimenta pimenta* → **Pimenta dioica** Merr. This change is made to avoid a tautonym.

306 *Anamomis longipes* → **Psidium longipes** (Berg) McVaugh var. **longipes.**

306 *Anamomis bahamensis* → **Psidium longipes** var. **orbiculare** (Berg) McVaugh.

306 *Anamomis lucayana* → **Myrcianthes fragrans** (Sw.) McVaugh. The first two of these changes is in accord with the interpretation of these species by McVaugh (1973). *Psidium longipes* var. *orbiculare* is further elaborated in the same paper by McVaugh by describing unnamed races which can be distinguished. *Myrcianthes fragrans* is defined in an earlier paper by McVaugh (1963).

ONAGRACEAE

310 *Jussiaea suffruticosa* → **Ludwigia octovalvis** subsp. **sessiliflora** (Micheli) Raven. This name change follows the treatments of *Ludwigia* by Raven (1962; 1968).

UMBELLIFERAE (AMMIACEAE)

313 *Foeniculum foeniculum* → **Foeniculum vulgare** Gaertn. This change is made to avoid a tautonym.

MYRSINACEAE

315 *Icacorea paniculata* → **Ardisia escallonioides** Cham. et Schl.

316 *Icacorea guadalupensis* → **Ardisia obovata** Desv. *Ardisia* is conserved over *Icacorea.* The Bahama plants need further study and interpretation, but they appear to be named best as stated above.

316 *Rapanea guianensis* → **Myrsine floridana** A. DC. *Rapanea guianensis* Aubl. may be typified by a specimen of Aublet's in P (lectotype of Gillis). It represents a plant with lustrous, large leaves from northern South America. The northern West Indian and Floridian species has dull, smaller leaves. Futhermore, it represents the group of species with a globose stigma, a character which has been used to separate *Myrsine* from *Rapanea.* Stearn (1969) made the

combination *Myrsine punctata* (Lam.) Stearn for this species, but the name is a later homonym for a species of the Pacific region which had been published several years earlier. The earliest available name for this plant is *Myrsine floridana* A. DC. If one prefers this species in *Rapanea,* then its name should be *R. punctata* (Lam.) Lundell.

PRIMULACEAE

318 *Samolus floribundus* → **Samolus parviflorus** Raf. This change is made in accordance with Channell and Wood (1959); it is based on an earlier epithet.

SAPOTACEAE

320 *Chrysophyllum* — consult Cronquist (1945).

321 *Sideroxylon foetidissimum* → **Mastichodendron foetidissimum** (Jacq.) Cronq. This change is made in accord with the treatment by Cronquist (1946a).

322 *Lucuma serpentaria* → **Pouteria domingensis** (Gaertn.) Cronq. var. **domingensis.** This change follows the treatment by Cronquist (1946a).

322 *Dipholis salicifolia* → **Bumelia salicifolia** (L.) Sw. Although Cronquist (1945) retained *Dipholis* as a segregate genus, Stearn (1968) merged it with *Bumelia.* It is the latter treatment which is followed here.

323 *Bumelia angustifolia* → **Bumelia celastrina** H.B.K.

323 *Bumelia loranthifolia* → **Bumelia americana** (Mill.) Stearn subsp. **americana.**

323 *Bumelia bahamensis* → **Bumelia americana** (Mill.) Stearn subsp. **americana.** The *Bumelia* complex in the West Indies has been treated by Stearn (1968), a treatment followed here. The following key should help clarify the species in the Bahamas:

1. Ovary glabrous; endosperm copious; leaves longer than 7 cm.; terminal shoots never becoming thorns .. *Bumelia salicifolia* (L.) Sw.
1. Ovary pubescent; endosperm little or none;

leaves shorter than 6 cm.; terminal shoots often thorny . . . . 2.

2. Leaves narrow, linear to spathulate, 2-10 mm. broad (juveniles may be larger); fruit oblong; plant inhabiting shores, mangal, and saline areas . . . . *Bumelia celastrina* H.B.K.
2. Leaves obovate to oblanceolate, 1-4 mm. broad; fruits globose; inhabiting uplands . . . . *Bumelia americana* (Mill.) Stearn subsp. *americana*.

324 *Mimusops emarginata* → **Manilkara bahamensis** (Baker) Lam. et Meeuse. Probably no species in the Bahamas is easier to identify and yet harder to name than the wild dilly! In addition to the long list of synonyms given in B&M, it has been called *Achras emarginata* (L.) Little, *Mimusops jamaiqui* (Wright) Dubard, *M. jamaiqui* subsp. *emarginata* (L.) Cronq., and *Manilkara parvifolia* (Nutt.) Dubard, to name a few. For the moment, I have selected *Manilkara bahamensis* (Baker) Lam. et Meeuse. Thus, it resides in the same genus preferred by Moore and Stearn (1967) for its close relative, the sapodilla, and also preferred by Cronquist (1945).

324 *Sapota achras* → **Manilkara zapota** (L.) P. van Royen. By the same token as with the wild dilly (above), the cultivated sapodilla has had a variety of names, many of which are permutations of each other. Moore and Stearn (ibid.) analyzed the problem thoroughly and leave a choice of names depending upon the breadth of one's generic concepts. Along with them, I choose the one indicated above.

EBENACEAE

325 *Maba crassinervis* → **Diospyros crassinervis** (Krug et Urb.) Standl. *Maba* is treated as being a synonym of *Diospyros*. The name given above in *Diospyros* is temporary. A new combination will soon be published by Mr. Frank White (Oxford).

OLEACEAE

328 The *Mayepea bumelioides* of B&M will be placed in *Chionanthus* by Stearn at a later date, at which time a new combination will be published.

GENTIANACEAE

331 Based on Shinners's typification (1957), the name of the marsh gentian remains the same, but the author of the binomial and place and date of publication change from what is given in B&M: *Eustoma exaltatum* (L.) Salisb., Parad. Lond. t. 34. 1806.

331 *Sabbatia campanulata* → **Sabatia stellaris** Pursh.

332 *Sabbatia simulata* → **Sabatia stellaris** Pursh. Wilbur (1955) and Perry (1971) have studied the taxonomy of *Sabatia* in detail. As a consequence, one species only is considered to be in the Bahamas. The correct spelling of the generic name should also be noted.

MENYANTHACEAE

333 *Nymphoides aureum* → **Nymphoides grayana** (Griseb.) Kuntze. This name change is made in accord with the treatment by Ornduff (1969). It should be noted that this so-called endemic *Nymphoides* (according to B&M) is also found in Cuba.

APOCYNACEAE

334 *Plumiera obtusa* → **Plumeria obtusa** L. var. **obtusa.**

334 *Plumiera inaguensis* → **Plumeria obtusa** L. var. **obtusa.**

334 *Plumiera bahamensis* → **Plumeria obtusa** L. var. **obtusa.**

335 *Plumiera rubra* → **Plumeria rubra** L.

335 *Plumiera sericifolia* → **Plumeria obtusa** var. **sericifolia** (C. Wright) Woodson. Woodson (1938) reworked the species of *Plumeria*, taking up the correct spelling of the generic name. He considered several of the "species" of B&M to be insular races of *P. obtusa* var. *obtusa*.

335 Woodson (1936) recognized *Neobracea bahamensis* as endemic, but also noted that there are three other species in Cuba, i.e., it is not a monotypic genus as stated in B&M.

336 Stearn (1964) confirmed the name of the periwinkle as *Catharanthus roseus* (L.) G. Don.

336 *Echites echites* → **Echites umbellata** Jacq. var. **umbellata.**

337 *Rhabdadenia paludosa* → **Rhabdadenia biflora** (Jacq.) Muell.-Arg.

337 *Rhabdadenia sagraei* → **Angadenia berteri** (A. DC.) Miers.

338 *Urechites lutea* → **Urechites lutea** var. **serica** Long. Woodson (1936) redefined the generic limits of a number of American Apocynaceous plants. His treatment is followed here. Long (1970a), in studying populations in South Florida, treated *Urechites* such that the Bahamian populations are recognized as a distinct pubescent population, *U. lutea* var. *sericea.* Because the *Apocynaceous* vines are not adequately keyed in B&M, and because the names of all of them have been changed, the following key has been prepared for use in separating them:

KEY TO BAHAMIAN APOCYNACEOUS VINES

1. Corolla white or ivory, usually more than 5 cm. long; leaves remaining flat or folding along the midrib when pressed; follicles of pair divergent, not tending to curve back like pincers, 4-10 mm. thick . . . . 2.
   2. Follicles of a pair widely divergent (greater than 180°); tube of corolla salverform with rotate lobes; cylindric part of corolla 10-15 times the length of the sepals; calyx lobes free nearly to base, linear to linear-lanceolate . . . *Echites umbellata* Jacq. var. *umbellata.*
   2. Follicles of a pair divergent less than 90°; tube of corolla funnelform; cylindric part of

corolla 2-3 times the length of the sepals; calyx lobes free scarcely more than 2/3 the length, ovate, to 2.5 mm. broad .... *Rhabdadenia biflora* (Jacq.) Muell.-Arg.

1. Corolla yellow, usually less than 5 cm. long; leaves tending to curl under at the edges when pressed; follicles of a pair diverging at an angle of less than 60°, curving back to touch near their tips, resembling a pair of pincers, 1.5-3 mm. thick .... 3.
   3. Vine scarcely 1 m. long; corolla 2-4 cm. long; leaves oblong, usually less than 1 cm. broad; pedicels glabrous; calyx lobes free less than half their length, 1-1.5 mm., acuminate; cylindric part of corolla visible most of its length (i.e., not hidden by sepals); petiole 2 mm. long .... *Angadenia berteri* (A.DC.) Miers
   3. Vine up to 3.5 mm. long; corolla 4-5 cm. long; leaves obovate or elliptic to 3 cm. broad; pedicels densely pubescent; calyx lobes free nearly to base, 8-12 mm. long, linear; cylindric portion of corolla hidden by sepals; petiole 1 cm. long .... *Urechites lutea* var. *sericea* Long

339 *Rauwolfia tetraphylla* → **Rauvolfia nitida** Jacq. Rao (1956) thought that *Rauvolfia tetraphylla* is indigenous to the Greater Antilles, Central America, and South America as far as Peru and Venezuela. The Bahamian species is *R. nitida,* which is not a synonym of *R. tetraphylla* as suggested in B&M.

339 *Vallesia glabra* → **Vallesia antillana** Woodson. Woodson (1937, 1938b) found that the true *Vallesia glabra* is a plant of Mexico and the Pacific Coast of South America. The species of southern peninsular Florida and the West Indies that has corollas twice the length of those of *V. glabra* needed a name. The name *V. glabra* of B&M is thus misapplied.

ASCLEPIADACEAE

342 *Metastelma northropiae* → **Cynanchum northropiae** (Schltr.) Alain.

342 *Metastelma hamatum* → **Cynanchum caribaeum** Alain.

343 *Metastelma inaguense* → **Cynanchum inaguense** (Vail) Howard et Dunbar.

343 *Metastelma linearifolium* → **Cynanchum savannarum** Alain.

343 *Metastelma eggersii* → **Cynanchum eggersii** (Schltr.) Alain.

343 *Metastelma palustre* → **Cynanchum angustifolium** Pers. *Metastelma* species are considered synonymous with *Cynanchum*. (See Woodson, 1941; Alain, 1955). Much work needs to be done on the Bahamian species, but almost certainly several will be united. I shall refrain from making transfers to *Cynanchum* of several names which have not already been transferred because I feel certain at this point that these names are synonyms of other names in the flora. (See also Howard and Dunbar, 1964). Merrill and Hu (1949) discovered that Muhlenberg had found *Cynanchum angustifolium* to be the eariest legitimate name for the last species listed above. They indicated the extensive synonyms for this species, a few of which had never ben included in the standard indices.

344 *Philibertella clausa* → **Sarcostemma clausum** (Jacq.) R. & S. *Sarcostemma* is an earlier name than *Philibertella* (Woodson, 1941).

CONVOLVULACEAE

347 *Evolvulus glaber* → **Evolvulus convolvuloides** (Willd.) Stearn.

347 *Evolvulus alsinoides* → **Evolvulus alsinoides** var. **grisebachianus** Meissn. in Mart.

347 *Evolvulus linifolius* → **Evolvulus alsinoides** var. **linifolius** (L.) Baker. Stearn (1972) has modified the nomenclature of several species of *Evolvulus* in the flora in the course of typification of their names. The

last taxon listed above is now believed not to occur in the flora.

348 *Jacquemontia jamaicensis* → **Jacquemontia havanensis** (Jacq.) Urb. Dr. Kenneth Robertson (personal communication) has pointed out that this name change is required because of an earlier basionym.

349 *Calonyction aculeatum* → **Ipomoea alba** L.

350 *Calonyction tuba* → **Ipomoea macrantha** R. et S. Both Ooststroom (1940) and Gunn (1972) have worked with *Calonyction*. Gunn's nomenclature is followed here.

350 *Quamoclit quamoclit* → **Ipomoea quamoclit** L.

350 *Quamoclit coccinea* → **Ipomoea hederifolia** L. *Quamoclit*, like *Calonyction*, is treated as a section of *Ipomoea*. (see Ooststroom, 1953).

352 *Ipomoea cathartica* → **Ipomoea acuminata** (Vahl) R. et S.

352 *Ipomoea pes-caprae* → **Ipomoea pes-caprae** subsp. **brasiliensis** (L.) Ooststr. This treatment of *Ipomoea* follows that of Ooststroom (1940) and St. John (1970). The citation for *Ipomoea stolonifera* in B&M is incorrect; there is an earlier publication date of the combination: *Ipomoea stolonifera* (Cyrill.) Gmel., Syst. Veg. I: 345. 1796.

353 *Ipomoea dissecta* → **Merremia dissecta** (Jacq.) Hall. f. *Merremia* is segregated from *Ipomoea* on the basis of its smooth pollen and its corolla without a red or purple eye (O'Donell, 1941; Ooststroom with Hoogland, 1953; Verdcourt, 1963).

355 *Dichondra*. Consult Tharp and Johnston (1961).

CUSCUTACEAE

356 *Cuscuta pentagona* → **Cuscuta campestris** Yuncker. This species needed a new name because of confusion in the old one (Yuncker, 1932).

HYDROPHYLLACEAE

357 *Marilaunidium jamaicense* → **Nama jamaicensis** L.

Nama is an earlier name than *Marilaunidium.* Furthermore, *Nama jamaicensis* L. is the conserved type species.

BORAGINACEAE (EHRETIACEAE)

357 *Sebesten sebestena* → **Cordia sebestena** L.

358 *Varronia globosa* → **Cordia globosa** var. **humilis** (Jacq.) Johnston.

358 *Varronia bahamensis* → **Cordia bahamensis** Urb.

359 *Varronia brittonii* → **Cordia brittonii** (Millsp.) Macbride.

359 *Varronia lucayana* → **Cordia lucayana** (Millsp.) Macbride. *Sebesten* and *Varronia* should be treated as synonyms of *Cordia* (Macbride, 1916; Johnston, 1949).

360 *Rochefortia bahamensis* → **Rochefortia spinosa** (Jacq.) Urb. According to Lefor (1968), the *Rochefortia* in the Bahamas is not an endemic species, but the same as that found in Cuba.

361 There is debate over the generic selection for bay lavender. For the moment, I maintain *Mallotonia,* as in several other recent floras (Gooding, Loveless, and Proctor, 1965; Adams, 1972).

362 *Heliotropium parviflorum* → **Heliotropium angiospermum** Murray. The change of name is required because *H. angiospermum* is an earlier name.

363 *Heliotropium inundatum* → **Heliotropium procumbens** Mill. *Heliotropium procumbens* is an earier name for the same species. Both names can be typified by specimens at BM; the lectotypes have been selected by me.

VERBENACEAE

365 *Valerianoides fruticosa* → **Stachytarpheta fruticosa** (Millsp.) B. L. Robinson.

366 *Valerianoides jamaicensis* → **Stachytarpheta jamaicensis** (L.) Vahl. *Stachytarpheta* is conserved over *Valerianoides.*

366 *Bouchea prismatica* → **Bouchea prismatica** var. **longirostra** *Grenzen.* This treatment follows the revision of *Bouchea* by Grenzenbach (1926). Moldenke (1971) believes that the typical variety is also present in the Bahamas.

367 *Priva* — consult Kobuski (1926).

368 *Lippia stoechadifolia* → **Phyla stoechadifolia** (L.) Small.

368 *Lippia nodiflora* → **Phyla nodiflora** (L.) Greene var. **nodiflora.**

369 *Lippia reptans* → **Phyla nodiflora** var. **reptans** (H.B.K.) Moldenke. These changes are made in accord with the treatment of *Phyla* by Moldenke (1965). *Lippia geminata* of B&M is probably not found within the archipelago. The appropriate treatment of this binomial would be *Lantana microcephala* A. Rich. in any event.

369 According to treatment by Long (1970a) our variety of *Lantana ovatifolia* would be the typical variety (var. *ovatifolia*).

371 Using Moldenke's treatments (1958a, b, and c) of *Citharexylum,* I have prepared the following key to distinguish the Bahamian species:

Pedicels less than 1.2 mm. long during anthesis; pyremes 2-loculate, fruit not shiny; leaves ± pilose, closely reticulate-veined, the reticulation prominent above and below . . . *Citharexylum fruticosum* L.

Pedicels 2 mm. long or more during anthesis; pyremes 1-loculate, fruit shiny; leaves glabrous, widely reticulate-veined, reticulation obscure above . . . . *Citharexylum caudatum* L.

Moldenke (1958a; 1971) has considered 5 infraspecific taxa of *C. fruticosum* to exist in the Bahamas: var. *fruticosum,* var. *smallii* Moldenke, var. *subvillosum* Moldenke, var. *villosum* (Jacq.) O. E. Schultz, and forma *bahamense* Moldenke. Having made field studies on the characters upon which these taxa are based, I consider these to be insular forms or populations without names. For those who wish to name these variations, an appropriate key is found in Moldenke (1958a).

373 *Callicarpa* — consult Moldenke (1936).

373 *Petitia* — consult Moldenke (1937).

374 *Volkameria aculeata* → **Clerodendrum aculeatum** (L.) Schlecht. var. **aculeatum.** *Volkameria* is treated by Moldenke (1971) as a section of *Clerodendrum.* The place of citation for *C. aculeatum* is incorrect in B&M. The author of the combination is Schlechtendahl, and the citation is Linnaea 6: 750. 1831.

375 *Clerodendrum fragrans* → **Clerodendrum philippinum** Schauer. Howard and Powell (1968) found that *C. fragrans* was an illegitimate name. Moldenke (1971) considers the Bahamian population to be var. *pleniflorum* Schauer.

375 *Avicennia nitida* → **Avicennia germinans** (L.) L. Stearn (1958) found this earlier epithet which applies to the species of black mangrove in the West Indies, but failed to note that its earliest combination was by Linnaeus himself.

LABIATAE (LAMIACEAE)

376 *Melosmon cubense* → **Teucrium cubense** Jacq. Epling (1925) united *Melosmon* and *Teucrium.*

377 *Leonurus* — consult Epling (1925).

378 The place of publication for *Leonotis nepetifolia* (L.) R.Br. is the Prodromus florae Novae Hollandiae, p. 504. 1810, and not as given in B&M (Epling, 1925).

378 In Epling's treatment (1938-39), *Salvia serotina* L. and *S. micrantha* Vahl (indicated as synonyms in B&M) were separated on rather minor characters. Through the courtesy of Dr. Mildred Mathias and Dr. Raymond Harley, I have seen an unpublished manuscript of Epling and Carlos Jativa in which

these species were reunited. It seems best to continue to treat them as synonymous. (Permission of Carlos Jativa to refer to this unpublished material is acknowledged with appreciation.)

379 On the basis of rather minor characters of the calyx, Shinners (1962) reworked the *Micromeria brownei* complex, recognizing the Bahamian populations as *M. bahamensis* Shinners. Because my own collections from Inagua more closely resemble the taxon which Shinners cites from Hispaniola, I believe more work needs to be done before the matter is resolved. Chiefly because of the minor nature of the characters which are used in defining Shinners's species, I continue to recognize a broadly treated *M. brownei* (Sw.) Benth.

SOLANACEAE

381 *Physalis angulata* → **Physalis angulata** L. var. **angulata.**

382 *Physalis turbinata* → **Physalis cordata** Mill.

382 *Physalis pubescens* → **Physalis barbadensis** Jacq. These changes are in accord with the treatment by Waterfall (1967).

383 *Solanum verbascifolium* → **Solanum erianthum** D. Don. Roe (1968) found that the old name for this plant did not apply to the species in our flora.

385 *Lycium spathulifolium* → **Lycium tweedianum** var. **chrysocarpum** (Urb. et Ekm.) Hitchc. In the monograph of *Lycium* (Hitchcock, 1932), the Bahamian plant required a name change. Although it is possible that the species of the Florida Keys (*L. carolinianum* Walt.) is in the Bahamas, it has yet to be found.

SCROPHULARIACEAE

388 *Maurandya antirrhinaeflora* → **Maurandya antirrhiniflora** H. et B. ex Willd. This orthographic change is required by the Seattle Code. I can now report this species to be on the far side of the archipelago from New Providence as recorded in B&M: *Gillis 11780* from Grand Turk.

389 *Bramia monnieri* → **Bacopa monnieri** (L.) Pennell. *Bacopa* has been conserved over *Brami* and *Moniera.* It is an earlier name than *Bramia.*

390 Although Pennell (1935) segregated *Erinus* from *Mecardonia,* I believe that *Mecardonia* is best treated as an inclusive genus, thus maintaining *Mecardonia procumbens* (Mill.) Small as in B&M.

392 *Afzelia cassioides* → **Seymeria cassioides** (Walt.) Blake. *Seymeria* is conserved over *Afzelia.*

393 *Buchnera elongata* → **Buchnera floridana** Gandoger. Philcox (1965) thinks that *B. elongata* is a misapplied name for the Florida and Bahama populations.

LENTIBULARIACEAE

394 *Setiscapella subulata* → **Utricularia subulata** L.

395 *Stomoisia cornuta* → **Utricularia cornuta** Michx. Taylor (1967) includes *Setiscapella* and *Stomoisia* within *Utricularia.*

BIGNONIACEAE

397 *Macrocatalpa punctata* → **Catalpa punctata** Griseb. var. **punctata.** This change is made in accord with the treatment of *Catalpa* by Paclt (1952).

PEDALIACEAE

399 *Sesamum orientale* → **Sesamum indicum** L. These names are synonymous binomials of the same publication date. *Sesamum indicum* L. has been used more commonly than the other name. Hill (1939) pointed out that DeCandolle (Pl. Rar. Jard. Genève 18, t.5 — 1889) was the first to unite the two names under *Sesamum indicum.*

ACANTHACEAE

401 *Blechum brownei* should be retained despite the attempt of some to change the name of this species to *Blechum pyramidatum.* The Linnaean binomial is *Ruellia blechum.* Lamarck renamed the species *Bar-*

laria pyramidata, but this name is illegitimate, being superfluous when published. Jussieu later published a new name in *Blechum;* this is accepted because the tautonym which would be created by transferring the Linnaean epithet is illegitimate (Bremekamp, 1938; Long, 1970b).

402 *Gerardia droseroides* → **Stenandrium droseroides** Nees in DC.

402 *Gerardia bracteosa* → **Stenandrium bracteosum** (Britt. et Millsp. Britt. ex Leonard). *Stenandrium* is conserved over *Gerardia.*

403 *Anthacanthus spinosus* → **Oplonia spinosa** (Jacq.) Raf. Stearn (1971) has studied the generic complex of which this species is a part and has recognized our plant to be an *Oplonia.*

404 *Diapedium assurgens* → **Dicliptera assurgens** (L.) Juss. *Dicliptera* is conserved over *Diapedium* (see also Long, 1970b). I have chosen the lectotype to be at LINN (No. 28:23 according to the Savage Catalog, 1945).

RUBIACEAE

407 The Rubiaceae are in need of in-depth treatment as a whole. Names accepted here may be subject to revision as more work is done.

408 *Oldenlandia callitrichoides* → **Hedyotis callitrichoides** (Griseb.) Lewis. Merrill and Metcalf (1942) and Lewis (1961) have united *Oldenlandia* and *Houstonia* with *Hedyotis.* Lewis's treatment is followed here.

409 *Rachicallis americana* → **Rhachicallis americana** (Jacq.) Hitchc. The original spelling of the generic name has been restored. Despite the fact that it has been written without the first "h" ever since the original publication, there seems no reason not to accept the original orthography considering the Greek origin. Nickerson and Tripp (1973) have reported this species to have either male or perfect flowers, never female.

410 *Randia mitis* → **Randia aculeata** L. These two names,

synonyms of the same date of publication, have been united under *R. aculeata.*

411 *Catesbaea parviflora* → **Catesbaea parviflora** var. **septentrionalis** Krug et Urb. ex Urb. The Bahamian populations fit this variety better than do the typical species form.

412 *Hamelia erecta* → **Hamelia patens** Jacq. These names are synonyms of the same date of publication. Thomas Elias (personal communication) has informed me that L'Héritier was the first to unite them, and should be followed.

413 *Guettarda taylori* → **Guettarda nashii** Britt. et Millsp.

413 *Guettarda inaguensis* → **Guettarda nashii** Britt. et Millsp. There does not seem to be sufficient difference to maintain three distinct species of *Guettarda* supposedly endemic to the vicinity of Matthew Town, Inagua. Having studied both the type specimens (at NY) and material in the field, I have concluded that Britton and Millspaugh named specimens, not species. *Guettarda inaguensis* is represented by a type that appears to have come from an aberrant form with long lengths of bare branches and leaves only near the tips. *Guettarda taylori* is represented by a type that has no flowers left and for which no fruits were ever known. Because of the inadequancy of these two specimens, it seems best to select the name for the united species by the type possessing the most adequate material. Inasmuch as these three species names originate from the same data, I am choosing *G. nashii* as the name to be used when all three are united. The populations of *Guettarda* in the vicinity of Matthew Town, although variable, appear to me to be best treated as a single species.

414 *Stenostomum lucidum* → **Antirhea lucida** (Sw.) Hook. f. in Benth. et Hook. f.

415 *Stenostomum myrtifolium* → **Antirhea myrtifolia** (Griseb.) Urb.

415 *Stenostomum densiflorum* → **Terebraria resinosa** (Vahl.) Sprague. *Stenostomum* as used by B&M is better divided into *Antirhea* and *Terebraria*. *Antirhea* is an older name than *Stenostomum* and hence must be the name used for those species traditionally placed in *Stenostomum*. The tortuous history of the name of *Terebraria resinosa* is recounted thoroughly by Sprague (1932). Sprague recognized two West Indian species of *Terebraria*, differing only in shape of the areoles of the leaf venation. In his treatment, the Bahamian population would be *T. densiflora*. I consider these differences to represent only insular forms, not worthy of nomenclatural separation. A key to the species in the Bahamas of the old *Stenostomum* follows:

1. Ovary 2 (-4) loculate; flowers without bracts; anthers half-exserted; stipules deciduous; foliage without resinous secretions .... *Antirhea lucida* (Sw.) Hook. f. in Benth. et Hook. f.
1. Ovary 4-6 loculate; flowers subtended by minute bracts; anthers included; stipules persistent; foliage resinous-viscid .... 2.
    2. Leaves 3 cm. long or less, elliptic to obovate-oblong; diffusely-branched shrub with leaves crowded near ends of branches; midvein very pronounced, often white; 2-4 flowers per branch of inflorescence; stipules ovate, not forming a collar around stem; inflorescences paired on either side of stem, but not branched .... *Antirhea myrtifolia* (Griseb.) Urb.
    2. Leaves 4-9 cm. long, oblong-lanceolate; coarsely-branched shrub or small tree with leaves widely scattered; midvein only slightly more pronounced than lateral veins; more than 6 flowers per branch of inflorescence; stipules forming a collar 2-4 mm. broad

around stem; inflorescence bifid with flowers only on inside (adaxial surface) of branches ..... *Terebraria resinosa* (Vahl) Sprague.

419 *Psychotria undata* → **Psychotria nervosa** Sw. Jacquin described *P. undata* in the *Plantarum rariorum horti caesarei schoenbrunnensis.* According to Stafleu (1967), the title page date of 1798 is probably in error, and actual date of publication may have been as late as 1803. In any event, Swartz in his *Prodromus* (1788) published the name *Psychotria nervosa* for the same species, clearly the earliest date of publication. *Psychotria nervosa* Benth. (1841) and *P. nervosa* D. Don (1825) are later homonyms.

420 *Ernodea cokeri* → **Ernodea taylori** Britton.

421 *Ernodea nashii* → **Ernodea millspaughii** Britton. It is difficult to make hard-and-fast decisions on the *Ernodea* problems in the Bahamas at this juncture. Whether *E. littoralis* and *E. angusta* are truly distinct is questionable. Long (1970a) has treated *E. angusta* as a variety of *E. littoralis* which may be the best way to handle these perplexing taxa. Until intensive study is made of these two species with comparisons to the other *Ernodea* taxa in the Bahamas, I shall continue to recognize these two as species. Distinctions among the other four species do not seem to hold up when examined under field conditions. Although more study will be carried out on *Ernodea* in the Bahamas, under a tentative arrangement which seems reasonable at this stage, *E. cokeri* is considered to be a synonym of *E. taylori*, and *E. nashii* is merged with *E. millspaughii.* The latter name was chosen from the two originating at the same date of publication because it is represented by the type specimen possessing both flowers and fruits. The type of *E. taylori* has no flowers at all; the type of *E. nashii* must have had flowers at the time Britton described the species, but they are missing from the type

specimens now (types are at NY). The differences as observed in the type specimens of these microspecies seem inadequate for maintenance in this exceedingly variable genus (also see Britton, 1908, for descriptions of "races" within this complex). A key to identify the Bahamian species of *Ernodea* within my species concept at the moment follows:

1. Calyx lobes nearly as long as the fruit, or longer .... 2.
    2. Corolla white to very pale pink .... *Ernodea littoralis* Sw.
    2. Corolla red ...... *Ernodea angusta* Small.
1. Calyx lobes less than half as long as the fruits .... 3.
    3. Leaves 6-8 mm. wide .... *Ernodea millspaughii* Britton.
    3. Leaves 1-3 mm. wide .... *Ernodea taylori* Britton.

422 *Borreria saxicola* → **Borreria brittonii** Standl. Unlike *Ernodea*, the eight species of *Borreria* in the Bahamas — or, at least most of them — seem to be good biological species with a high degree of endemism in the southern islands, especially Inagua and the Caicos group. Whereas actual treatment of this genus is deferred for the moment, one name change needs to be cited. Following Standley (1931), the name *B. saxicola* Britt. is replaced because it is a later homonym.

423 *Spermacoce* — consult Bacigalupo (1972).

CUCURBITACEAE

426 *Anguria pedata* → **Psiguria pedata** (Jacq.) Howard. In his treatment of modern names for plants discussed in Jacquin's *Selectarum,* Howard (1973) found that the name *Anguria* Jacq. was a later homonym for *Anguria* Mill. The next available generic name is *Psiguria;* Howard made the necessary new combinations for this species.

LOBELIACEAE

428 *Lobelia* — consult McVaugh (1943).

GOODENIACEAE

429 *Scaevola plumierii* → **Scaevola plumieri** (L.) Vahl. This orthographic change is made to conform to the present International Code.

COMPOSITAE (AMBROSIACEAE AND CARDUACEAE)

431 *Xanthium chinense* → **Xanthium strumarium** L. *Xanthium strumarium* is an earlier name than *X. chinense.*

432 *Ambrosia paniculata* → **Ambrosia artemisiifolia** L. I have selected a lectotype of *Ambrosia paniculata* from material in the Michaux Herbarium at Paris. Furthermore, I have examined the lectotype of *A. artemisiifolia* which was selected by Payne (1970) at LINN, and concur with Payne that these plants are conspecific. The Linnaean name is obviously the older one and should be used.

432 *Iva* — consult Jackson (1960).

436 *Ageratum latifolium* → **Ageratum conyzoides** subsp. **latifolium** (Cav.) M. F. Johnson. This name change has been made in accord with the treatment by Johnson (1971). The typical subspecies has also been reported from the Bahamas, thus adding a taxon to the flora.

440 *Chrysopsis graminifolia* → **Heterotheca graminifolia** (Michx.) Shinners. Shinners (1951), Wagenknecht (1960), and Harms (1964) have argued for the merger of *Heterotheca* and *Chrysopsis.*

441 *Aster bracei* → **Aster tenuifolius** var. **aphyllus** Long. Long (1970a) has treated the Bahamian populations in connection with those of South Florida which he was studying. This taxon seems best treated as a variety of the more widespread *A. tenuifolius.*

443 *Leptilon linifolium* → **Conyza floribunda** H.B.K.

CUPRESSACEAE (PINACEAE)

462 *Juniperus lucayana* → **Juniperus bermudiana** L. More work needs to be done on typification and on population studies in *Juniperus* to place the Bahamian plant properly. For the moment, it is treated in accord with Moore, 1966.

CYCADACEAE

463 A thorough monograph of *Zamia* is needed. In a manuscript by Chamberlain, left unpublished at his death, *Z. lucayana* has been referred to the Cuban *Z. guttierezii* Sauv. So little material of this plant, as well as of *Z. angustifolia* and *Z. tenuis*, is available at this time, that it is not appropriate to make a nomenclatural judgment now. The recent rediscovery of the Long Island population of "*Z. lucayana*" by S. R. Hill (in press) and its subsequent cultivation will help to make material available for further study.

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STONE'S PLANTS OF SOUTHERN NEW JERSEY: A REPRINT[1]

To those who had always considered Witmer Stone as an ornithologist — and one of the country's greatest — the appearance in 1911 of his "Plants of Southern New Jersey" came as a distinct surprise. Had they known more about the man they would have realized that he was one of the last of the all-around naturalists, interested in mammals, insects and plants as well as birds.

The recent facsimile reprint of Stone's book, by the Quarterman Publications, Inc., of Boston, makes available once more a work which for more than sixty years has been the standard reference for everyone who is interested in the flora of the Pine Barrens, as well as the other plant provinces of southern New Jersey.

Originally published as Part II of the Annual Report of the New Jersey State Museum, this important volume has for many years been out of print and has, indeed, become something of a collector's item.

Although one can not be other than grateful that this flora is once again in circulation, it is to be regretted that the Foreword was not written by a professional botanist, preferably one who was intimately acquainted with Witmer Stone.

Since this reprint is a facsimile, every word, every punctuation mark and every misprint appears exactly as it did in the original. There are numerous discrepancies between its nomenclature and that in use today. It would have been helpful to the reader if Elizabeth M. Woodford, who wrote the Foreword, had explained the reasons for this.

Partly because he was a zoologist and partly because of his friendship with Dr. N. L. Britton of the New York Botanical Garden, Stone's treatment of plant names follows the now-abandoned American Code of Botanical Nomen-

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[1] Stone, Witmer. The Plants of Southern New Jersey. Reprint. 1973. Quarterman Publications, Inc., Boston, Massachusetts. 828 pp. Illust. $25.00.

clature. This code, like that of the zoologists, permits the use of tautonyms or duplicate binomials. Hence we find in Stone such combinations as *Blephariglottis blephariglottis, Hepatica hepatica, Linaria linaria* and others.

The American Code never embraced the principle of the conservation of generic names and Stone therefore consistently employed what he considered to be the earliest generic epithets. As a consequence we have scores of generic names which are unfamiliar to most present-day taxonomists. A few examples will suffice: *Spathyema* for *Symplocarpus, Juncoides* for *Luzula, Abama* for *Narthecium, Vagnera* for *Smilacina, Gyrostachys* for *Spiranthes, Hicoria* for *Carya, Ammodenia* for *Arenaria* (*peploides*), *Meibomia* for *Desmodium,* etc.

Fortunately most of the presently accepted names are cited in synonymy (although not always with the correct authority), but it seems a pity that a republication of this work should not have suggested some revision and updating of its nomenclature. It might also have corrected such misprints as "Sandy Hood" for "Sandy Hook" (page 432) and "dandelon" for "dandelion" (page 817).

Mrs. Woodford states that Stone's collection of 12,000 specimens went to the herbarium of the Academy of Natural Sciences of Philadelphia. Such is not the case. Realizing that many of his duplicates were already in the Academy and that he had frequently been in the field with members of the Philadelphia Botanical Club whose specimens had likewise been deposited there, I suggested to Dr. Stone that he leave his herbarium to the University of Pennsylvania. He readily agreed, and in the fall of 1942 the University received his collection of more than 14,000 sheets, rich not only in plants from southern New Jersey, but also in material from northern Pennsylvania. It was my pleasant task to supervise the incorporation of this collection into the herbarium of the University.

Witmer Stone once told me that his manuscript for the New Jersey Flora had been prepared in a little more than four months. Doubtless he had made some preliminary efforts to put together his observations accumulated over many years of field work, but even so this was a prodigious accomplishment. He added that the Director of the New Jersey Museum had approached him in desperation to give them something for their Annual Report and urged him to prepare a paper on the Pine Barrens of New Jersey. Stone's reply was that this would be like treating one vegetational province in a vacuum and that he preferred to deal with the entire flora of the lower three-fifths of the state, at the same time emphasizing the geographic origins of the various elements represented therein. This he did superbly well, in a manner which certainly would have elicited the approbation of Asa Gray.

Mrs. Woodford gives a picture of Witmer Stone as a warm, friendly human being with a wide breadth of interests and a well developed sense of humor. With this I can heartily agree. It was my good fortune for many years to spend my summers at Cape May, where Dr. Stone also had a cottage, and in many walks with him I came to appreciate his encyclopedic knowledge and great capacity for friendship.

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THE ASIATIC SPECIES OF DESMODIUM: A REVIEW

A new series of monographic studies, Ginkgoana,[1] was inaugurated early in 1973 with the publication of Number 1, "The Asiatic species of *Desmodium* and its allied genera (Leguminosae)," by Hiroyoshi Ohashi of the Department of Botany, University of Tokyo.

The first study in the series is truly a book, printed in a clear and pleasing type face, and very well edited. The text is written in English. This study is a portion of the thesis presented by Mr. Ohashi for the degree of Doctor of Science. It is an inclusive treatment with clearly stated conclusions.

Since the genus *Desmodium* (in the broad sense) is one in which I have long had a particular interest and since I know the Asiatic species less well than the American and African, I am pleased to see this detailed piece of work. Of special importance are the pollen studies and the meticulous investigations of floral parts, seeds, and seedlings. Dr. Ohashi confirms the conclusions of Ambrose[2] for *Desmodium* (i.e. the species of *Desmodium* ser. *Americana* have hypogaeous germination, while those of other species observed have an epigaeous type of germination), and presents new information for additional species.

The chapter considering observations on morphological characters demonstrates well the care and scope of Dr. Ohashi's observations on habit, leaves, inflorescences, bracts, bracteoles, androecia or stamens, pollen grains, fruits ["pods"], seeds, seedlings, and chromosome numbers. He has illustrated with clarity the basic structures and probable evolutionary progression in the development of the

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[1] Ginkgoana, Contributions to the Flora of Asia and the Pacific Region. No. 1, The Asiatic Species of *Desmodium* and its Allied Genera (Leguminosae), by Hiroyoshi Ohashi, 318pp., 86 figures, 76 plates [18.1 × 25.6 cm.]. February 15, 1973. Academia Scientific Book Inc., Tokyo, Japan.

[2] The Michigan Botanist 6: 97-99. 1967.

inflorescence for the group (*Desmodium* sens. lat.) and also of the bracts and bracteoles. In both cases the tendencies indicated could be compared profitably with parallel or similar progressions in the New World and African groups of related genera. The resulting comparisons, particularly with New World genera and species, should be of much interest because of the numerous groups of closely related species which radiate from the centers of diversity in Mexico and Brazil.

The taxonomic treatment has well constructed keys, detailed descriptions, ample citations of specimens, exceedingly good illustrations of floral parts and of fruits, and distribution maps. In general, I think Dr. Ohashi has rather over-classified the group he has studied so carefully, following Schindler and Hutchinson in large part. However, he has documented his data and stated his reasons so carefully that his occasionally debatable conclusions do not detract from the usefulness of the work. The treatment of *Desmodium* subgenus *Sagotia* is perhaps the one which troubles me most. Dr. Ohashi says "The subgenus *Sagotia* is one of the most polymorphic and widespread groups of the genus *Desmodium.* It is characterized by having mostly the terminal racemes composed of 2(-3)-flowered fascicles which are subtended usually only by the primary bracts (i.e. lacking the secondary bracts), ebracteolate flowers, diadelphous androecia and rather small-sized articles of the fruits." He includes, however, species with secondary bracts, among them *Desmodium velutinum, D. gangeticum,* and *D. dichotomum;* some with bracteoles, such as *D. caudatum* and *D. benthamii;* some with flowers borne singly; and some with loment articles of considerable size.

It seems to me that the only reason the genus *Sagotia* (sensu Ohashi) is so polymorphic is that Dr. Ohashi has assigned to it very unlike elements which do not have a close natural relationship. His arrangement may seem feasible when studying only Asian species, but on a world wide basis I think it would become wholly unworkable and its defects would be much magnified. In some infrageneric groups in Asia as for most of the genus *Desmodium* in Africa there are many unrelated, distinctive species in contrast to the situation in North and South America where there are many small to large groups of closely related species. This makes for a very different aspect of a presumed phylogeny, of proposed evolutionary series, and for an understanding of interspecific relationships in Asia and Africa on the one hand and in America on the other, even though there are some species which bridge the gap by natural or artificial means.

The only serious omissions in this careful study are in the areas of ecology and phytogeography, discussion of the former being almost totally lacking and of the latter only minimal. This may indicate a lack of field experience which can be remedied later by an active field program. Field work might also give Dr. Ohashi a broader view of the taxa with which he is working and a somewhat different approach to their interrelationships.

In concluding this review I would stress the meticulous care of the observations Dr. Ohashi has made and the great gap he has filled in our knowledge of one large complex in the family Leguminosae.

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A MAGNIFICENT SWISS FLORA MANUAL[1]
A REVIEW

One of the most important tasks of botanists specializing in taxonomy and geobotany is the compilation of flora manuals for their colleagues in general and for the much more numerous amateur botanists in particular. In this way, the author himself gets a supplementary survey over the plants of the region in which he works and gathers experience that enables him to solve problems of unusual importance. At the same time he gets a rare opportunity to stimulate interest in his subject and to gather new proselytes among the younger generation to carry on in his footsteps. Only a few botanists have the encyclopedic knowledge and ability to write floras, and still fewer want to take the risk of being unfairly criticized for this least gratifying of scientific occupations, because in no other field is it easier to be criticized for opinions and judgements. This is the perennial trouble for compilers of floras and also the main cause of the scarcity of good manuals. If the author also ventures to make deviations from the accepted delimitations, descriptions and names of the plants included, he runs the additional risk of condemnation by his more conventional colleagues, because scientists are no less conservative than are other citizens. Ordinary manuals are always valuable, but unconventional floras ought to be doubly welcome, because nothing else can stimulate future research to a higher degree.

Although Switzerland is one of the smaller European countries, it has fostered astonishingly many of the botanical giants. Several of its botanists certainly have been conventional and followed the trend of their times, whereas others have dared to have new ideas and have looked at the

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[1] Hans Ernst Hess, Elias Landolt, Rosemarie Hirzel: Flora der Schweiz und angrenzender Gebiete. Three volumes, 29 × 23 cm., 2690 pages, with 9 colored plates and about 3450 drawings. Birkhäuser Verlag, Basel & Stuttgart, 1967, 1970, 1972. Price 450 Schweizer francs.

plants of their country from new points of view. These latter we have to thank for the unusually large number of presently well-known species that were first described from Switzerland. Although many of the great Swiss botanists of the past are now always mentioned with reverence, there were times when their contemporaries called them names and were critical about their scientific abilities. Such is the fate of those who are born too early or try to be prophets in their own land, but time is their confederate.

It would be difficult to mention all the many flora manuals, which have been published in Switzerland in the past, and the list of those which have reached fame far outside the country because of scientific quality is far from being short. One such flora was Albrecht von Haller's great "Historia stirpium indigenerorum Helvetiae inchoata", which was published in 1768 in three folio volumes. That work has stood in a class by itself for two centuries as the most monumental botanical manual ever written in the field of descriptive floristics. It still remains important for its clear descriptions and other information, but the conservatism in nomenclature and the reluctance to accept what would be the future in that field has detracted from the nomenclatural importance of the work though it always will be a text of literary superiority rarely achieved in scientific books.

Although many good Swiss floras have been published since Haller's work, two centuries had to pass before a text of similar magnitude and quality again was compiled for this flora of more than 3500 species. This is the new "Flora der Schweiz," by H. E. Hess, E. Landolt and R. Hirzel, the three large volumes of which were published in 1967, 1970 and 1972. It is a work of extraordinary quality and quantity, based on fifteen years of intensive work by the two first authors and on equally intensive work of drawing the excellent pictures of more than 3450 of the species by the third author.

The virtues of this manual are too many to be even simply listed, and readers with different inclinations will always find some matters of special interest. Considerable information on the methods and philosophy adopted in the compilation of this great work is given in an introductory chapter, which then is followed by almost thirty pages on the history and origin of the flora and its distribution, and more than forty pages on its ecology. Specialists are apt to find omissions in these chapters, and some may perhaps join issue with the authors as to some of the explanations given. That is to be expected in any work of this magnitude and concentration. But this reviewer, who believes he has gathered considerable knowledge about this flora through visits and reading numerous good books and reports during the past three decades, finds these chapters to be highly educational and of great interest from more points of view than he cares to mention. Numerous maps in these introductory chapters ought to make it easy for those unfamiliar with the geography of the land to follow the detailed account.

The manual itself is arranged according to the Engler system as are most modern European floras. A general key to the higher groups leads to keys to the families of the major groups where these commence, and keys to genera and species are then given in appropriate places in the text. Families and genera are described in detail, followed under the latter by information about the size of the genus and its distribution, and about cytological information available. After the generic key there are detailed reports of possible hybridization observed, frequently with explanations of the morphological, geographical, and cytological characteristics of the plants.

Most species are represented by a good drawing, frequently with additional details. Their Latin names are followed by synonyms, if any, and German names, and a very detailed description is given of the morphological characteristics. For every species there is also information on chromosome number and other cytological peculiarities, and the authors have done an admirable work in looking up the original papers in order to be able to exactly inform the reader about the geographical origin of the material. This is the only place where such information has been compiled, and it is admirably corect, although some few mistakes have not been avoided. Then there are reports on the ecological occurrence of each species in Switzerland, and on the general distribution of the taxon elsewhere in the world. Frequently, the authors then add taxonomical and geographical remarks on the variation of the species within and outside their country, especially when they feel that it is to be regarded as a critical taxon in need of more close investigation, with references to the most recent literature in every special case.

It is easy to find points of disagreement in a work of this magnitude, although this reviewer is of the opinion that the authors have succeeded unusually well in avoiding harsh judgements. They have made an effort to accept a modern species concept although sometimes this may not have succeeded well enough, and the descriptions of the taxa are clear and moderately concise. It is a pity that they have found it impossible to mention subspecific categories, but since Switzerland abounds in such variations which frequently may be of doubtful value, it is understandable that the authors avoided spending perhaps twice as much time in evaluating these. The only serious remark to be made seems to be that the authors adopted, for present-day European botanists, an unusually conservative attitude towards the nomenclature, so that sometimes their eccentricity may look disturbing. Nevertheless, this is understandable, and the explanation of this given in the last volume is not unreasonable although I believe that a more liberal attitude would have made the work better and also more useful for a longer period of time.

After the description of the last species in the third volume, there are more than 90 pages of corrections and additions, half a page with an epilogue, where some criticism of plant sociology and nomenclature by reviewers of the first two volumes are met, and four pages on which the terminology used is explained. There are good indexes of Latin and German names, and these are preceded by sixty pages of a very important bibliography.

The three volumes are printed in the unusual size 29 × 23 cm, with considerable empty space on every page that is partially used for the large drawings. The heavy volumes are strongly and tastefully bound in green linen, and they are certainly reasonably priced for their size and quality. Their weight would make it difficult to carry them into the field, but the authors are compiling a smaller manual with the keys only and new drawings of selected species that will be a handy companion on excursions in the Alps and elsewhere.

The "Flora der Schweiz" is an unusually thorough and scholarly work which will long be the standard reference for this part of Europe. It is also an invaluable source of information for botanists from other parts of the continent, and also for specialists in other fields, especially that of cytotaxonomy. The text and pictures are so detailed and exact that the book can be highly recommended to those foreign botanists and institutions which need good and reliable information on European plants which may have been introduced overseas, because no other flora complements the comprehensive Flora Europaea more excellently for southern and central European plant species.

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A SYSTEMATIC TREATMENT OF THE NATIVE UNIFOLIOLATE CROTALARIAS OF NORTH AMERICA (LEGUMINOSAE)[1, 2]

DONALD R. WINDLER

Crotalaria is a large genus of tropical, subtropical, and temperate plants comprised of about 550 species, over 400 of which occur in Africa. In 1939 Senn reported 31 species for North America with the majority growing in Mexico and the West Indies; only 21 of these species were considered to be native. Eight of the 21 species, including the Linnean *C. sagittalis,* form a group that is so distinctive that Rafinesque (1837) separated it into the subgenus *Iocaulon.* The Iocaulon[3] Crotalarias are annual or perennial plants characterized by simple leaves; decurrent stipules, when present; terminal or leaf-opposed inflorescences; and glabrous, inflated fruits that become black at maturity. Senn (1939) indicated that this is the most difficult group of North American Crotalarias in which to delimit species and suggested the need for further work.

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[1] A portion of a dissertation submitted as partial fulfillment of the requirements for the Doctor of Philosophy Degree in the Department of Botany, University of North Carolina at Chapel Hill.

[2] Contribution number 7 from Towson State College Herbarium. Cost of Publication of illustrations assisted by the Towson State College Faculty Research Fund.

[3] The name Iocaulon will be used as an adjective throughout this paper to refer to the unifoliolate Crotalarias related to *C. sagittalis.*

The history of the classification of *Crotalaria* has been reviewed by Baker (1914), Senn (1939), and Polhill (1968). While Baker treated the African species of *Crotalaria* primarily, he also reviewed the history of the classification of the genus and discussed its separation from the closely related genus *Lotononis*. Senn reviewed rather briefly the nomenclatural history of *Crotalaria* in North America, and discussed the placement of the North American species into sections described by Baker. Senn's treatment includes a key to the species, nomenclature and synonomy, Latin descriptions for newly described species, lists of specimens examined, and a few comments on each of the taxa. Most species lack descriptions and all lack illustrations, which makes it difficult to identify a plant if the key only narrows the choice to a group of species.

Polhill (1968), while dealing primarily with the African species of *Crotalaria*, presented a discussion of the history of generic subdivisions, discussed typification of the genus, and proposed a new arrangement of species into sections based on combinations of flower characters. The characters used were: (1) type and position of standard appendages, (2) twisting of the keel, (3) lobing of the calyx, (4) calyx-keel length ratio, (5) pubescence of the style, (6) style shape, and (7) receptacle size. Polhill placed *C. sagittalis* and its relatives in the section *Calycinae* Wight & Arnott. All the characters that Polhill used for this placement were found to be consistently present in the Iocaulon Crotalarias studied.

COLLECTIONS STUDIED

In addition to the personal collections made in the United States and Mexico, specimens were borrowed from twenty-one herbaria. The names and locations of the herbaria from which specimens were borrowed appear below, accompanied by the abbreviation of each as listed in *Index Herbariorum*, except in one case, marked by an asterisk, where no listing could be found for the herbarium and an arbitrary abbreviation is used.

A — Arnold Arboretum, Cambridge, Massachusetts. ALU — University of Alabama, University, Alabama. AUA — Auburn University, Auburn, Alabama. GA — University of Georgia, Athens, Georgia. GH — Gray Herbarium, Cambridge, Massachusetts. LAF — University of Southwestern Louisiana, Lafayette, Louisiana. MICH — University of Michigan, Ann Arbor, Michigan. *MISS — University of Mississippi, University, Mississippi. NCU — University of North Carolina, Chapel Hill, North Carolina. NY — The New York Botanical Garden, New York, New York. SIU — Southern Illinois University, Carbondale, Illinois. TEX — University of Texas, Austin, Texas. UC — University of California, Berkeley, California. US — United States National Museum, Washington, D.C. USF — University of South Florida, Tampa, Florida. WIS — University of Wisconsin, Madison, Wisconsin.

BM — British Museum of Natural History, London, England. G — Conservatoire et Jardin Botanique, Geneva, Switzerland. K — Royal Botanic Gardens, Kew, Great Britain. MEXU — Universidad Nacional de México, Mexico City, Mexico. P — Museum Nacional d'Histoire Naturelle, Paris, France.

Crotalaria plants from more than 60 locations in the United States and Mexico were grown from seed at the North Carolina Botanical Garden, Chapel Hill, during the summer of 1968. Data from the garden plantings were used in evaluating the status of taxa. Another paper detailing the results of the field and garden studies is published elsewhere (Windler, 1973).

SYSTEMATIC TREATMENT

CROTALARIA (Dillenius ex Linnaeus, Hort. Cliff. p. 218, 1737, pro parte) L., Sp. Pl. p. 714 pro maxima parte. Type species: *Crotalaria lotifolia* L. (see Polhill, 1968 pp. 174-5).

GENERAL DESCRIPTION OF THE NATIVE IOCAULON CROTALARIAS

Erect, ascending, spreading, decumbent, or procumbent terrestrial herbs or shrubs. Root a taproot with slender branches, nodules frequently present. Stems single in the erect species to many in the decumbent and procumbent species, the epidermis green, frequently becoming purple, with an indument varying from nearly glabrous to sericeous, of spreading or appressed, simple trichomes. Stipules absent or varying from a pair of subulate lobes projecting from near the leaf base to inverted-sagittate, decurrent, foliaceous appendages which wing the stem for a portion of the subtending internode, a full internode, or for several of the subtending internodes, the lobes spreading, incurved toward the stem or parallel to the stem. Leaves alternate, unifoliolate, undivided, entire, ciliate, membranaceous to fleshy, broadly ovate to lanceolate or linear, 0.9-10.2 cm. long, 0.3-4.6 cm. wide, the adaxial surface dark green, glabrous, or with spreading or appressed, simple trichomes, the abaxial surface usually lighter green than the adaxial and with spreading or appressed simple trichomes; petioles 0.5-3 mm. long.

Inflorescences loose racemes, peduncles borne terminally, or opposite leaves and 0.0-3 cm. below the node. Bracts lanceolate, elliptic, subulate, or linear, to 14 mm. long, one at the base of each flower, frequently persistent after flower or fruit abscission. Flowers papilionaceous. Calyces bilabiate, deeply cleft, the upper two lobes free and broader than the lower three, the lower usually remaining coherent, the calyx bearing two lateral bracteoles, one on either side. Standards (vexillum, banner) orbicular, obovate, or elliptic-oblong, the apex rounded or retuse, 4 mm. shorter to 6 mm. longer than the upper calyx lobes, yellow, the adaxial surface frequently becoming red-tinged, lined or unlined, nearly glabrous with a few trichomes along the main vein on the adaxial surface, with lamelliform appendages at the base of the abaxial surface of the blade. Wings (alae) oblong, attached by a stalk continuous with the lower margin (cleaver-shaped), the blades usually puckered between some of the veins, yellow. Keel (carina) petals twisted at the tip, white or greenish-white, lanate-ciliate. Stamens 10, monadelphous, the staminal tube split on the upper side, anthers dimorphic, with basifixed long anthers alternating with medifixed short anthers, the short anthers positioned above the elongate at anthesis. Styles geniculate at the base, bearing a spiral line of trichomes transversing the length and culminating in a tuft of trichomes on the stigma.

Fruit an inflated, sub-cylindric, short-stipitate legume, glabrous inside and out, becoming black at maturity. Seeds 7-46 per pod, oblique-cordiform, smooth.

The systematic treatment presented here covers twelve native North American unifoliolate species of *Crotalaria* section *Calycinae*. The descriptions are based on materials collected during the study and on numerous herbarium specimens. Measurements of stipule width are taken at the base of the sinus between the two lobes and include the width of both at that point. Length measurements of the calyx and standard are made from the base of the torus to the tip of the respective structure in the undissected flower. Illustrations were prepared by Mrs. Jerry Meyer.

Since data on cross-fertility between the numerous populations sampled is not available, taxa have been distinguished primarily on patterns of morphological discontinuity. It is assumed that these discontinuities also reflect breeding discontinuities, especially in areas where species are sympatric. In mountainous areas, however, many populations are well isolated, frequently leading to morphological discontinuity between populations. In these instances greater emphasis has been placed on similarities in interpreting relationships.

Diagnostic characters that have been useful in the group are plant habit; general size; position of inflorescence; presence, absence, size, and shape of the stipules; length and position of trichomes; and flower size. Most of the diagnostic characters are present on the plants during the entire growing season.

The synonomy includes only those names that were possible to check either against types or clear descriptions. A special effort is made to point out all places where the present treatment differs from that of Senn's.

A set of duplicate specimens from the author's field collections has been deposited in the herbarium of the University of North Carolina at Chapel Hill (NCU).

KEY TO THE SPECIES OF IOCAULON CROTALARIAS WHICH OCCUR IN NORTH AMERICA

A. Inflorescence terminal, or terminal and also leaf-opposed. .... B.
  B. Plants with decurrent stipules. (West Indies, Central and South America). .... 1. *C. pilosa.*
  B. Plants without decurrent stipules. .... C.
    C. Shrubs and subshrubs with diffuse habit. .. D.
      D. Peduncles 9 cm. or more long; calyx 15-20 mm. long. (Mexico, Central and South America). .... 2. *C. nitens.*
      D. Peduncles 6 cm. or less long; calyx 10-11 mm. long. (Northwestern Mexico). .... 3. *C. brevipedunculata.*
    C. Herb with decumbent or ascending habit. (Western Mexico). .... 4. *C. polyphylla.*
A. Inflorescence not terminal, always leaf-opposed. .... E.
  E. Plants erect or strongly ascending. .... F.
    F. Stem pubescence spreading; adaxial leaf surfaces regularly pubescent. .... G.
      G. Stipules with lobes recurved. (West Indies and South America). .... 5. *C. stipularia.*
      G. Stipules with lobes spreading. (Throughout). .... 6. *C. sagittalis.*
    F. Stem pubescence appressed, adaxial leaf surfaces glabrous or with appressed trichomes. .... H.
      H. Upper leaf surface glabrous. .... I.
        I. Plants perennial; stipules usually conspicuous; peduncles 7.5-23 cm. long.

(Southern United States). .... 7. *C. purshii.*

I. Plants annual; stipules absent or inconspicuous; peduncles 2.5-8 cm. long. (Mexico and Central America). .... 8. *C. quercetorum.*

H. Upper leaf surface bearing trichomes. . . J.

J. Peduncles 0.5-2 cm. long, usually as thick as the stem; stipules present; trichomes dense, obscuring the stem. (Mexico). .... 9. *C. mexicana.*

J. Peduncles 2.5 cm. long or longer, thinner than the stem; stipules absent; trichomes not obscuring the stem (except occasionally near the top). (Southern United States). . . 10. *C. rotundifolia.*

E. Plants decumbent, procumbent or spreading. . . K.

K. Mature plants decumbent or procumbent from a thick taproot, stems usually less than 6 dm. long; trichomes on stem 0.3-3.2 mm. long. (Mexico and Southeastern United States). . . .. 10. *C. rotundifolia.*

K. Mature plants diffuse or spreading, stems usually more than 6 dm. long; trichomes on stem usually less than 1 mm. long. (Mexico). . . L.

L. Calyx 13-20 mm. long; stipules 0.5-2.7 cm. broad. (Mexico). . . 11. *C. bupleurifolia.*

L. Calyx 7.5-12 mm. long; stipules narrow or absent. (Mexico). . . 12. *C. nayaritensis.*

1. **Crotalaria pilosa** Miller, Garden Dict. No. 2. 1768, non *C. pilosa* Roxb. ex Mart. Denkschr. Konigl. Akad. Wiss. München **6**: 156, 1920, non *C. pilosa* Thunb. Prod. Pl. Capensium 125.

Crotalaria pterocaula Desv. J. Bot. (Desvaux) 3: 76. 1814. Type: not located.

Crotalaria genistella HBK. Nov. Gen. et. Sp. Pl. **6**: 398. 1824. Type: *Humboldt 2050* (P, IDC Microfiche observed).

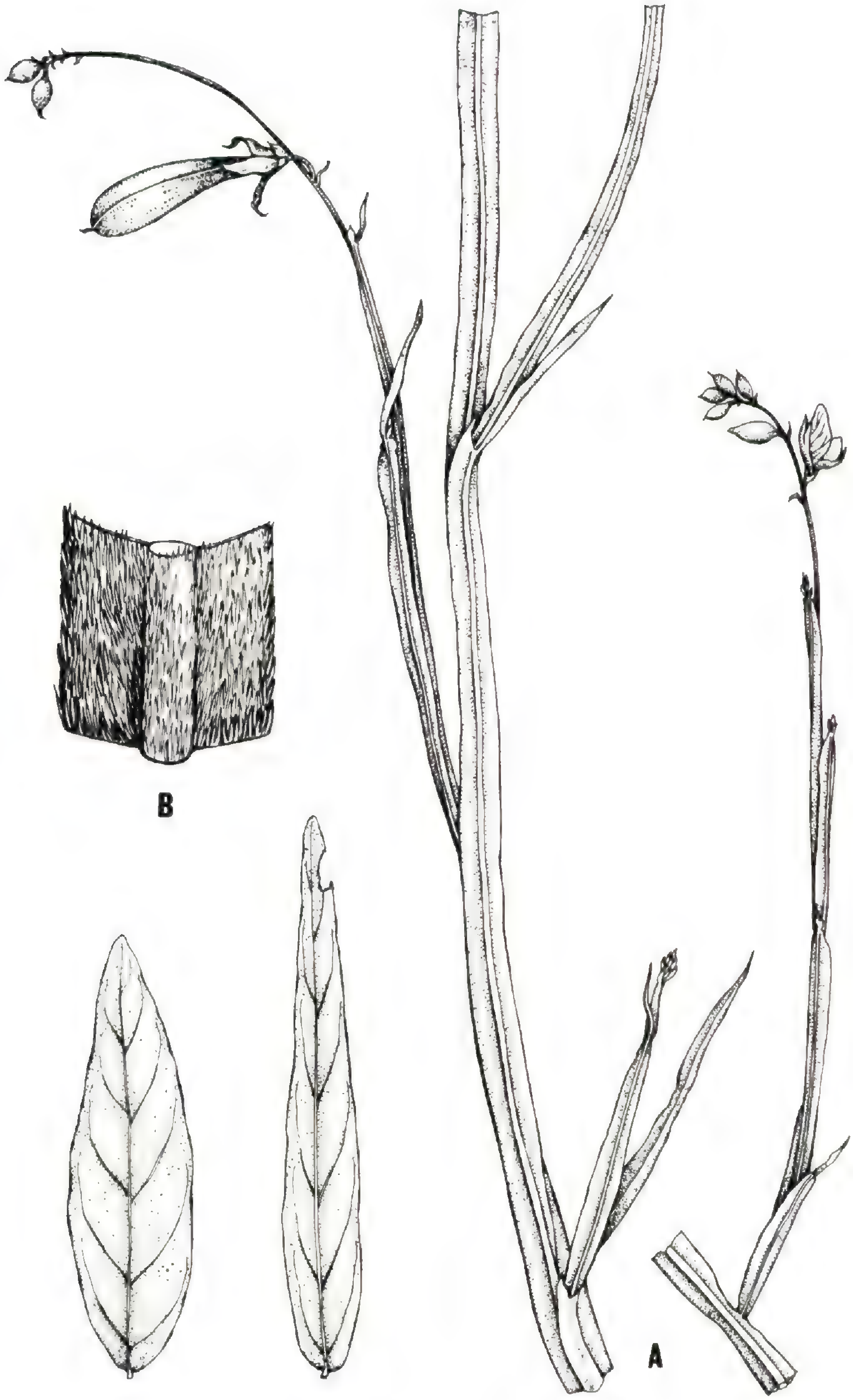
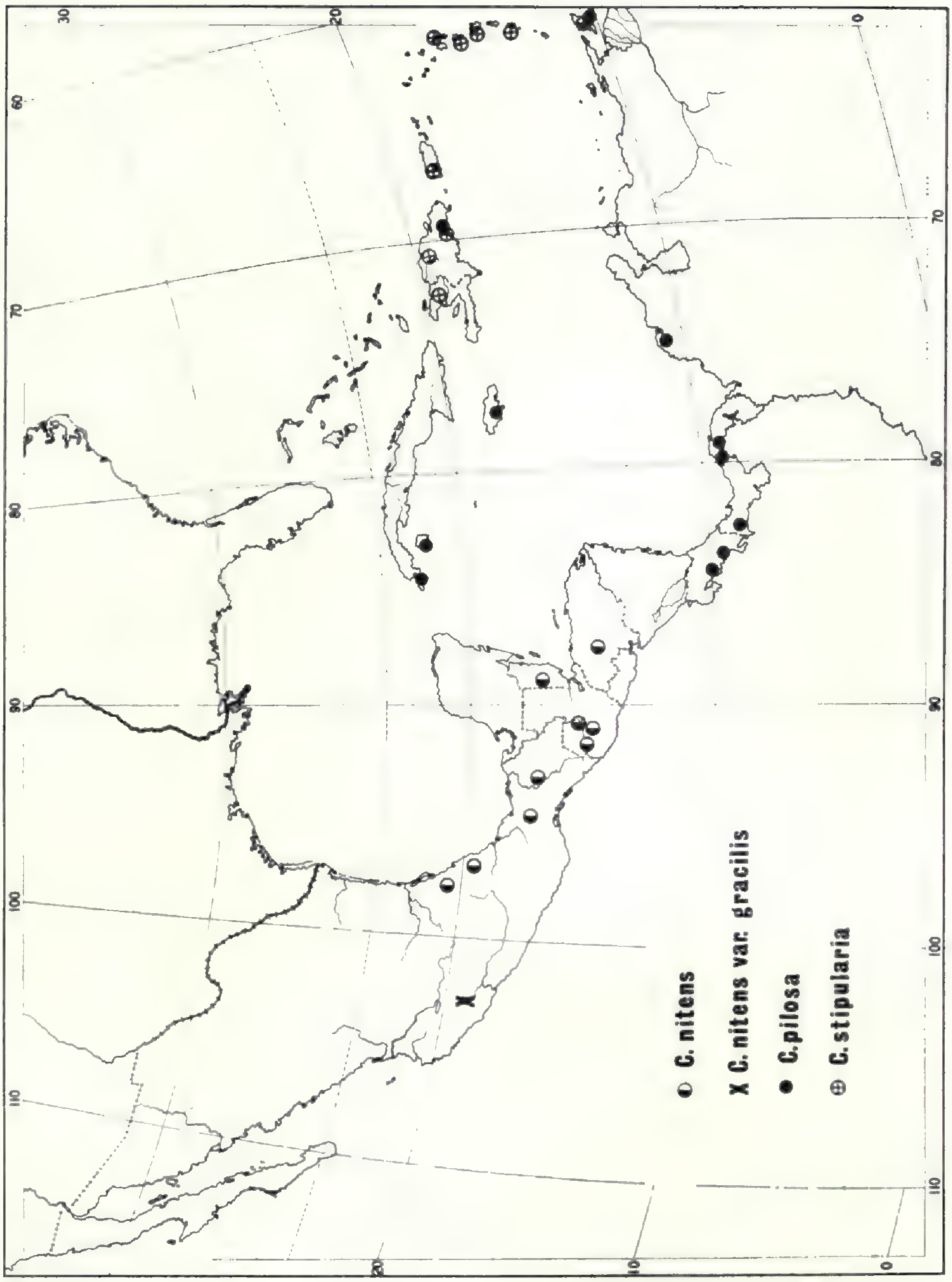


Figure 1. *Crotalaria pilosa.*
A. Habit and leaf variation
B. Stem



Map 1. Distribution of *Crotalaria nitens* var. *nitens*, *C. nitens* var. *gracilis*, *C. pilosa*, and *C. stipularia*.

Crotalaria pilosa Miller var. *skutchii* Senn, Rhodora **41**: 331. 1939. Type: *Skutch 3071* (GH).

Annual erect herb with a taproot to 0.4 cm. thick. Stem single, 2.8-9.5 dm. long, 1.3-4 mm. thick, the longest internode 2.8-8.2 cm. long; vestiture of appressed or loosely appressed trichomes 0.5-1.5 mm. long. Stipules present, decurrent more than the length of the internode, 0.3-0.8 cm. wide, the width constant, the lobes 2.1-9.7 mm. long, usually not spreading. Leaves elliptic, lanceolate, narrowly lanceolate, or linear, 3.3-8.6 cm. long, 3.5-25 mm. wide, base rounded to cuneate, the apex acute; vestiture of both surfaces of appressed trichomes 0.4-2 mm. long; petioles 1-1.3 mm. long. Inflorescences terminal or leaf-opposed and terminal, peduncles 4.5-12 cm. long. Bracts sessile, linear, or subulate, 3.1-4 mm. long, 0.3-0.5 mm. wide; pedicels 3-4.3 mm. long. Calyces 9-11.5 mm. long, the tube 2.5-3.1 mm. long, with appressed, loosely appressed, or somewhat spreading trichomes 0.5-1 mm. long; bracteoles elliptic, narrowly elliptic, or subulate, 2.5-4 mm. long, 0.4-0.5 mm. wide. Corollas yellow, the standards 9-12.8 mm. long, equaling or to 1.7 mm. longer than the upper calyx lobes; elongate anthers 1.5-2 mm. long, short anthers 0.3-0.5 mm. long; style 5.5-5.8 mm. long. Fruits 2.5-3.6 cm. long, breadth not known; seeds tan, brown, or red-brown, 15-23 per pod, 2-2.5 mm. long. Chromosome number: $n=16$. Flowering time: July-March. Habitat: sandy and gravelly soils in fields and open pine woods, elevation sea level to 2,400 feet. Range: Costa Rica, Cuba, Jamaica, Panama. (Also widely distributed in South America.) Figure 1, Map 1.

Type: "La Vera Cruz in New Spain" (Mexico, Cuba or Jamaica?), *Houstoun* (BM; photo., NY!).

In spite of the fact that Miller, in his original description, cited *Crotalaria pilosa* as "growing naturally at La Vera Cruz in New Spain", no specimens have been observed from Veracruz, Mexico. The citation appears to be in error. The probable true type locality was either in Cuba or Jamaica. Senn, in his treatment of *C. pilosa*, recognized the species as being composed of three varieties. Senn's variety *skutchii* is here treated as being a part of variety *pilosa;* his variety *robusta* is transferred to *C. bupleurifolia* and treated as a variety of that species. No field collections were made of *C. pilosa* during this study and no seed was obtained for garden plantings.

Crotalaria pilosa is characterized by its erect habit, terminal or leaf-opposed and terminal inflorescences, and stipules that wing the stem for more than one node below the node of origin (Figure 1). Occasional specimens have spreading lobes at the summit of the stipules. Such specimens observed are *Britton, Britton, & Shafer* 734 (NY) and *Bro. Leon & Fr. M. Rosca* 8837 (NY), both from Cuba. *Crotalaria pilosa* is alone among the species covered in this treatment in possessing both terminal inflorescences and stipules.

REPRESENTATIVE SPECIMENS: **COSTA RICA.** Cina Grande, entre San Ramon y Otevas, *Brenes* 11332 (NY). **CUBA.** Isle of Pines: pinelands, *Britton, Britton,* and *Wilson* 14615 (NY, US); PINAR DEL RIO: near Rio de las Vueltas, N of S. Diego de los Banos, *Bro. Leon* 4908 (GH). **DOMINICAN REPUBLIC.** TRUJILLO: between Bayaguana and Guerra, *Howard* and *Howard* 9924 (GH). **JAMAICA.** Upper Clarendon, James Hill Savannah, *Harris* 12844 (GH, NY, US). **PANAMA.** Ancon Hill, Canal Zone, open hillside, *Killip* 12075 (US). **TRINIDAD.** Without date or specific locality, *de Suber* 369 (P).

2. **Crotalaria nitens** HBK. Nov. Gen. et Sp. **6**: 399. 1824.

Crotalaria bracteata Schlecht. et Cham. Linnaea 5: 575. 1830, non Roxburgh, Hort. Bengal 54. 1814. (Type: *Schiede* 597, Hacienda de la Laguna, (B; photo., F!).

Crotalaria schiedeana Steudel, Nomen. Botanicus. 1: 445. 1840. Type: same as for *C. bracteata* for which this was a nomen nov.

Shrub with unknown root type. Stems 5-15 dm. long, 2-4 mm. thick, the longest internode 1-5.5 cm. long; vestiture of appressed or loosely appressed trichomes, 0.5-1 mm. long. Stipules absent. Leaves elliptic, lanceolate, oblong, or oblanceolate, 2.5-7.5 (10) cm. long, 3.5-18.5 mm. wide, base rounded to cuneate, the apex rounded, acuminate, or acute; vestiture of both surfaces of appresed or loosely appressed trichomes, 0.3-1 mm. long; petioles 1.3-3 mm. long. Inflorescenses terminal, peduncles 6-51 cm. long. Bracts petiolate, lanceolate, the petioles 0.3-1 mm. long, the blades 4-14 mm. long, 0.6-3 mm. wide; pedicels 4.1-7 mm. long. Calyces 15-18 (20) mm. long, the tubes 3.3-5 mm. long, bearing appressed or loosely appressed trichomes 0.3-1 mm. long; bracteoles lanceolate, elliptic-lanceolate or linear, 4.5-9 mm. long, 0.5-1.4 mm. wide. Corollas yellow, the standards 13.5-19 (22) mm. long, equaling to 2.5 mm. longer than the upper calyx lobes; elongate anthers 2.2-3.6 mm. long, short anthers 0.6-1.2 mm. long; styles 8.5-11.5 mm. long. Fruits 2.5-3.2 cm. long, breadth not known; seeds grey-brown, brown, or red-brown, 26-40 per pod, 1.8-2.8 mm. long. Chromosome number: not known. Flowering time: September-December. Habitat: bare soil, dry open mountainsides and pinelands, elevation 4,000-7,200 feet. Range: Guatemala; Mexico: Chiapas, Jalisco, Oaxaca, Veracruz (Also widely distributed in South America).

Type: Mariquita (Colombia), *Humboldt* (P, IDC Microfiche observed).

A photograph of the type of *Crotalaria nitens* was observed in the IDC microfiche photographs of the Humboldt, Bonpland, and Kunth herbarium (P). It bears only the name *C. nitida* and the location Mariquita which is also mentioned in the location sites for *C. nitens*. It compares favorably with the photograph examined by Senn (1939) of the "co-type" in the Willdenow Herbarium. Senn's application of the name is followed in this treatment.

Crotalaria nitens is characterized by its shrubby habit, lack of stipules, terminal inflorescences, and large flowers. Of the North American species, it most resembles *C. brevipedunculata* but differs from it in having a larger flower size and longer peduncles.

Two varieties are recognized:

Peduncles stout, 1-2 mm. thick; bracts 7.5-14 mm. long, 1.2-3 mm. wide. . . . . 2a. *C. nitens* var. *nitens*.
Peduncles slender, 0.5-0.6 mm. thick, bracts 4-5 mm. long, 0.6-0.8 mm. wide. . . . . 2b. *C. nitens* var. *gracilis*.

Figure 2. *Crotalaria nitens* var. *nitens.*

A. Habit and leaf variation
B. Stem
Crotalaria nitens var. *gracilis.*
C. Habit
D. Stem

2a. **Crotalaria nitens** HBK var. **nitens** Figure 2, Map 1.

REPRESENTATIVE SPECIMENS: **BRITISH HONDURAS.** EL CAYO: near Hydram, Rio Frio Augustine, Mt. Pine Ridge, *Hunt* 214 (US). **GUATEMALA.** VERAPAZ: Coban, 1,350 m., *Türkheim* 1948 (MICH, NY, US). **HONDURAS.** Comayagua, near Siguatepeque, 1,080-1,400 m., *Standley* 56370 (US). **MEXICO.** CHIAPAS: Muncipio of Tenejapa, 6,000 ft., *Breedlove* 10976 (US); OAXACA: Entre Puerto Eligio a Comaltepec, *Calderon* 394 (MICH, US); VERACRUZ: Zacuapan, *Purpus* 8007 (NY, US).

2b. **Crotalaria nitens** HBK var. **gracilis** Windler, Phytologia 21: 263. 1971. Figure 2, Map 1.

Type: Mexico: Jalisco; Sierra de Halo, logging road 7 miles south southwest of Tecalitlan and extending southeast toward San Isidaro, 13-16 miles from highway. *McVaugh & Koelz* 1188 (MICH).

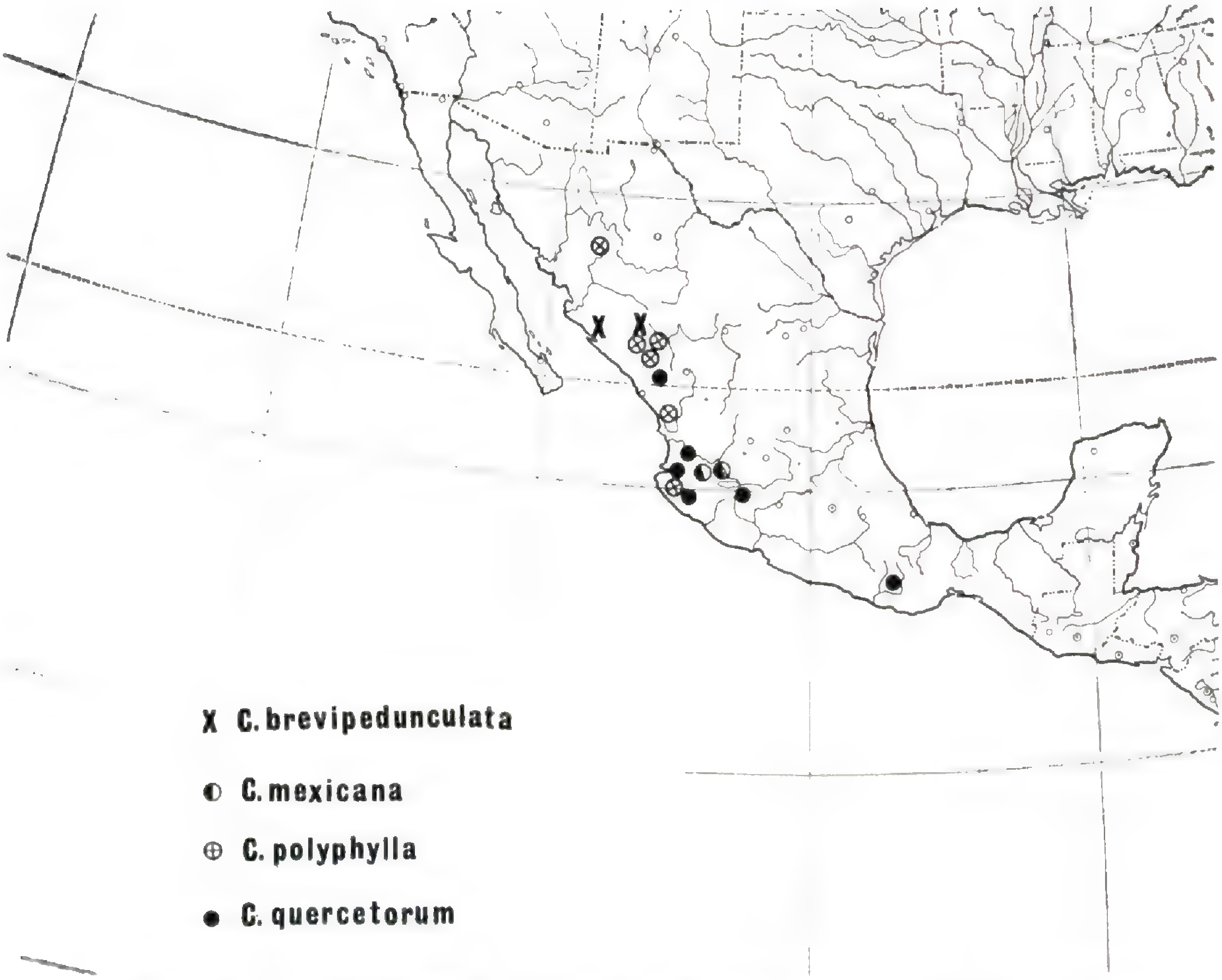
3. **Crotalaria brevipedunculata** Windler, Phytologia **21**: 257. 1971.

Shrub or suffrutescent herb with root type unknown. Stems more than 3 dm. long, 3.5 mm. thick, the longest internode 1.2 cm. long; vestiture of dense, short spreading trichomes 0.6-0.7 mm. long. Stipules absent. Leaves elliptic or elliptic-oblong, 2.1-4.4 cm. long, 5-13.5 mm. wide, base cuneate to widely acute, the apex acuminate; vestiture of loosely appressed trichomes 0.5-0.9 mm. long; petioles 1.6-2.1 mm. long. Inflorescenses terminal and also leaf-opposed, peduncles 1.2-6.1 cm. long. Bracts sessile, linear or narrowly lanceolate, 4-4.4 mm. long, 0.3-0.6 mm. wide; pedicels 3.8-4.2 mm. long. Calyces 10.5-11 mm. long, the tubes 2.5 mm. long, bearing spreading trichomes 0.5-0.7 mm. long; bracteoles linear, 3.5 mm. long, 0.2-0.3 mm. wide. Corollas yellow, the standards 10.5-11 mm. long, equaling the upper calyx lobes; elongate anthers 1.6-2 mm. long, short anthers 0.3-0.4 mm. long; style 6.4 mm. long. Fruits and seeds not known. Chromosome number: not known. Flowering date: December 20. Habitat: shady canyon slope with oaks and palms, elevation 3,500 feet. Range: Mexico: Durango, Sinaloa. Figure 3, Map 2.

Type: Sierra Tres Picos, Durango, infrequent, scattered. *Gentry* 5311 (GH).

Figure 3. *Crotalaria brevipedunculata.*

A. Habit
B. Stem



Map 2. Distribution of *Crotalaria brevipedunculata*, *C. mexicana*, *C. polyphylla*, and *C. quercetorum*.

Crotalaria brevipedunculata is characterized by its lack of stipules, its short terminal inflorescences and small flowers. It most nearly resembles *C. nitens*, but differs from it in its smaller flower size and shorter peduncles.

In addition to the holotype only one other collection of this species has been observed: **Mexico.** SINALOA: Puerto a Tamiapa, *Gentry* 5815 (MICH, NY).

4. **Crotalaria polyphylla** Riley, Kew Bulletin 43: 333. 1923.

Perennial decumbent or ascending herb with a taproot to 1.4 cm. thick. Stems 4-10, 1.2-3 dm. long, 1-2.5 mm. thick, the longest internode 1-3.2 cm. long; vestiture of short appressed or long spreading trichomes, the appressed 0.3-0.6 mm. long, the spreading 0.8-1.2 mm. long. Stipules

Figure 4. *Crotalaria polyphylla.*

A. Habit and leaf variation

B. Stem

absent. Leaves elliptic, oval, or elliptic-oblong, 1.6-4.2 cm. long, 5-13 mm. wide, base rounded to cuneate, the apex obtuse, rounded, or acuminate; vestiture of both surfaces of loosely appressed trichomes 0.5-1.1 mm. long; petioles 1-2.5 mm. long. Inflorescences terminal or terminal and also leaf-opposed, peduncles 4-16 cm. long. Bracts sessile, narrowly elliptic to narrowly lanceolate, 2.5-9.5 mm. long, 0.3-1.4 mm. wide; pedicels 4-6 mm. long. Calyces 9-13.5 mm. long, the tubes 2-3 mm. long, bearing appressed trichomes 0.3-1 mm. long; bracteoles linear, narrowly lanceolate or narrowly elliptic, 3-7 mm. long, 0.4-1 mm. wide. Corollas yellow, the standards 10-14 mm. long, 0.5-1.5 mm. longer than the upper calyx lobes; elongate anthers 1.7-2.3 mm. long, short anthers 0.5-0.7 mm. long; styles 6-7.3 mm. long. Fruits 1.4-2.4 cm. long, 0.5-0.9 cm. broad; seeds green, grey-green, green-brown, brown, or tan, 7-18 per pod, 1.8-2.5 mm. long. Chromosome number $n=16$. Flowering time: June-October. Habitat: slopes in open pine woods, elevation 6,500-9,500 feet. Range: Mexico: Chihuahua, Durango, Jalisco, Sinaloa. Figure 4, Map 2.

Type: Mexico: Sierra Madre, *Seeman* 2187 (K!).

Material here treated as *Crotalaria polyphylla* was included by Senn (1939) in *C. maritima* var. *maritima;* however, its terminal inflorescences and complete lack of stipules clearly separate it from *C. rotundifolia* (for treatment of Senn's *C. maritima,* see *C. rotundifolia* var. *rotundifolia*). The epithet *polyphylla* was used by Senn as the varietal name for Mexican plants he considered to be *C. purshii* (*C. purshii* var. *polyphylla*). Personal examination of the type has led to the recognition of *C. polyphylla* at the specific level. (For treatment of plants previously placed in *C. purshii* var. *polyphylla* by Senn see *C. quercetorum.*) *Crotalaria polyphylla* is characterized by its decumbent or ascending habit, lack of stipules, and terminal inflorescences.

REPRESENTATIVE SPECIMENS: **MEXICO.** CHIHUAHUA: Memelichi, Rio Mayo, pine slopes, *Standley* 2701 (GH, MEXU, US). DURANGO:

32.7 mi. W of Durango in allano slope below pine forest, 8,500 ft., *Johnston* 2694 (MEXU, MICH). JALISCO: Sierra de la Campana, along road to Mascota, 1,900-2,000 m., *McVaugh* 13777 (MEXU, MICH, US). SINALOA: Ocurahui, Sierra Surotato, *Gentry* 6227 (MICH, NY).

5. **Crotalaria stipularia** Desvaux, J. Bot. (Desvaux) 3: 76. 1814.

Crotalaria espadilla HBK. Nov. Gen. et Sp. Plantarum 6: 399. 1824. Type: *Humboldt* 1025, (P; observed IDC Microfiche).

Crotalaria stipularia var. *serpyllifolia* DC., Prodromus 2: 124. 1825. Type: (G; observed IDC Microfiche in Prodromus Herbarium).

Crotalaria stipularis, orthographic error by Grisebach, Flora Brit. West Ind. Isl. 178. 1864.

Crotalaria stipularis var. *oblongata* Grisebach, Flora Brit. West Ind. Isl. 178. 1864.

Crotalaria stipularis var. *sericea* Grisebach, Flora Brit. West Ind. Isl. 178. 1864.

Crotalaria stipularis var. *espadilla* Kuntze, Revisio Generum Plantarum 1: 175, 1891.

Crotalaria stipularia forma *eliptica* Chodat & Hassler, 4: 835. 1904.

Crotalaria stipularia var. *grandifolia* Senn, Rhodora 41: 333. 1939. Type: *Hahn* 239 (GH).

Annual, erect herb with a taproot to 0.6 cm. thick. Stem solitary, 1-6.3 dm. long, 1.2-5 mm. thick, the longest internode 3-8 cm. long; vestiture of loose appressed and/or spreading trichomes, 0.5-3 mm. long. Stipules present, decurrent the length of the internode, 1.1-3.2 cm. wide at the top, tapering to the subtending node, the stipule lobes incurved 1.2-1.6 cm. long. Leaves oval, oblong, elliptic, or lanceolate, 2.2-8.2 cm. long, 7.5-25 (-37) mm. wide, base rounded to cuneate, the apex retuse, rounded, acuminate, or acute; vestiture of both surfaces of appressed or loosely appressed trichomes 0.5-2.1 mm. long; petioles 0.5-1.5 mm. long. Inflorescences leaf-opposed, peduncles 3.1-10 cm. long. Bracts petiolate, elliptic, lanceolate to linear, the petioles

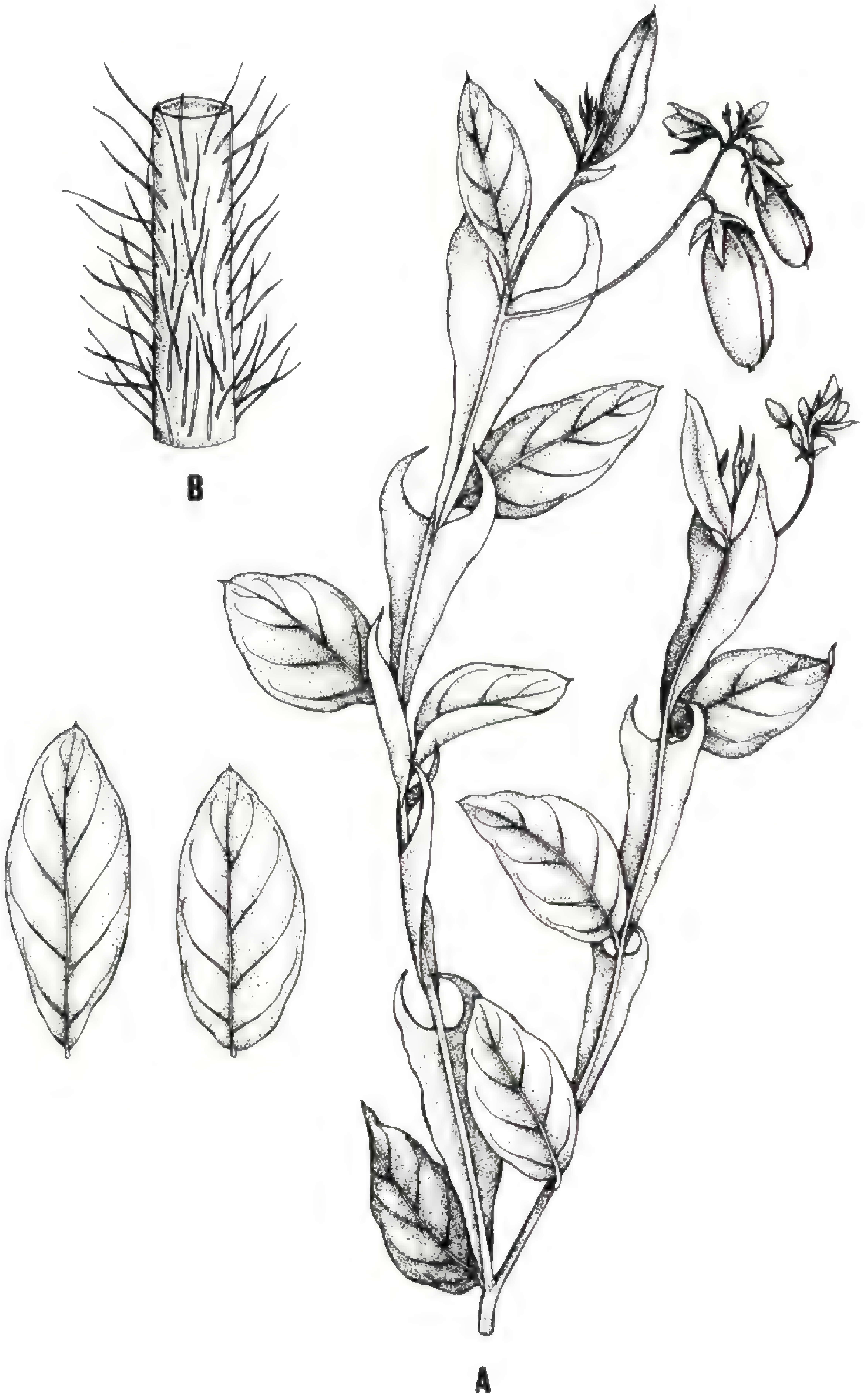


Figure 5. *Crotalaria stipularia.*
A. Habit and leaf variation
B. Stem

1-1.6 mm. long, the blades 3-5 mm. long, 0.3-1.2 mm. wide; pedicels 2-4 mm. long. Calyces 8-10 mm. long, the tubes 2-2.8 mm. long, bearing appressed or loosely appressed trichomes 0.7-1.2 mm. long; bracteoles elliptic, lanceolate, or linear, 3-4.5 mm. long, 0.4-0.7 mm. wide. Corollas yellow, the standards 6-10 mm. long, equaling to 1.5 mm. shorter than the upper calyx lobes; elongate anthers 1.1-1.3 mm. long, short anthers 0.3-0.5 mm. long; styles 4.5-5.2 mm. long. Fruits 2.5-3.3 cm. long, width not known; seeds tan, bronze, red-brown, or dark brown, 17-41 per pod, 2-3 mm. long. Chromosome number: $n=16$. Flowering time: February-December. Habitat: sandy soils, savannahs, clearings, fields and roadsides, elevations to 2,300 feet. Range: West Indies; Dominican Republic, Dominica, Guadeloupe, Haiti, Martinique, Puerto Rico, Trinidad. (Also widely distributed in South America.) Figure 5, Map 1.

Type: Not located.

Crotalaria stipularia, as treated by Senn, was divided into three varieties. Varieties "typica" and "grandifolia" are not different except in overall plant size. Both variations are found in a single location mass collection from Puerto Rico sent to me by Dr. R. A. Howard of the Arnold Arboretum. This size variation is probably typical of plants of this species at most locations. Senn's application of De Candolle's *C. stipularia* var. *serpyllifolia* is to a plant in which all of the original leaves were lost during drought (or some other catastrophe) and new branches with small leaves and shorter internodes had developed before the plant was collected. The wide decurrent stipules were not lost when the leaves were lost, which accounts for the variety having large stipules. The IDC Microfiche photograph of De Candolle's specimen in the Prodromus Herbarium shows a plant with smaller leaves, but not quite so small as those in Senn's cited specimens. No field collections were made of *C. stipularia* during this study, but seeds were obtained for garden studies (*Irwin* 1050 and *Stimson* 4264).

Crotalaria stipularia is characterized by its erect habit, leaf-opposed inflorescences, small flowers, and large stipules with incurved lobes. It most nearly resembles *C. sagittalis*, but the two taxa may be separated by stipule characters.

REPRESENTATIVE SPECIMENS: **DOMINICA.** Grand Savannah, *Lloyd* 835 (NY). **DOMINICAN REPUBLIC.** Prov. de la Vega: near Garabawa at Rio Yaquir, *Fuertes* 1669 (A, NY, P). **GUADELOUPE.** Montebello, alt. 50 m., *Questel* 432 (P, US). **HAITI.** Dept. du Nord: east of Marmelade, grassy summit of mountain, *Leonard* 7222 (US). **MARTINIQUE.** Fort Vaillant, *Hahn* 239 (GH; Photo., US). **PUERTO RICO.** Along railroad N of Mayaguez, *Heller* 4574 (MICH, NY, US). **ST. VINCENT.** near Barrovollic (Leeward), *Smith & Smith* 1053 (NY). **TRINIDAD.** south of Dabadie, *Bulton & Hazen* 702 (GH).

6. **Crotalaria sagittalis** L., Sp. Pl. p. 714. 1753.

Crotalaria fruticosa Miller, Gard. Dict. (pages not numbered) 1768. Type: Jamaica, *Houstoun*, (BM, photo., NCU).

Anonymos sagittalis (L.) Walt., Flora Carol. 181. 1788. Type: same as for *C. sagittalis* L.

Crotalaria parviflora Roth, Catalecta Bot. 1: 83. 1797. Type: not located.

Crotalaria sagittalis var. *β oblonga* Michx. Flora Boreali-Am. 2: 55. 1803. Type locality: "Virginia et Carolina".

Crotalaria platycarpa Link, Enum. Pl. Hort. Reg. Bot. Berol. Alt. part 2, 227. 1822. Type: destroyed in Berlin.

Crotalaria pringlei A. Gray, Proc. Am. Acad. **17**: 200. 1881-2. Type: Arizona, *Pringle*, summer 1881 (GH).

Crotalaria sagittalis var. *fruticosa* (Miller) Fawcett and Rendle, Fl. Jamaica 4: 10. 1920.

Crotalaria sagittalis var. *blumeriana* Senn, Rhodora **41**: 339. 1939. Type: *Blumer* 1772 (GH).

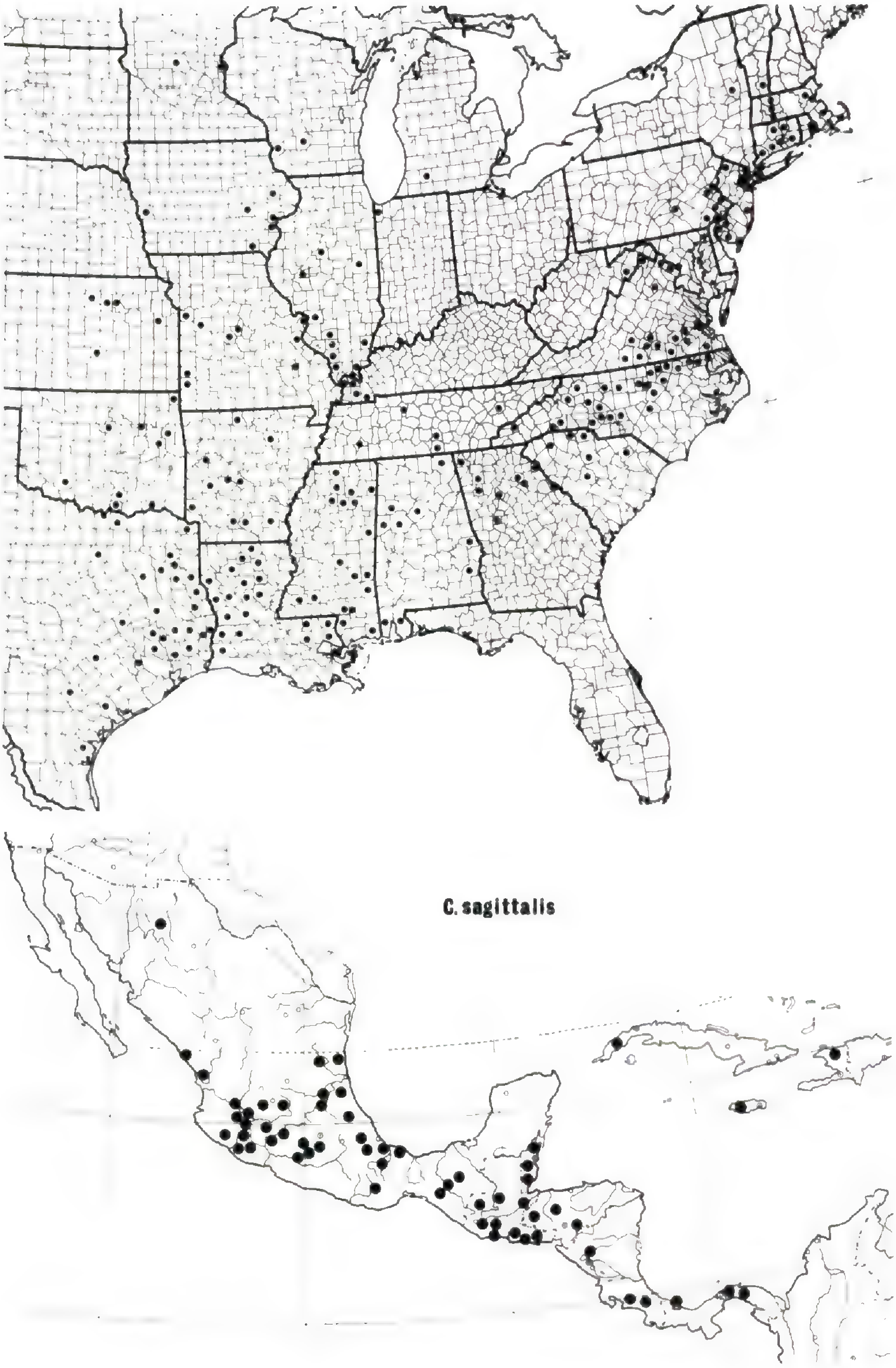
Crotalaria tuerckheimii Senn, Rhodora **41**: 339. 1939. Type: *von Tuerckheim II* 1282 (GH).

Crotalaria belizensis Lundell, Amer. Midl. Naturalist **29**: 473. 1943. Type: *Gentle* 4144 at (NY).

Annual or rarely perennial, erect herb with a taproot to 0.6 cm. thick. Stems 1 (-7), 0.25-4.1 dm. long, 1-2.5 mm. thick, the longest internode 0.4-4.2 cm. long; vestiture of long spreading trichomes, 1.5-3 mm. long. Stipules present,

Figure 6. *Crotalaria sagittalis.*

A. Habit and leaf variation
B. Stem



Map 3. Distribution of *Crotalaria sagittalis.*

decurrent from ½ to the full length of the internode, 0.35-1.7 cm. wide at the top, tapering to the subtending node, the stipule lobes spreading 0.4-1.8 cm. long. Leaves elliptic, oblong, lanceolate, or linear-lanceolate, 1.1-10 cm. long, 2.5-15 (22.5) mm. wide, base rounded to cuneate, the apex obtuse, mucronate, acuminate, or acute; vestiture of both surfaces of spreading or loosely appressed trichomes 1-2.9 mm. long; petioles 1.2-2.5 mm. long. Inflorescences leaf-opposed, peduncles 2-8 (-12) cm. long. Bracts petiolate, lanceolate to elliptic lanceolate, the petioles 0.5-1.5 mm. long, the blades 4-8.1 mm. long, 0.5-1.3 mm. wide; pedicels 3.5-5.5 mm. long. Calyces 7-15 mm. long, the tubes 2.3-3.9 mm. long, bearing loosely appressed trichomes 0.8-2 mm. long; bracteoles elliptic lanceolate, lanceolate, or linear, 2.5-7 mm. long, 0.7-1.2 mm. wide. Corollas yellow, the standards 6-12.5 mm. long, equaling to 4 mm. shorter than the upper calyx lobes; elongate anthers 0.9-2 mm. long, short anthers 0.3-0.5 mm. long; styles 4-5.3 mm. long. Fruits 1-2.7 (3.6) cm. long, 0.5-1.1 cm. broad; seeds tan, tan-green, olive, green-brown, or coffee-brown, 7-32 per pod, 1.4-3 mm. long. Chromosome number: $n=16$. Flowering time: May-October. Habitat: road and railroad rights-of-way, disturbed ground, sand deposits, fields, prairies, lake margins, and dry oak and pine forests, elevation sea level — 8,500 feet. Range: Eastern and Central United States through Mexico and Central America to Panama and on the Greater Antilles. Figure 6, Map 3.

Lectotype: "2 Kalm sagittalis" (LINN) (see Taxon 21: 545.)

Type locality: "Brasilia, Virginia" as cited in Species Plantarum.

Plants included here under *Crotalaria sagittalis* include material cited by Senn as variety *blumeriana* and variety *fruticosa,* as well as Senn's variety "typica". Early leaves of plants of *C. sagittalis* tend to be broader than the later leaves, and all branches tend to have narrower leaves than the main stem. In addition, the further south a plant occurs, the longer the plant grows, and the more early leaves are lost before the end of the growing season. There is also a tendency for southern plants to have narrower early leaves than northern plants. Garden studies have shown *Crotalaria sagittalis* var. *blumeriana* to be a dry habitat ecophene of the typical species. Although a great deal of variation exists in *C. sagittalis*, especially in the Mexican representatives, little in the way of a clear pattern that would allow a useful segregation of the plants (and populations) into varieties has been detected. Further study of this wide-spread but poorly understood species, to gain a more complete picture of the relationships between plant variation, geographic, and ecological factors, may prove helpful, especially in Mexico, Central and South America.

REPRESENTATIVE SPECIMENS: BRITISH HONDURAS. Honey Camp, *Lundell* 665 (US). COSTA RICA. Paturage a San Jose de Costa Rica, *Tonduz* 443 (MICH, P). CUBA. **Pinar del Rio:** Herradura, *Britton, Britton, Earle, & Gager* 6404 (NY). GUATEMALA. **Alta Verpaz:** Coban, alt. 4,300 ft., *Tuerckheim* 239 (GH, US). HAITI. Massif de la Selle Nouvelle Touraine, alt. 1,400 m., *Ekman* 1501 (NY, US). HONDURAS. Morazan, hills around Zamorano Valley, alt. 800-900 m., *Swallen* 11252, (US). JAMAICA. Castleton, 490 ft., *Harris* 11855 (GH, NY, P, US). NICARAGUA. **Comarca ElCabo:** LaTronquera, alt. 60 m., *Molina* 14881 (NY). PANAMA. **Panama:** Sabana de Dormisolo, near Chepo, *Pittier* 4686 (US). EL SALVADOR. **Ahuachapan:** *Ahuachapan*, alt. 800-1,000 m., *Standley* 19747 (GH, NY, US). MEXICO. **Baja California:** S side of La Carrerita, Sierra El Taste, 1,500-1,600 m., *Carter & Chisaka* 3504 (MEXU). **Chiapas:** Tenejapa, 7,800 ft., *Breedlove* 12713 (US). **Chihuahua:** Madera, *Pennell* 19228 (US). **Colima:** Colima, *Palmer* 130 (US). **Durango:** without locality, *Garcia* 942 (US). **Guanajuato:** NE of Guanajuato, *Ripley & Barneby* 13351 (NY). **Jalisco:** near Chapala, *Rose & Painter* 7636 (NY). **Mexico:** Puerto del Salitre, 1,300 m., *Hinton* 1780 (GH, MEXU, NY). **Michoacan:** vicinity of Coalcoman, 1,000 m., *Hinton* 12862 (NY, US). **Morelos:** Cuernavaca, *Rose & Painter* 6850 (GH, NY, US), **Nayarit:** Cerro de la Cruz, E of Tepic, *Mexia* 669 (GH). **Oaxaca:** near city of Oaxaca, *Rose & Hough* 4623 (NY, US). **Puebla:** 72 km. SE of Mexico City, *Weaver* 995 (US). **San Luis Potosi:** 7-8 mi. NE of Xilitla, *King* 4360 (US). **Sinaloa:** near Mazatlan, *Windler & Windler* 2885 (NCU). **Sonora:** NE of El Tigre, 6,000 ft., *White* 4370 (GH, MICH). **Tamaulipas:** vicinity of Gomez Farias, ca. 350 m., *Palmer* 341 (US). **Veracruz:** SE of Catemaco, meadow, *Dressler & Jones* 114 (MEXU, MICH, NY, US). UNITED

STATES. **Alabama:** MOBILE CO.: Dauphin Island, *Jones* 585 (ALA). **Arkansas:** SALINE CO.: ridges, Benton, *Demaree* 37333 (SIU). **Connecticut:** MIDDLESEX CO.: Middlefield, *Kofoid* (GH). **Georgia:** JACKSON CO.: 11 mi. N of Athens, *Cronquist* 4571 (GH). **Illinois:** JACKSON CO.: roadside S of Elkville, *Bailey & Swayne* 462 (SIU, NCU). **Indiana:** LAKE CO.: East Gary, *Hull* 18 July 1936 (GH). **Iowa:** JONES CO.: railroad right-of way, Sect. 7, Oxford Twp., *Isely* 5913 (GA). **Kansas:** RILEY CO.: ravines, *Norton* 80 (GH, P). **Kentucky:** GRAVES CO.: railroad embankment, Fancy Farm, *O'Dell & Windler* 936 (SIU). **Louisiana:** CALCASIEU PARISH: 1½ miles NNW of Starks, Sect. 26, *Lasseigne* 1579 (LAF). **Maryland:** Montgomery?, Wildwood, *Dowell* 1626 (GH). **Massachusetts:** MIDDLESEX CO.: shore of Winter Pond, *Bartlett* 224 (GA, GH, TEX, WIS). **Michigan:** KALAMAZOO CO.: 1 mi. E of Schoolcraft, *Hanes* 1796 (GH). **Minnesota:** CHISAGO CO.: Lindstrom, *Anderson* 6458 (GH, WIS). **Mississippi:** LAYAYETTE CO.: near Tula Cemetery, 18 mi. SE of Oxford, *Pullen* 64294 (GA, MISS, NCU). **Missouri:** BARTON CO.: prairies, Milford, elev. 750 ft., *Demaree* 39377 (GA, NCU, USF). **New Jersey:** BERGEN CO.: Hackensack, route 4, sandy field, *Rush & Svenson* 6769 (GH, WIS). **New York:** SARATOGA CO.: N of Crescent, *Burnham 8 Sept. 1906* (GH). **North Carolina:** CALDWELL CO.: 1 mi. SE of Hudson, *Randolph & Randolph* 1096 (GH, NCU). **Oklahoma:** MUSKOGEE CO.: 2 mi. S of Braggs, *Edmond* 164 (TEX). **Pennsylvania:** DELAWARE CO.: Wayne, dry gravel bank, *Bartram* 1162 (GH). **Rhode Island:** Cumberland (?) without collection name & number, *Aug. 1840* (GH). **South Carolina:** GREENVILLE CO.: 2½ mi. SW of Berry's Pond, *Freeman* 56577A (NCU). **Tennessee:** KNOX CO.: sandy soil near Knoxville, *Ruth* 661 (WIS). **Texas:** JASPER CO.: 3 mi. N of Evadale, *Turner & Tharp* 3079 (TEX). **Vermont:** WINDHAM CO.: Vernon, *Blanchard* 1901 (GH). **Virginia:** CULPEPER CO.: 0.3 mi. N of Lakota on Co. Rt. 621, *Ahles & James* 61692 (NCU). **West Virginia:** HARDY CO.: Lost River Bridge, wasteground, *Core* 18 Aug. 1931 (GH).

7. **Crotalaria purshii** DC., Prodromus 2: 124. 1825.

Crotalaria sagittalis var. β L. Sp. Pl. 714. 1753.

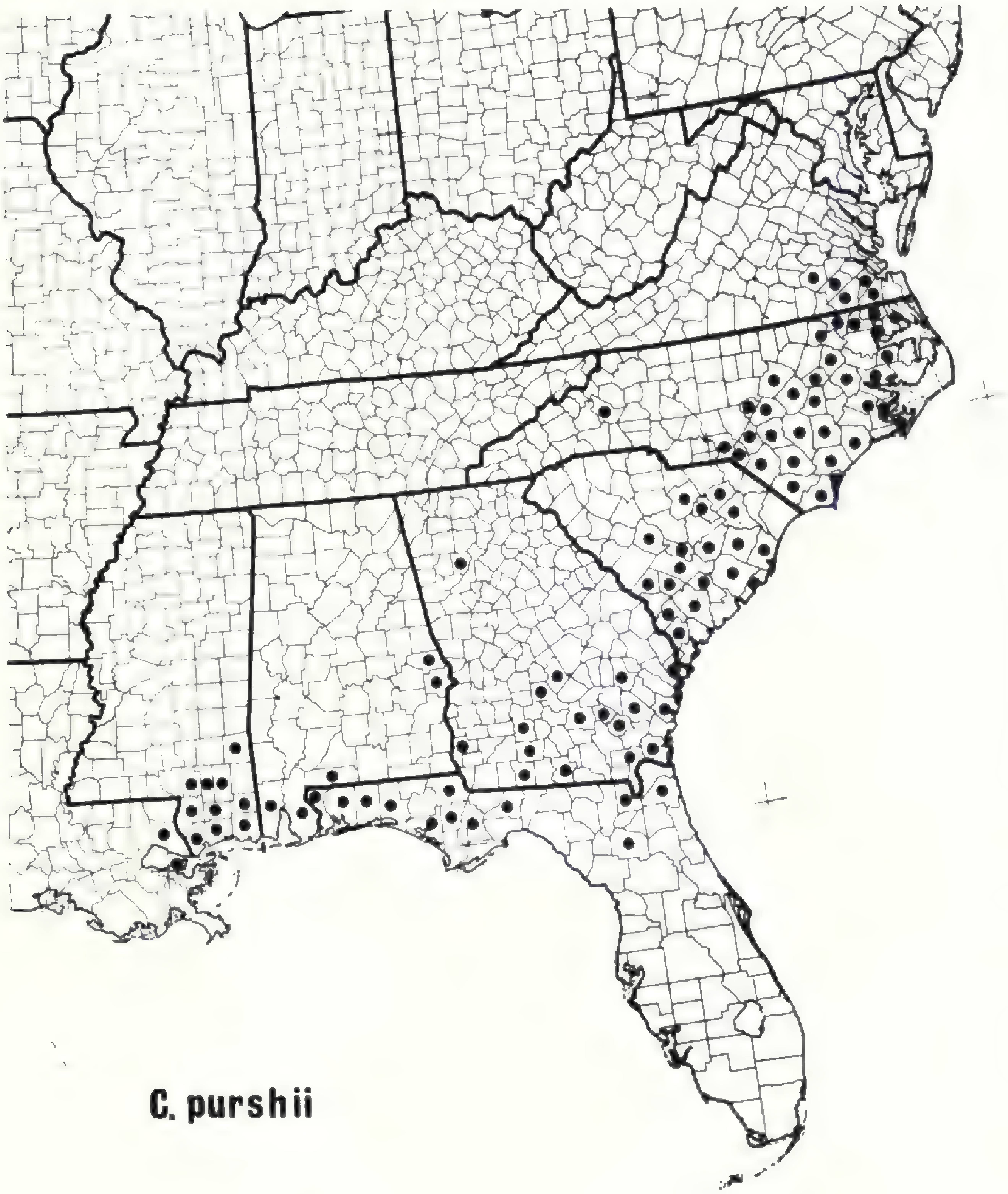
Crotalaria sagittalis var. α *linearis* Michx., Fl. Boreali-Am. 2: 55. 1803. Type locality: "Virginia et Carolina".

Crotalaria laevigata Pursh, Fl. Am. Sept. 469, non Lam., Encyc., 2: 198. 1786. Type: Pursh specimen not located; Syntype was plate in Plukenet, Phytographia-Amagestum Bot. *t. 277, fig. 2.* 1694. Specimen from which this figure was drawn is in Sloane collection at BM.

Perennial, erect herb with a taproot to 0.7 cm. thick.

Figure 7. *Crotalaria purshii.*

A. Habit and leaf variation
B. Stem



Map 4. Distribution of *Crotalaria purshii.*

Stems 1-4 (8), 1.5-5 dm. long, 1-1.5 mm. thick, the longest internode 3.3-8.5 cm. long; vestiture of short appressed or loosely appressed trichomes 0.4-0.8 mm. long. Stipules present, decurrent one-half to the full length of the internode, 0.3-0.9 cm. wide at the top tapering to the base, the stipule lobes spreading 0.5-1.7 cm. long. Leaves linear, oblong, linear-lanceolate or elliptic, 4.9-10 cm. long, 1.7-12 mm. wide, base rounded to cuneate, the apex obtuse or acute; the lower surface bearing appressed trichomes 0.3-0.7 mm. long, the upper surface glabrous; petioles 0.5-2 mm. long. Inflorescences leaf-opposed, peduncles 7.5-23 cm. long. Bracts petiolate, elliptic-lanceolate to lanceolate, the petioles 0.5-1.6 mm. long, the blades 4.5-7 (8.5) mm. long, 0.6-1.8 (2) mm. wide; pedicels 4.5-6 mm. long. Calyces 9-12.5 mm. long, the tubes 2.5-3.5 mm. long, bearing appressed trichomes 0.2-0.5 mm. long; bracteoles lanceolate or ellipitc-lanceolate, 3.5-5 mm. long, 0.8-1.2 mm. wide. Corollas yellow, the standards 8-13.5 mm. long, 2 mm. shorter to 0.5 mm. longer than the upper calyx lobes; elongate anthers 1.2-1.6 mm. long, short anthers 0.3-0.6 mm. long; styles 2.7-4.6 mm. long. Fruits 1.4-2.8 cm. long, 0.6-1 cm. broad; seeds tan, olive, green-brown, or dark brown, 11-37 per pod, 1.8-2.9 mm. long. Chromosome number: $n=16$. Flowering time: March-October. Habitat: savannahs, sandhills, and open pine woods, coastal plain. Range: United States: Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Virginia. Figure 7, Map 4.

Type: Based on *Crotalaria laevigata* Pursh.

Type locality: Pine woods of Virginia and Carolina.

Crotalaria purshii, named by De Candolle, was based on material from Virginia and Carolina. He cites *C. laevigata* of Pursh as being the same, but proposes the name *C. purshii* since *C. laevigata* had been previously used by Lamarck. *Crotalaria sagittalis* var. β L. is based on Plukenet's figure (Plukenet, 1694, *t. 277, Fig. 2*) which is *purshii.*

Senn (1939) recognized a variety, *polyphylla,* under

Crotalaria purshii. Most specimens of this variety are here treated as *C. quercetorum.* For further information concerning the epithet *polyphylla* see the discussion under *C. polyphylla.*

Crotalaria purshii is characterized by its erect habit; sparse, short, appressed pubescence; spreading stipule lobes; frequently narrow leaves, the upper surfaces of which are glabrous; and long peduncles. *Crotalaria purshii* is similar to *C. sagittalis* in habit and general appearance in parts of its range, but it may be distinguished from *C. sagittalis* by its glabrous upper leaf surfaces, appressed pubescence, and long peduncles. The extremely variable *C. rotundifolia* var. *rotundifolia* may occasionally bear a resemblance to *C. purshii,* but these plants lack glabrous upper leaf surfaces.

REPRESENTATIVE SPECIMENS: UNITED STATES. **Alabama:** BALDWIN CO.: sandy field, *Jones* 496 (AUA). **Florida:** CALHOUN CO.: Cypress Park, Dead Lakes, *Godfrey & Clewell* 62916 (LAF). **Georgia:** WAYNE CO.: open pinelands, 5 mi. S. of Jessup, *Duncan* 6941 (GA). **Louisiana:** ST. TAMMANY PARISH: 7¾ mi. S of town of Pearl River, Sect. 13, *Lasseigne* 1480 (LAF). **Mississippi:** PEARL RIVER CO.: 1 mile N of Picayune along Hwy. 12, low pine lands, *Bollwinkel & Wunderlin* 9 (SIU). **North Carolina:** CRAVEN CO.: pine savannah, 0.6 mi. SW of Havelock, *Radford* 34504 (NCU). **Virginia:** ISLE OF WIGHT CO.: dry sandy pine and oak woods ca. 1 mile SE of Zuni, *Fernald & Long* 6233 (GH).

8. **Crotalaria quercetorum** Brandegee, U. Cal. Pub. Bot. **10:** 407. 1924.

Crotalaria purshii var. *polyphylla* (Riley) Senn, Rhodora **41:** 346. 1939. (see note below)

Annual, erect, or ascending herb with a slender taproot to 0.25 cm. thick. Stem solitary, 1.1-5.3 dm. long, 1-3.1 mm. thick, the longest internode 1.3-5.2 cm. long; vestiture of short appressed trichomes, 0.3-0.4 mm. long. Stiples usually absent or very narrow, decurrent 1/5 the length of the internode, 0.3-0.4 cm. wide at the top narrowing to the base, the stipule lobes spreading 0.1-0.25 cm. long. Leaves elliptic, narrowly oblong, narrowly elliptic, narrowly lanceo-

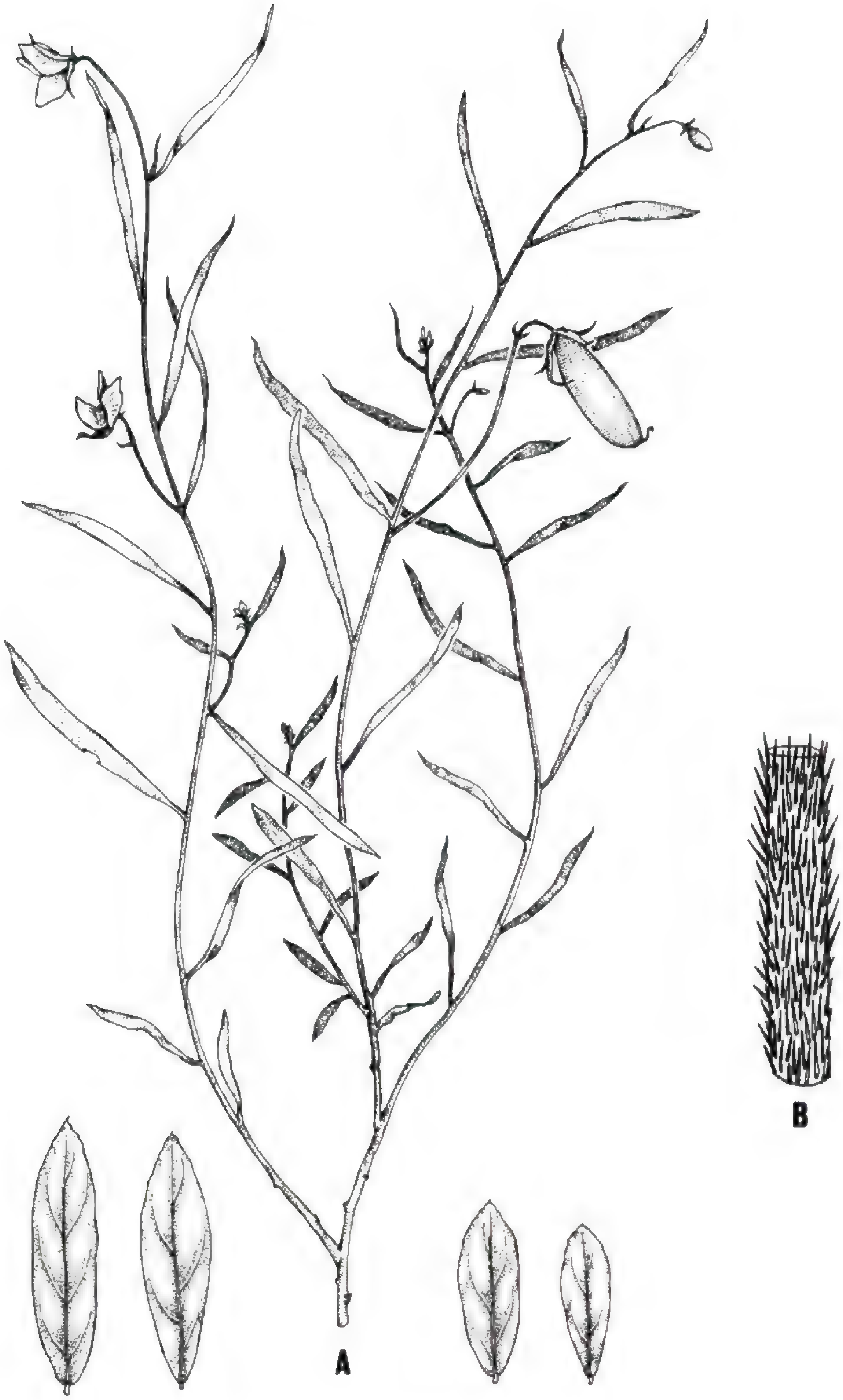


Figure 8. *Crotalaria quercetorum.*
A. Habit and leaf variation
B. Stem

late, or linear, 3-6.8 cm. long, 2-5.5 (-8) mm. wide, base rounded to cuneate, the apex acute or acuminate; vestiture of appressed trichomes 0.2-0.5 mm. long, the upper surface usually glabrous; petioles 1.5-3 mm. long. Inflorescences leaf-opposed, peduncles 2.5-8 cm. long. Bracts sessile, narrowly elliptic, or linear, 2.5-3.5 mm. long, 0.2-0.3 mm. wide; pedicels 2.5-4.2 mm. long. Calyces 8.2-11 mm. long, the tubes 1.5-2 mm. long, bearing appressed trichomes 0.2-0.3 mm. long; bracteoles linear or narrowly elliptic, 1.5-3.5 mm. long, 0.2-0.3 mm. wide. Corollas yellow, the standards 7.5-10.5 mm. long, equaling to 2 mm. shorter than the upper calyx lobes; elongate anthers 0.8-1.4 mm. long, short anthers 0.2-0.3 mm. long; styles 3.5-3.6 mm. long. Fruits 1-2.4 cm. long, 0.4-0.7 cm. broad; seeds olive, green-brown, or brown, 24-30 per pod, 1.4-2 mm. long. Chromosome number: $n=16$. Flowering time: August-March. Habitat: ridges and slopes in oak, oak-pine, and pine woods, elevation 2,600-7,000 feet. Range: Mexico: Chiapas, Jalisco, Michoacan, Nayarit, Oaxaca, Sinaloa. Figure 8. Map 2.

Type: Mexico: Chiapas: Hacienda Monserrate, *Purpus* 9144 (UC!).

Crotalaria quercetorum was included under *C. purshii* by Senn. Unfortunately, Senn chose to use the epithet *polyphylla* for what he recognized as a variety of *C. purshii*. Examination of the type of *C. polyphylla* Riley leads to the conclusion that the name is erroneously applied to the material here treated as *C. quercetorum*. The holotype of *C. quercetorum* is a mixed sheet with one specimen present which may be interpreted as intermediate between *C. quercetorum* and *C. sagittalis*. The isotype (US) examined is also composed of several elements, but all are referable to *C. quercetorum*.

Crotalaria quercetorum is characterized by its short appressed pubescence, lack or near lack or stipules, usually narrow foliage, short peduncles and small flowers. *Crotalaria quercetorum* is similar to *C. purshii* but may be distinguished by its much shorter peduncles and its usually smaller size. Because a number of specimens with intermediate morphology have been collected, hybridization between *C. quercetorum* and *C. sagittalis* is suspected in parts of their range where they are sympatric. *Windler & Windler* 2994 (NCU) is a collection in which some specimens seem to reflect this putative hybridization.

REPRESENTATIVE SPECIMENS: GUATEMALA. Exact locality not given, *Bernoulli* 282 (G). MEXICO. CHIAPAS: Hacienda Monserrate, *Purpus* 9144 (UC, US); **Jalisco:** 15-20 mi. SE of Autlan-Sierra Manantlan ca. 1,700 ft., *McVaugh* 13973 (MICH); **Michoacan:** 32 mi. W of Jiquilpan along road to Manzanillo, 7,000 ft., *Fearing* 1195 (TEX); **Nayarit:** 1 mi. from town of Santa Maria del Oro on way to Laguna Santa Maria, 3,700 ft., *Windler & Windler* 2917 (NCU); **Oaxaca:** 5-6 Km NE of Putla, 350 m., *McVaugh* 22248 (MICH); **Sinaloa:** Puerto a Tamiapa, 4,500 ft., *Gentry* 5815 (MEXU).

9. **Crotalaria mexicana** Windler, Phytologia 21: 259. 1971.
Crotalaria sagittalis var. *fruticosa* (Miller) Fawcett and Rendle, 4: 10, 1920, pro parte, sensu Senn, non sensu typus.

Annual erect herb with a slender taproot to 0.3 cm. thick. Stems solitary, 1.2-2.3 dm. long, 1.6-2.4 mm. thick, the longest internode 1-1.5 cm. long; vestiture of dense, appressed trichomes, 1.2-2.5 mm. long. Stipules absent. Leaves narrowly elliptic, linear-lanceolate or linear, 2.2-4.6 cm. long, 4-8 mm. wide, base rounded to cuneate, the apex rounded, acute or acuminate; vestiture of both surfaces of dense, loosly appressed trichomes 1.1-2.1 mm. long; petioles 0.5-0.6 mm. long. Inflorescences leaf-opposed, peduncles 0.8-2 cm. long. Bracts sessile, lanceolate, 3.3-3.6 mm. long, 0.7-0.8 mm. wide; pedicels 2.5-4 mm. long. Calyces 10.5-11.5 mm. long, the tubes 2-2.5 mm. long, bearing loosely appressed and spreading trichomes 0.8-2 mm. long; bracteoles linear-lanceolate, 4-4.5 mm. long, 0.5-0.6 mm. wide. Corollas yellow, the standards 10-10.5 mm. long, equaling to 0.5 mm. shorter than the upper calyx lobes; elongate anthers 1.5-1.7 mm. long, short anthers 0.5-0.6 mm. long; styles 4.8-5.3 mm. long. Fruits 2.1-2.5 cm. long, 0.8-1 cm. wide; seeds brown, number per pod not known, 1.8-2 mm. long. Chromosome number: not known. Flowering time: Sep-

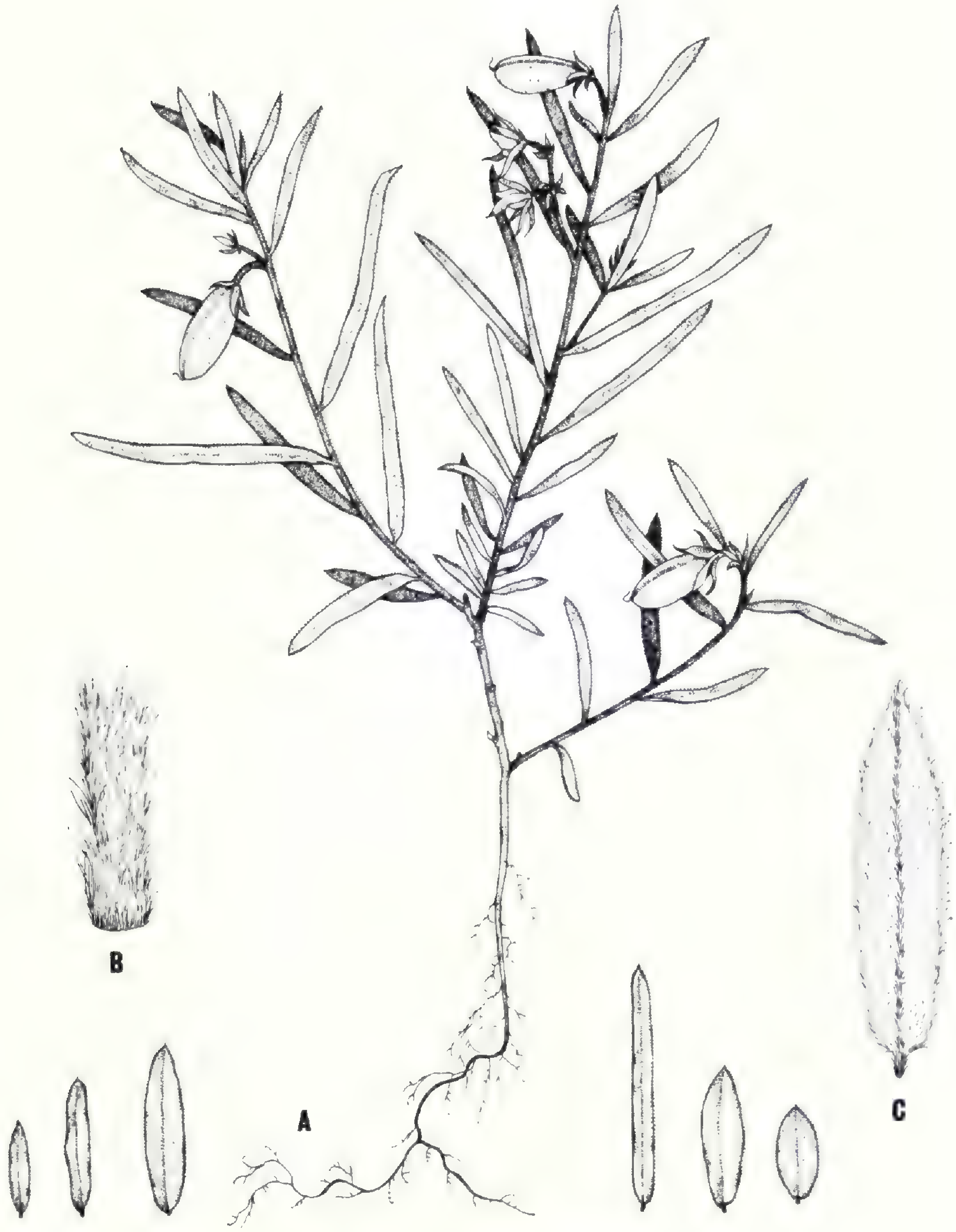


Figure 9. *Crotalaria mexicana.*

A. Habit and leaf variation
B. Stem
C. Leaf pubescence

tember-October. Habitat: dry slopes of mountains, elevation ca. 6,000 ft. Range: Mexico: Jalisco. Figure 9. Map 2.

Type: Mexico: Jalisco, mountainside above Etzatlan, *Pringle* 8855 (holotype, GH; isotypes, TEX, US).

Crotalaria mexicana is a new species, the representatives of which were referred by Senn (1939) to *C. sagittalis* var. *fruiticosa* (here treated as *C. sagittalis* var. *sagittalis*). *Crotalaria mexicana* is most similar to *C. sagittalis* and *C. quercetorum*. It differs from *C. sagittalis* in its lack of stipules and absence of spreading pubescence, and from *C. quercetorum* in its short thick peduncles and in its dense pubescence. *Crotalaria mexicana* is characterized by its erect habit, dense, appressed pubescence, lack of stipules, and extremely short, leaf-opposed peduncles.

REPRESENTATIVE SPECIMENS: **MEXICO.** JALISCO: near Etzatlan, *Pringle* 8855 (=type), *Pringle* 11807 (GH, US), *Rose & Painter* 7571 (US); near Guadalajara, *Rose & Painter* 7469 (US).

10. **Crotalaria rotundifolia** (Walt.) Gmelin in Linne . . . Systema Naturae **2**: 1095. 1792.

Anonymos rotundifolia Walter, Flora Caroliniana, 181. 1788. Type: BM, photo., NCU!

Crotalaria sagittalis var. *ovalis* Michx. Flora Boreali-Am. **2**: 55. 1803. Type locality: "Virginia et Carolina".

Crotalaria rotundifolia Poiret, Encycl. Meth. **2**: 402. 1812, non Gmelin, 1792. (see Ward, 1962).

Crotalaria ovalis (Michx.) Pursh, 469. 1814, nomen illegit.

Crotalaria hookeriana A. DC. in A.P. & A. DC., Mem. Soc. Phys. Genève **9**: 97. 1841. Type: not observed.

Crotalaria leptoclona Schauer, Linnaea **20**: 737. 1847. Type: Mexico, *Aschenborn* 172, not located.

Crotalaria maritima Chapman, Flora South. United States, Suppl. 614. 1883. Type: not located.

Crotalaria linaria Small, Flora SE United States 679. 1933. Type: Pine Key, Fla., *Blodgett* (NY!).

Crotalaria maritima var. *linaria* (Small) Senn, Rhodora **41**: 347. 1939.

Crotalaria rotundifolia var. *linaria* (Small) Fernald & Schubert, Rhodora **50**: 203. 1948.

Perennial procumbent, decumbent, or ascending herb with a taproot to 1.2 cm. thick. Stems 2-20, 0.3-6.5 dm. long, 0.5-3.1 mm. thick, the longest internode 0.6-4.8 cm. long; vestiture of appressed, loosely appressed, or spreading trichomes, appressed 0.3-0.6 mm. long, spreading 0.8-3.2 mm. long. Stipules present, with only the stipule lobes present or the stipules decurrent from ¼ to the full length of the internode, 0.13-2.3 cm. wide at the top tapering to the base, the stipule lobes spreading 0.15-1.7 cm. long. Leaves round, oval, oblong, ovate, lanceolate, elliptic, or linear, 0.9-5.5 cm. long, 1.0-33.1 mm. wide, base rounded to widely cuneate, the apex rounded, obtuse, mucronate, acuminate, or acute; vestiture of both surfaces of erect, appressed, or loosely appressed trichomes 0.3-2.8 mm. long; petioles 0.5-3 mm. long. Inflorescences leaf-opposed, peduncles 1.3-33.9 cm. long. Bracts with or without petioles, elliptic, lanceolate, or linear, the petioles to 1.5 mm. long, the blade 2-7.1 mm. long, 0.3-2 mm. wide; pedicel 2-5 mm. long. Calyces 7-14.9 mm. long; the tubes 1.5-4.5 mm. long, bearing appressed, loosely appressed or spreading trichomes 0.2-1.5 mm. long; bracteoles broadly to narrowly elliptic, lanceolate, or linear, 1.8-6.5 mm. long, 0.3-1.3 mm. wide. Corollas yellow, the standards 6-15 mm. long, 2.5 mm. shorter to 1.9 mm. longer than the upper calyx lobes; elongate anthers 0.9-2.1 mm. long, short anthers 0.3-0.7 mm. long; styles 4-6.9 mm. long. Fruits 1.2-2.8 cm. long, 0.5-1.1 cm. broad; seeds tan, bronze, green-tan, olive, green-brown, or red-brown, 12-46 per pod, 1.5-2.7 mm. long. Chromosome number: $n=16$. Flowering time: United States, January-October; Mexico, July-March. Habitat: road and railroad rights-of-way, rocky slopes, sandridges, sandhills, open pine, and pine-hardwood forests, elevation sea level — 8,250 feet. Range: Costa Rica; Guatemala; Mexico: Chihuahua, Guanajuato, Hidalgo, Jalisco, Mexico, Michoacan, Morelos, Nayarit, Oaxaca, Puebla, San Luis Potosi, Sonora, Veracruz; El Salvador; United States: Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Virginia.

Type: In Walter Herbarium at BM, photo observed.

Crotalaria rotundifolia was first recognized as a distinct species by Walter (1788) who also recognized it as being congeneric with *C. sagittalis* L. Walter apparently thought that *C. rotundifolia* and *C. sagittalis* represented a new genus distinct from *Crotalaria*, but, instead of describing a new genus, he placed them in a miscellaneous category under the genus name *Anonymos*. A few years later, Gmelin placed Walter's *Anonymos* species under other genera (Sprague, 1939). *Anonymos rotundifolia* was placed with *C. sagittalis* L. under *Crotalaria*. In 1812, Poiret again published the combination, and he, rather than Gmelin, is frequently attributed the authorship of the combination *C. rotundifolia*. In 1814, Pursh also placed Walter's *Anonymos rotundifolia* into *Crotalaria*. He, however, proposed a new species name, *C. ovalis*, and cited Walter's name as a synonym, making *C. ovalis* a superfluous epithet when published and therefore illegitimate.

Senn (1939), after examining a photograph of Miller's type of *Crotalaria angulata*, thought that it was synonymous with *C. rotundifolia*, and the name has since been used for the American plants. In 1897, Britten and Baker examined the specimen and concluded it did not differ from *C. biflora* L. A comparison of the photograph of Miller's specimen with an IDC microfiche of a *C. biflora* specimen in the Linnaean Herbarium leads me to agree with Britten and Baker. In addition, Miller indicated that the flowers were produced singly on the sides of the branches and that the leaves were sessile. Neither of these characters agrees with the type from the Miller Herbarium. It may also be possible that Miller made a mistake in indicating the location of the place of origin of the seed. It now seems better to recognize the epithet of Walter and to reject the Miller name for our American plants.

Fernald and Schubert (1948), after studying photographs of Walter's Herbarium (taken by Schubert) at the British Museum of Natural History, suggested that the name *Crotalaria rotundifolia* actually refers to the plants with short appressed pubescence previously referred to as *C. maritima.* A more recent photograph of the specimen figured by Fernald and Schubert has been supplied by Dr. Norman K. B. Robson of the British Museum. Dr. Robson (personal communication) indicates that the plant has "appressed-sericeous" pubescence and would "run down easily in Senn's key to *C. maritima* Chap.". In light of this information, the name *C. rotundifolia* is recognized as applying to the material previously recognized as *C. maritima,* as Fernald and Schubert suggested.

Crotalaria rotundifolia may be distinguished by its procumbent, decumbent, or occasionally ascending habit; leaf-opposed inflorescences; and the presence of stipules. It is an extremely variable species, especially in the Florida peninsula.

Two varieties may be distinguished in the following way:

Plants with appressed stem pubescence. . . . . 10a. *C. rotundifolia* var. *rotundifolia.*
Plants with spreading stem pubescence. . . . . 10b. *C. rotundifolia* var. *vulgaris.*

10a. **Crotalaria rotundifolia** var. **rotundifolia** Figure 10, Map 5.

While plants of some populations in the higher Florida Keys and along the Florida Gulf coast have only narrow leaves, plants at most locations in the state are extremely variable. *Crotalaria linaria* Small was based on narrow leaved plants and was maintained by Senn as a variety of *C. maritima.* Since a narrow leaved plant usually cannot be differentiated as being from either the entirely narrow leaved populations or the heterogeneous populations on the peninsula, no purpose is served by maintaining the variety or by reducing it to the status of *forma.*

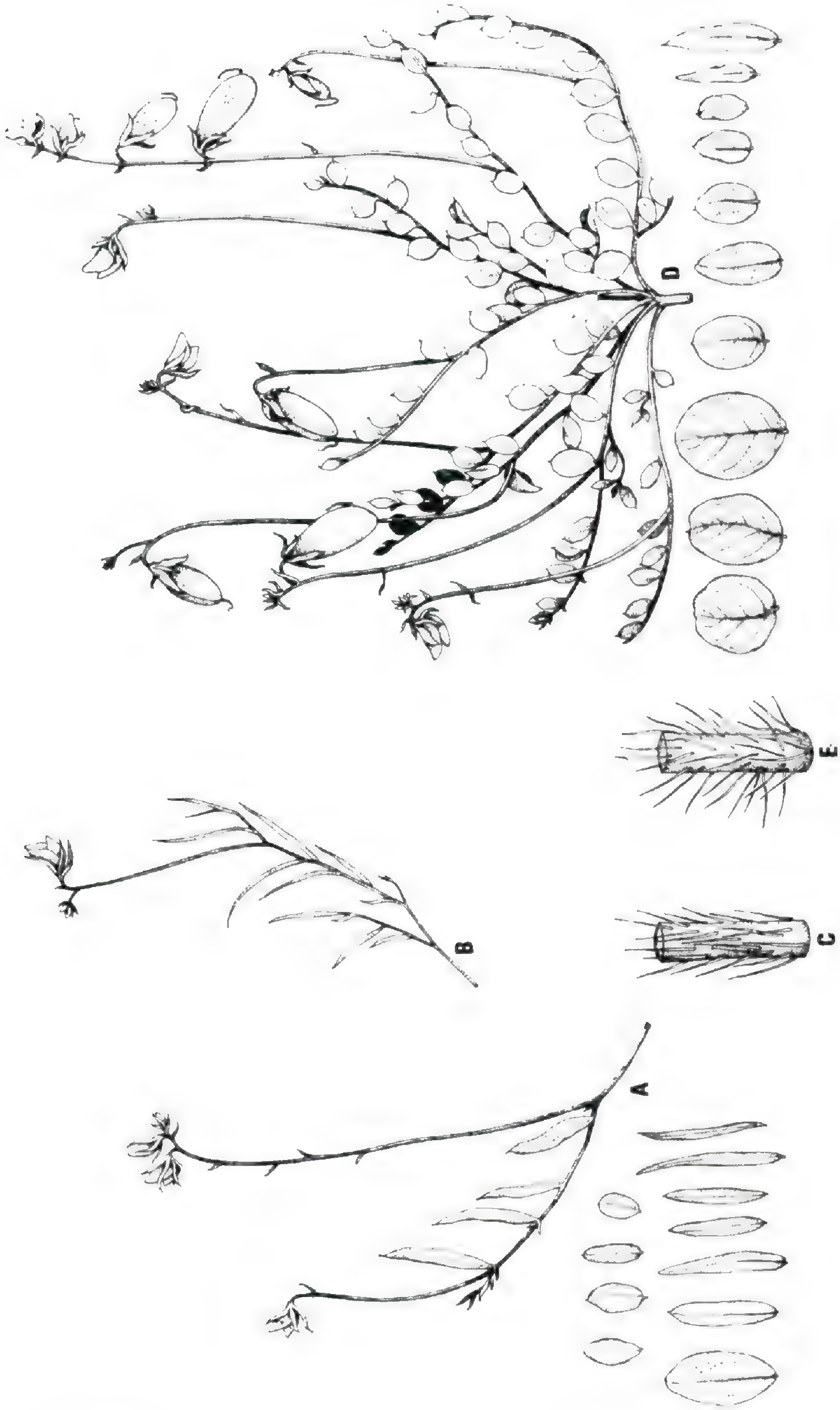
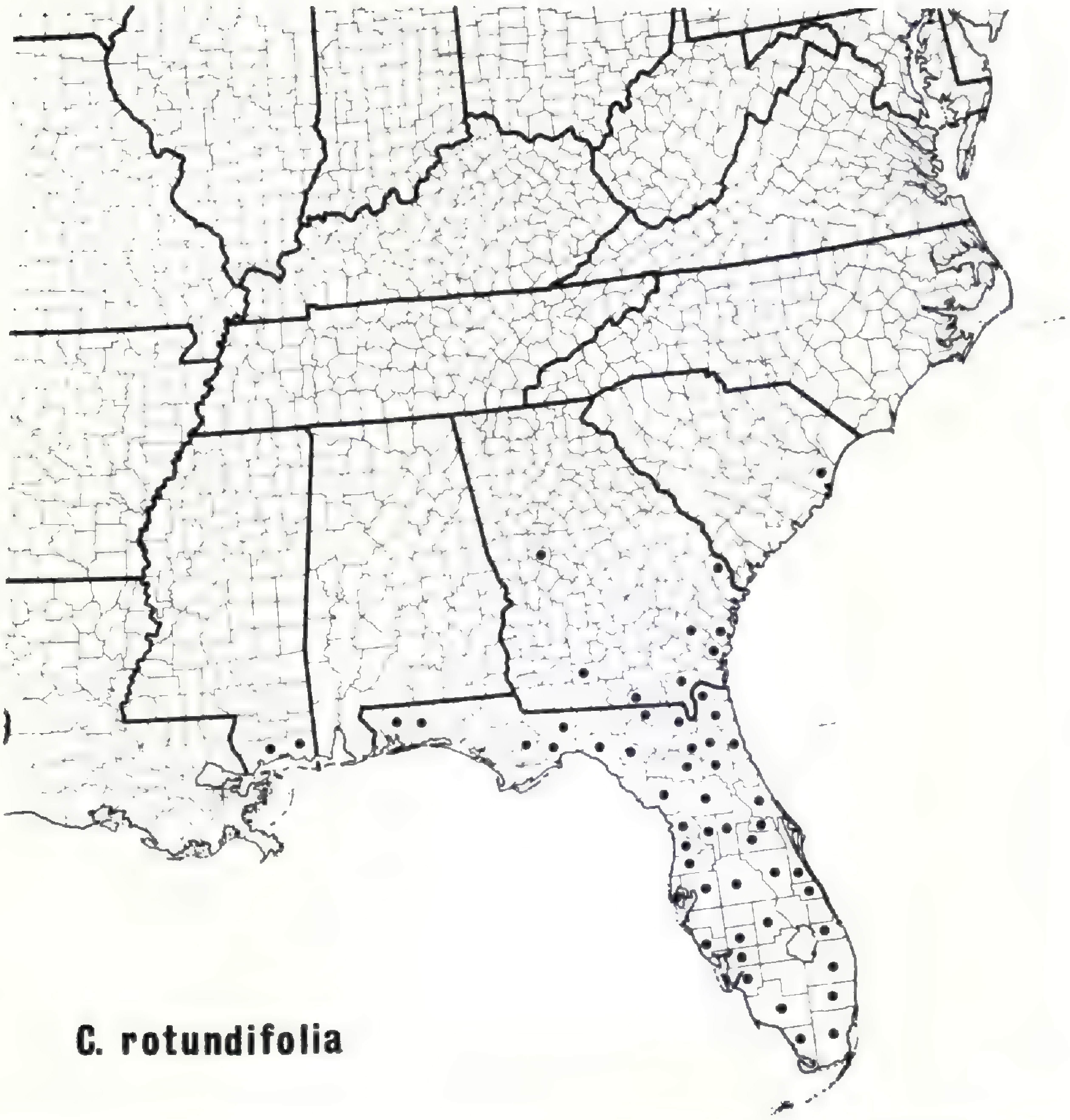
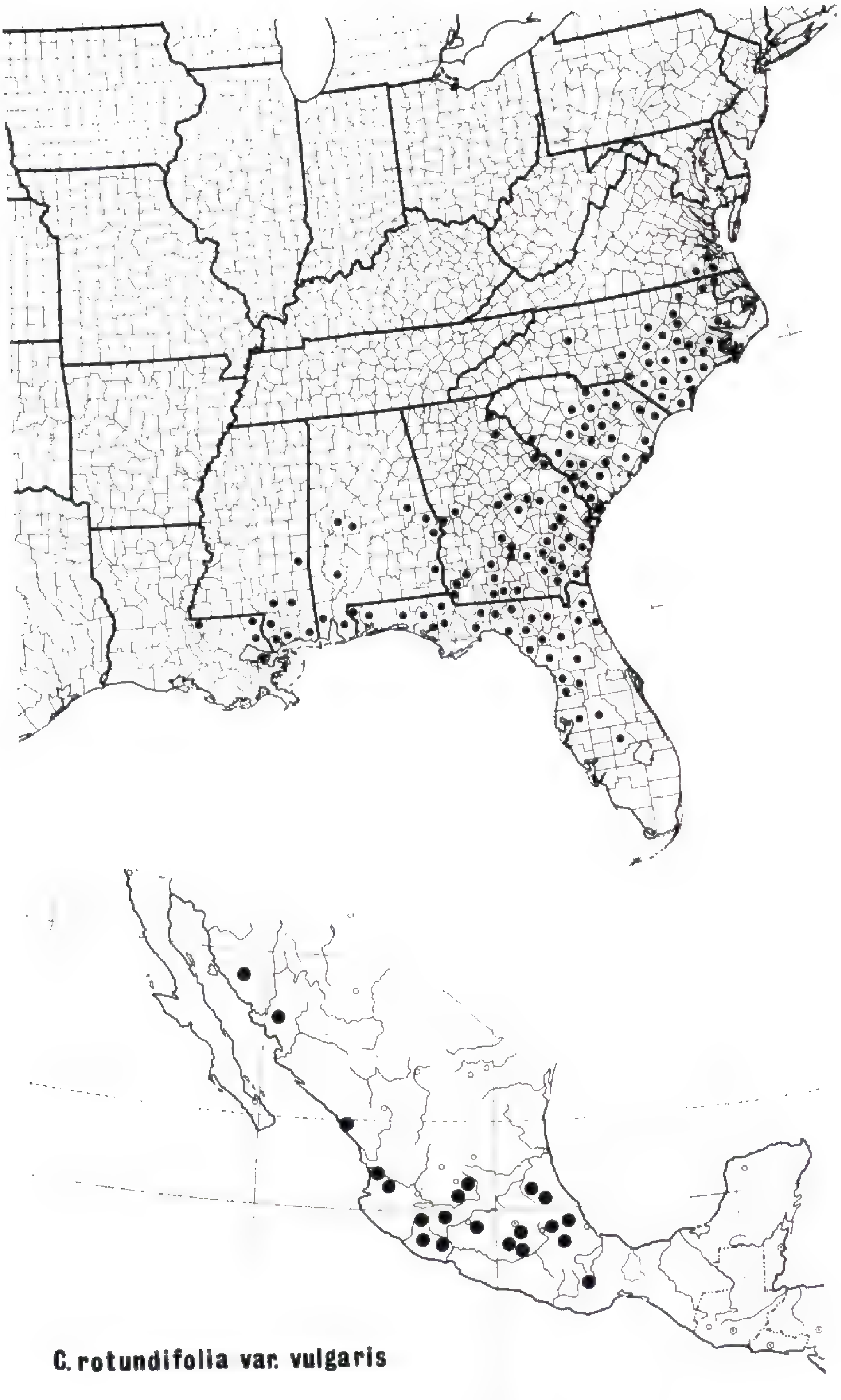


Figure 10. *Crotalaria rotundifolia* var. *rotundifolia.*
A., B. Habit and leaf variation
C. Stem
Crotalaria rotundifolia var. *vulgaris*
D. Habit and leaf variation
E. Stem



Map 5. Distribution of *Crotalaria rotundifolia*, var. *rotundifolia*.



Map 6. Distribution of *Crotalaria rotundifolia* var. *vulgaris*.

REPRESENTATIVE SPECIMENS: PUERTO RICO. Vicinity of Dorado, white sand, *Britton, Britton, & Brown* 6653 (US). UNITED STATES. **Florida:** LEVY CO.: evergreen scrub oak sandridge, Cedar Key, *Godfrey* 56571 (GA, GH, USF). MONROE CO.: open dry sandy swale behind low coastal shell ridge, Middle Cape, Cape Sable, Everglades National Park, *Ward* 3939 (GA, LAF, NCU). **Georgia:** MCINTOSH CO.: sandhill thicket 1.3 mi. N of Ft. Barrington, Cox Road on ridge, *Boseman* 458 (NCU). **Mississippi:** JACKSON CO.: Ocean Springs and vicinity of Gulf Coast Research Laboratory, sandy soil under pines, west end of Deer Island, *Channell* 414 (USF). **South Carolina:** GEORGETOWN CO.: roadsides, 5.6 mi. S of Maryville, *Radford* 28670 (NCU).

10b. **Crotalaria rotundifolia** var. **vulgaris** Windler, Phytologia **21:** 264. 1971.

Crotalaria angulata Miller, 1768, sensu Senn, 1939. (See discussion above.

Figure 10, Map 6.

Type: South Carolina: Hampton County, about three miles northwest of Yemassee on South Carolina Highway 68. Sandhill. 23 July 1967, *D. R. & B. K. Windler* 2769 (NCU).

Crotalaria rotundifolia var. *vulgaris* is distinguished by its spreading pubescence. Over most of its range var. *vulgaris* is also characterized by round to oval leaves, but in northern Florida and southern Georgia it intergrades with the usually narrower leaved var. *rotundifolia*.

REPRESENTATIVE SPECIMENS: COSTA RICA. Cartago, Elev. 4,500 ft., *Cooper* 165 (US). GUATEMALA. **Chimaltenango:** alt. 2,100 m., *Standley* 61485 (NY). PANAMA. **Panama:** roadside, Rio Tapia, *Standley* 28214 (US). EL SALVADOR. vicinity of San Salvador, alt. 650-850 m., *Standley* 22444 (NY). MEXICO. **Baja California:** San Antonio, Cape region, *Purpus* 475 (US). **Guanajuato:** 20 mi. NW of Irapuato, *Barkley, Rowel, & Parson* 752 (TEX). **Hidalgo:** Dist. Zimapan, on road from Hwy. at km. 242 to Encarnacion, *Moore & Wood* 4319 (MEX). **Jalisco:** 5 mi. W of Guadalajara on Hwy. 15, beneath cliff face in road cut, brown sandy soil, *Irwin* 1257 (TEX). **Mexico:** Lecheria, *Pringle* 13411 (GH, US). **Michoacan:** growing in oak, 2 mi. above Tancitaro, elev. 7,000 ft., *Leavenworth* 517 (GH). **Morelos:** km. 56-57, road from D.F. to Cuernavaca, roadside embankment, *Moore* 125 (GH). **Nayarit:** 13 mi. SE of Tepic, in red clay, *Irwin* 1293 (TEX). **Oaxaca:** Valley of Oaxaca, alt. 5,500-7,500 ft., *Nelson* 1481 (GH). **Puebla:** vicinity of Puebla, *Arsene* 1414 (US). **San Luis Potosi:** 15 mi. E of Ciudad del Marz on Rt. 80, ca. 1,000 m., *Mickel* 544 (MICH). **Sinaloa:** dry hill, vicinity of Mazatlan, *Rose, Standley, & Russell* 13823 (US). **Sonora:** 3 mi. NE of Matape, *Wiggins & Rollins* 400 (GH). **Veracruz:** Misantla, *Purpus* 5907 (GH, NY, US). UNITED STATES. **Alabama:** CLARKE CO.: near Choctaw Lake, elev. 170 ft., *Demaree* 50694A (LAF, NCU). **Florida:** HERNANDO CO.: Chinsegut Hill Bird Sanctury, open area along margins of pine woods, *Windler* 1136 (NCU). **Georgia:** BEN HILL CO.: open pine-oak on sandy upland, 7.1 mi. N of Fitzgerald, *Duncan & Hardin* 14301 (GA). **Louisiana:** WASHINGTON PARISH: mixed woods, edge, along Pushepetappa Creek, 2 mi. WNW of Varnado, *Thieret* 25910 (LAF). **Mississippi:** LAMAR CO.: 12 mi. WSW of Hattiesburg along Black Creek, low area, *Doughty* 162 (MISS). **North Carolina:** BLADEN CO.: wet ditch on 701 to White Lake, *Radford & Radford* 2065 (NCU). **South Carolina:** BERKELEY CO.: common on sandy bank ca. 15 mi. S of Moncks Corner on 52, *Wilbur* 3547 (GA). **Virginia:** NANSEMOND CO.: dry white sand of pineland SW of Marsh Hill School S of South Quay, *Fernald & Long* 11050 (GH).

11. **Crotalaria bupleurifolia** Schlecht. & Cham., Linnaea **5**: 575. 1830.

Crotalaria heldiana A. DC. in A. & A.P. DC. Mem. Soc. Phys. Geneve **9**: 97. 1841. Type: Grown from seed of unknown source in the garden at Carlsruhe, (G!).

Annual or perennial spreading suffrutescent herb with a taproot to 2 cm. thick. Stems few-many, 5-27 dm. long, 2-3.5 mm. thick, the longest internode 3.5-10 cm. long; vestiture of spreading or loosely appressed trichomes 0.2-1.3 mm. long. Stipules present, decurrent for 1/4 to the full length of the internode, 0.5-2.7 cm. wide at the top tapering slightly to or past the subtending node, the stipule lobes absent or spreading 0.5-3 cm. long. Leaves oval, elliptic, ovate, broadly lanceolate, or lanceolate, 3.2-10.2 cm. long, 7-46 mm. wide, base obtuse to cuneate, the apex obtuse, mucronate, acuminate, or acute; vestiture of both sides of spreading or loosely appressed trichomes 0.2-1.6 mm. long or nearly glabrous; petioles 2-3 mm. long. Inflorescences leaf-opposed, peduncles 2-16 cm. long. Bracts sessile, linear, subulate, or narrowly lanceolate, 4.5-7.5 mm. long, 0.3-0.6 mm. wide; pedicels 4-5.5 mm. long. Calyces

13.5-19 mm. long, the tubes 2.5-5 mm. long, bearing loosely appressed or spreading trichomes 0.1-1.1 mm. long; bracteoles linear, subulate, or narrowly lanceolate, 3-6 mm. long, 0.2-0.7 mm. wide. Corollas yellow, the standards 16-25 mm. long, equaling to 6 mm. longer than the upper calyx lobes; elongate anthers 2-2.8 mm. long, short anthers 0.5-0.7 mm. long; styles 7-11 mm. long. Fruits 3-4.1 cm. long, breadth not known; seeds tan, green-brown, or brown, number per pod not known, 2.2-2.5 mm. long. Chromosome number: $n=16$. Flowering time: August-March. Habitat: North-facing slopes and bluffs and cloud forests with firs and broad leaf trees, elevation 2,500-7,500 feet. Range: Mexico: Chiapas, Guerrero, Jalisco, Mexico, Michoacan, Sinaloa, Veracruz.

Type: Hacienda de la Laguna? *Schiede et Deppe s.n.* (G!).

Crotalaria bupleurifolia was described by Schlechtendal and Chamisso in an article describing the collections of Schiede and Deppe in Mexico. A specimen collected by Schiede and Deppe at G is marked "Typus" and may well represent the type even though the location on the label reals "Mexique. Cuerta grande de Chiconquiaco" rather than "Hacienda de la Laguna" cited with the original description of *C. bupleurifolia*. The number 596 cited with Schiede's name in Senn (1939) refers to the species number which accompanied Schlechtendal et Chamisso's description.

Crotalaria bupleurifolia is characterized by its generally large size, unusual stipules, and large flowers and habit. It most closely resembles *C. nayaritensis* but may be distinguished from it by the large flower size, larger overall size, and usually wider stipules.

Two varieties may be recognized:

Stipules present only at the base of peduncles, decurrent for only a single internode. .... 11a. *C. bupleurifolia* var. *bupleurifolia*.

Stipules present at the base of most leaves, frequently decurrent for more than one internode. .... 11b. *C. bupleurifolia* var. *robusta*.

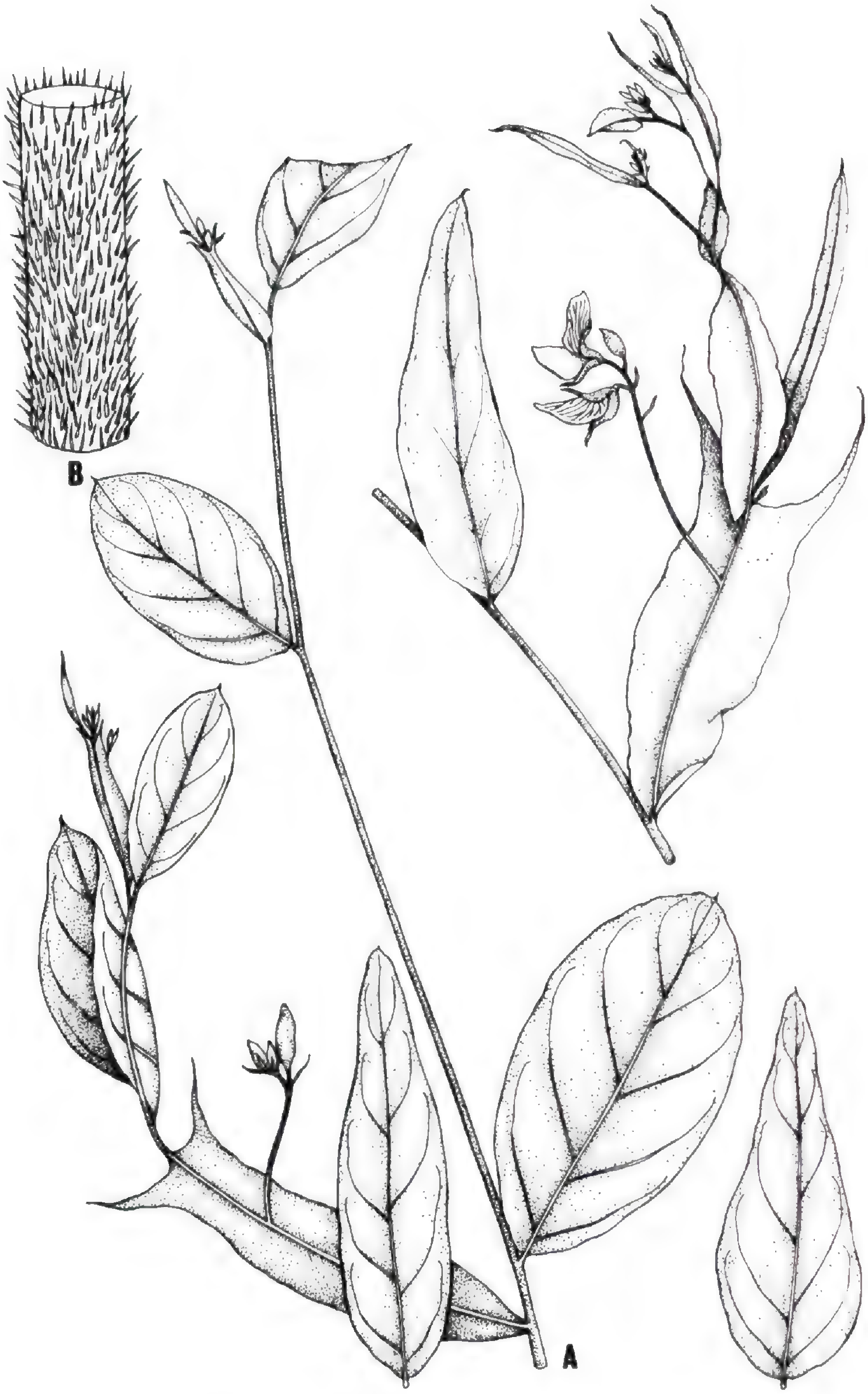
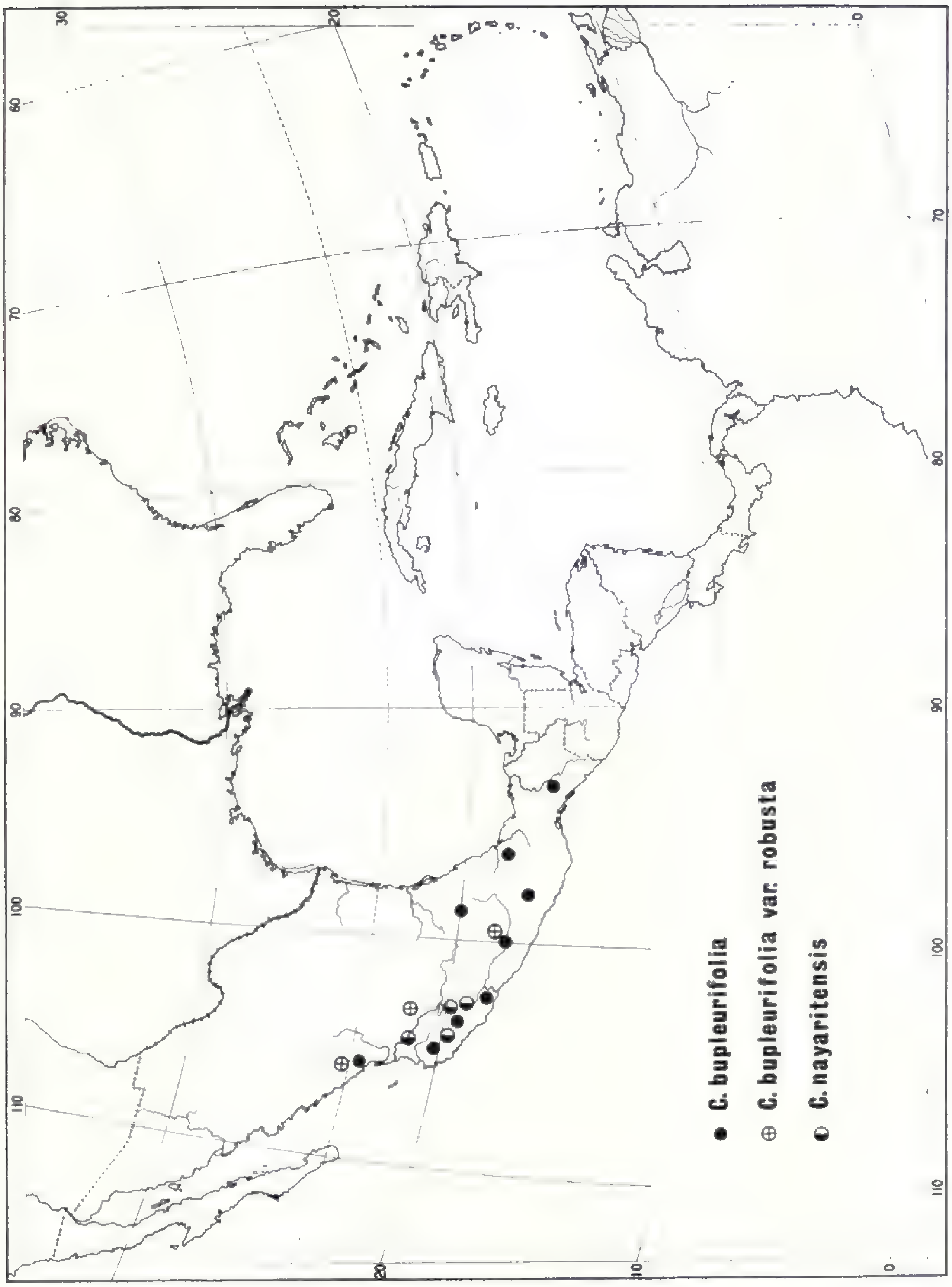


Figure 11. *Crotalaria bupleurifolia* var. *bupleurifolia*.
A. Habit and leaf variation
B. Stem



Map. 7. Distribution of *Crotalaria bupleurifolia* var. *bupleurifolia*, *C. bupleurifolia* var. *robusta*, and *C. nayaritensis*.

11a. **Crotalaria bupleurifolia** var. **bupleurifolia** Figure 11, Map 7.

REPRESENTATIVE SPECIMENS: MEXICO. **Chiapas:** NE of Bochil, *Miranda* 5746 (MEXU). **Guerrero:** San Antonio Buenos Aires, *Hinton* 11708 (GH, TEX, US). **Jalisco:** near Santa Monica, 1,950-2,050 m, *McVaugh* 14086 (MEXU, MICH, US). **Mexico:** Rincon del Carmen, Dist. Tamascaltepec, 1,340 m, *Hinton* 1730 (MEXU, NY, US). **Michoacan:** NW of Aguililla, 15 Km S of Aserradero Dos Aguas, 1,650-1,700 m, *McVaugh* 22767 (MICH). **San Luis Potosi:** Las Canoas, *Pringle* 8 (MEXU). **Sinaloa:** Batel, Concordia, *Dehesa* 1619 (US). **Tamaulipas:** 10 Km NW of El Progresso, 1,450 m, *Stanford, Retherford, & Northcraft* 1009 (GH). **Veracruz:** Barranca de Tenampa, Zacuapan, *Purpus* 3663 (GH, NY, US).

11b. **Crotalaria bupleurifolia** var. **robusta** (Senn) Windler, Phytologia **21:** 265. 1971.

Crotalaria pilosa var. *robusta* Senn, 1939, **41:** 331. Figure 12, Map 7.

Type: Temascaltepec, Cumbre de Tejupilco, *Hinton* 2686 (US!).

REPRESENTATIVE SPECIMENS: MEXICO. **Jalisco:** 10 Km al N de La Cuesta, sobre el camino a Talpa, 1,100 m, *Rzedowski* 15134 (MEXU). **Mexico:** Plaza de Gallos, 1,200 m. *Hinton* 4595 (GH, NY). **Sinaloa:** Km 1206 on Mexico Hwy. 40, ca. 30 mi. E of Mazatlan-Guadalajara Junction, 2,700 ft., *Windler & Windler* 2869 (NCU).

12. **Crotalaria nayaritensis** Windler, Phytologia **21:** 261. 1971.

Annual or perennial spreading herb with a taproot to 1.5 cm. thick. Stems 1-many, 6-12 dm. long, 1.5-2.5 mm. thick, the longest internode 3.8-10 cm. long; vestiture of short appressed trichomes, 0.2-0.7 mm. long. Stipules present, decurrent the length of the internode, 0.15-1.1 cm. wide at the top tapering to or past the subtending node, the stipule lobes parallel with the stem or spreading, 0.1-1.3 cm. long. Leaves oval, elliptic, ovate, narrowly ovate, oblong or lanceolate, 3.5-7.8 cm. long, 7-26 mm. wide, base obtuse to cuneate, the apex obtuse, mucronate, acuminate or acute; vestiture of both surfaces of appressed or loosely appressed trichomes 0.3-0.8 mm. long; petioles 1.2-2.5 mm. long. Inflorescences leaf-opposed, peduncles 3.2-16 cm. long.

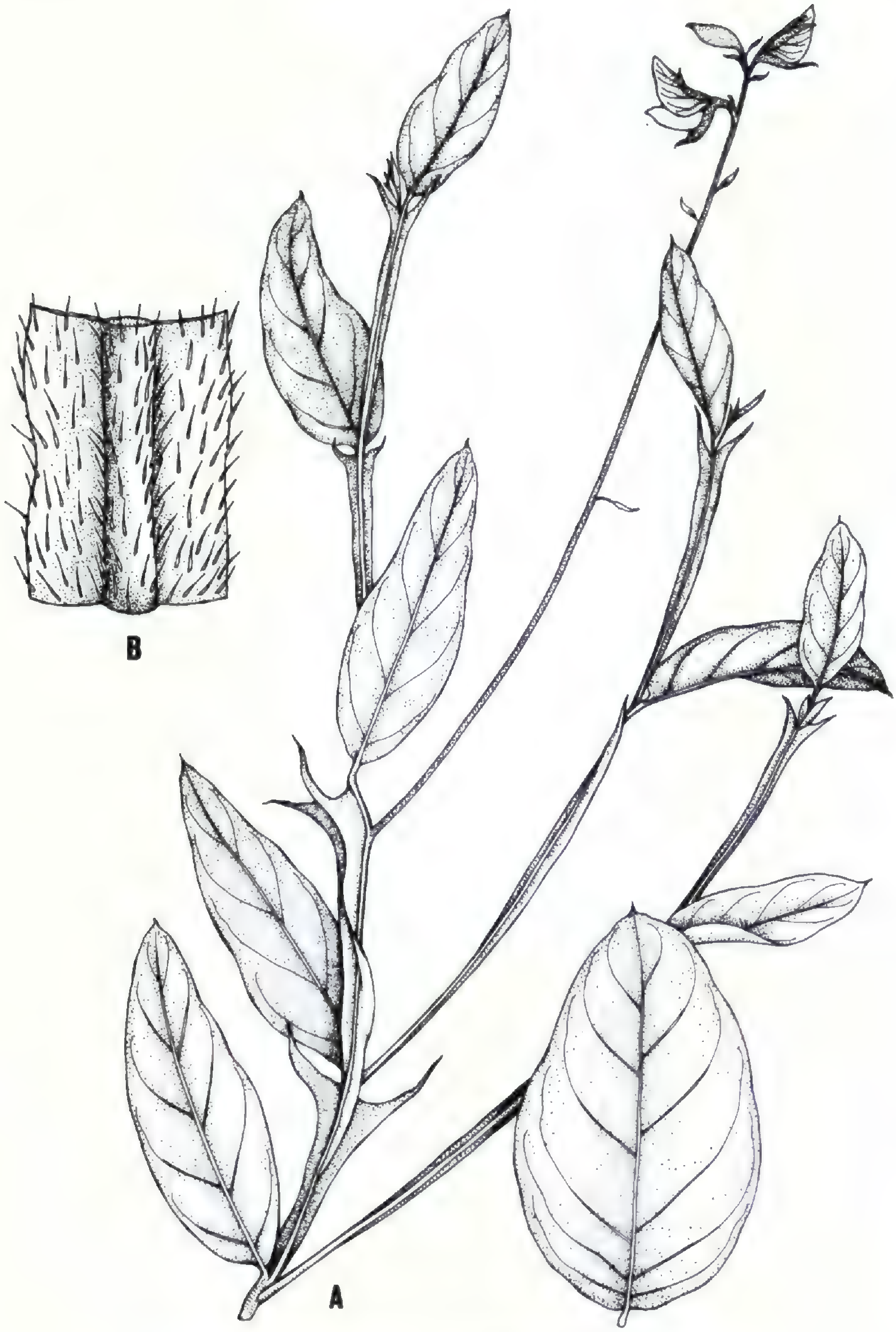


Figure 12. *Crotalaria bupleurifolia* var. *robusta*.
A. Habit and leaf variation
B. Stem

Bracts sessile, linear or elliptic lanceolate, 3-4.5 mm. long, 0.2-0.5 mm. wide; pedicels 2.8-3.8 mm. long. Calyces 7.5-12 mm. long, the tubes 2-3.2 mm. long, bearing appressed trichomes 0.1-0.5 mm. long; bracteoles linear or narrowly lanceolate, 1.5-3 mm. long, 0.2-0.3 mm. wide. Corollas yellow, the standards 7-12.5 mm. long, 2 mm. shorter to 1 mm. longer than the upper calyx lobes; elongate anthers 1.3-2.1 mm. long, short anthers 0.4-0.5 mm. long; styles 5-6 mm. long. Fruits 1.3-2.3 cm. long, 0.5-0.8 cm. broad; seeds tan, grey-tan, green-brown, brown or red-brown, 30-35 per pod, 1.6-2.4 mm. long. Chromosome number: $n=16$. Flowering time: August-February. Habitat: steep moist slopes and pine woods, elevation 2,500-6,600 feet. Range: Mexico: Jalisco, Nayarit. Figure 13, Map 7.

Type: Mexico: Nayarit, North of Compostella (near Km. 24), about 7 miles southwest of Tepic, along road between Tepic and Compostella. Road-cut through mountain on moist steep slope, *Windler & Windler* 2902 (NCU).

Crotalaria nayaritensis is a new species named for the Mexican state from which the holotype was collected. It is characterized by its spreading or diffuse habit, leaf-opposed inflorescences, small flower size, and appressed pubescence. Of the Mexican species it most nearly resembles *C. bupleurifolia,* but differs from it in having a smaller flower, appressed pubescence and usually narrower stipules.

REPRESENTATIVE SPECIMENS: MEXICO. **Jalisco:** 13 mi. SW of Autlan, 1,000 m, *McVaugh* 19886 (MICH); Llano Verde, municipio de Tecalitlan, 1,600 m, *Rzedowski* 17417 (MICH); 3 mi. S of Mazamitla, 2,100-2,200 m, *McVaugh* 12997 (MICH, US); San Sebastian, W to Mascota, 1,425 m, *Mexia* 1408 (US); Tepic, *Palmer* 1869 (NY, US). **Nayarit:** 10 mi. SE of Ahuacatlan, 1,100-1,300 m, *Fedema* 287 (MICH); N of Compostella, 3,000 ft., *Windler & Windler* 2902 (NCU); Mina Esperanza Rosa Morada, *Ortega* 6682 (US); 2 mi. N of Tepic, 3,000 ft., *Windler & Windler* 2897 (NCU).

PUTATIVE HYBRIDS BETWEEN CROTALARIA SPECIES

During the course of the study a number of putative hybrids were observed. The following presentation sets

Figure 13. *Crotalaria nayaritensis.*

A. Habit and leaf variation
B. Stem

forth the probable parents and lists of representative specimens which appear to be the results of crosses between the parents.

Crotalaria sagittalis × C. stipularia

ST. KITTS. Pastures near Sandy Point, *Britton & Cowell* 128 (NY).

Crotalaria sagittalis × C. rotundifolia var. **vulgaris**

UNITED STATES. **Alabama:** Mobile, *Mohr s.n.* 1873 (SIU). **Florida:** BAY CO., E of Panama City, *Windler & Windler* 2723 (NCU); N of Betts, *Windler & Windler* 2721 (NCU); ESCAMBIA CO., W of Century, *Windler & Windler* 2688 (NCU); JACKSON CO., Grand Ridge, *Windler & Windler* 2712 (NCU); OKALOOSA CO., 4 mi. W of Blackwater River Bridge on Fla. Hwy. 4, *Windler & Windler* 2700 (NCU); SANTA ROSA CO., E of Chumuckla, *Windler & Windler* 2693 (NCU); S of Milton, *Windler & Windler* 2697 (NCU). **Mississippi:** FOREST CO., S of Hattiesburg, *Windler & Windler* 2659 (NCU); HARRISON CO., N of Biloxi, *Windler & Windler* 2666 (NCU); LAMAR CO., 8.5 mi. SE of Hattiesburg, *Cooley* 62 (MISS); 7.5 mi. SW of Hattiesburg, *Cooper* 93 (MISS); Pearl River, 1 mi. N of Picayune, *Pullen* 641208 (MISS).

Crotalaria sagittalis × C. quercetorum

MEXICO. **Chiapas:** Bochil, *Windler & Windler* 2994 (NCU).

Crotalaria rotundifolia × C. purshii

UNITED STATES. **Alabama:** BALDWIN CO., Foley, *Windler & Windler* 2681 (NCU). **Florida:** CALHOUN CO., ½ mi. S of Clarksville, *Windler & Windler* 2425 (NCU); ESCAMBIA CO., 2½ miles N of Jct. Fla. Hwy. 97 — US Hwy. 29, *Windler & Windler* 2686 (NCU); SANTA ROSA CO., S of Milton, *Windler & Windler* 2699 (NCU). **Georgia:** GLYNN CO., Brythe Island, *Hardin & Duncan* 13785 (NCU); MCINTOSH CO., 2.6 mi. W of Cox, *Bozeman* 1078 (NCU); 1 mi. SE of Ft. Barrington, *Boseman & Radford* 2146 (NCU); THOMAS CO., SW of Thomasville, *Windler & Windler* 2734 (NCU). **Mississippi:** HARRISON CO.: Ship Island, *Demaree* 35028 (LAF); JACKSON CO., Round Island, *Demaree* 33742 (LAF).

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THE FLORA OF MOUNT MONADNOCK, NEW HAMPSHIRE

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Mt. Monadnock (Elevation 3,165 feet) lies in Southern New Hampshire at a distance from other hills of comparable height. This mass of granite and gneiss rising from a plain has given rise to the generic term "monadnock" for similar isolated rock peaks. The Grand Monadnock, as it is sometimes called, to distinguish it from other monadnocks, is situated in the towns of Dublin and Jaffrey. Roads surround the base of the mountain at elevations of 1,200 to 1,500 feet above sea level.

Botanically Mt. Monadnock is of interest because of the presence of a few arctic-alpine plants on the bare rocky summit area, far from other stations for them, and because of the records made by Thoreau on his four visits from 1844 to 1860, and later by other botanists, such as Stone (1885) and Deane (1890) and many later ones, some of whom deposited specimens in New England herbaria. It was my purpose to compare the present flora with that found by Thoreau.

The student of land use can read much of its history from the flora, since plant habitat is affected by what has happened to the plants. The history of Mt. Monadnock is of interest because of three distinct periods: (1) the development of complete forest cover since the time of glacial retreat, (2) its complete removal on the upper slopes by fire, and partial removal on the lower by clearing for pasture and fire, and (3) the slow renewal of vegetative cover during the last 150 years.

It is generally believed on the basis of geological and pollen evidence and observation of succession on rock and soil recently exposed by the retreat of present day glaciers, that the succession on Mt. Monadnock was probably as follows: the first pioneer plants, following lichens and mosses, may have been shrubs and forbs capable of surviving under severe cold, wind and fluctuating moisture. These may have included species that colonize mineral soil and rock crevices, including some of the arctic-alpines. Later, as climate moderated, spruces and pines (possibly *Pinus Banksiana*) occupied the accumulations of sand and organic matter in depressions. Finally, as humus accumulated, Red Spruce (*Picea rubens*) came to dominate the flora of the upper part of the mountain where soil development was indefinitely delayed.

Mt. Monadnock was completely forested at the coming of the White Man, the summit area covered with Red Spruce to the very summit, and the lower slopes with spruce and hardwood, much as the case of lesser mountains much farther north. All similar rocky peaks below the approximately 4,500 feet climatic timberline in New Hampshire are or were completely forest-clad. Mt. Monadnock is about 1,000 feet lower than climatic timberline and lies almost 100 miles south of the nearest timberline. Tree line is higher at lower latitudes. The bare rocky summits of New Hampshire such as Chocorua, Cardigan, Firescrew, and Percy Peaks all have documented history of fire.

Until recent years there were many old stumps and logs near the summit. Thoreau wrote in his *Journal* (June 1858): "The whole rocky part of the mountain, except the extreme summit, is strewn with the relics of spruce trees a dozen or fifteen feet long, and long since dead and bleached, so that there is plenty of fuel at hand." The remains nearest the summit were no doubt first consumed by visitors campfires. Visitors were very numerous in Thoreau's day and before, and in several of his writings he reports having seen fires at the top. Since the area at the extreme summit is quite level, with depressions, it is probable that it was originally as densely forested as the rest of the mountain. Chamberlain (1936) shows a picture (p. 73) of stumps near the top. Obviously, there could not have been such severe fires at the summit had there not been timber to burn. The 1953 fire on the east slope stopped when it reached the scrub zone where there was no fuel.

There are many published reports that confirm the original forested nature of the summit. Later the practice of clearing the slopes for pasture gave rise to numerous fires.

During the celebration of the centennial of the Town of Dublin in 1852, Charles Mason made an address on June 17 (Leonard 1855) including the following remark:

"Formerly covered with trees almost to the summit."

At the same celebration in Dublin (Leonard *op. cit.*) a letter was read from Daniel Elliott, M.D. in which he recalled: "I remember (Monadnock) when clothed with verdant foliage to the very summit." Similar records are found in the Town of Jaffrey: "When the town was first settled the mountain was covered to its summit with forest trees, principally spruce, excepting a small peak southeast of the top, which was called the "Bald Rocks" (Cutter 1881). "Belts of heavy spruce timber on the highest portions" were reported by Child (1885). Similar references may be found in Dana (1816) and Ellis (1880).

Ecologists recognized that forest had come to occupy the mountain much as peaks farther north. Braun (1950) refers to Monadnock (p. 423) as "covered with Red Spruce from 2,300 feet upward, thus producing a small outlier of the prevailing mountain vegetation in the north." Spurr (1964) states that "the summit of Mt. Monadnock . . . was clothed with a Red Spruce forest until destroyed by fire . . ."

Many fires have occurred during the recorded history of Mt. Monadnock, and it is possible that lightning fires may have burned in earlier times, but it is doubtful if Indians caused any fires on its forbidding slopes. In the same address referred to above (Leonard, *loc. cit.*) Charles Mason said: "A great fire spread over a great part of the superior portion of the mountain killing every tree and shrub. Dead trees falling, furnished materials for another conflagration. Some 30 years ago in the latter part of a dry summer, a fire in a clearing made its way up to the higher regions." "Some 30 years ago" would have placed this fire about 1820, although the cause of the fire differs from other accounts given below. Also the statement of Dr. Elliott on the same occasion: "I saw, year after year, the devouring flames climbing his lofty sides", suggests many fires.

Thoreau, on his second visit to Monadnock in 1852 (his first was in 1844, the journal report of which has not been preserved) related this incident during his passage through Peterborough: "A man in Peterborough told me that his father told him that Monadnock used to be covered with forest; that fires ran through it and killed the turf; then the trees were blown down, and their roots turned up and formed a dense and impenetrable thicket in which wolves abounded . . . till finally they set fire to this thicket and it made the greatest fire they had ever had in the county."

These and other records fail to give exact dates. As Chamberlain (1936) says (p. 97): "No documentary evidence has been found to show exactly when the fires occurred." He also quotes (p. 98) from the New Hampshire Sentinel of September 30, 1825, reporting a great fire of "some years ago". "This fire consumed only the turf. The trees turned over in every direction, and afforded about three years later fuel for a more tremendous scene." This places the two "great" fires closer together. The best evidence suggests a first fire about 1800, then the 1815 hurricane, and the final great fire in 1820. There were later ones, too. Thoreau reported ("A Walk to Wachusett", July 19, 1842) "A fire blazing on Monadnock that night, which lighted up the whole western horizon."

The first inroads of man occurred on the lower slopes that were cleared for pasture. Later, clearing progressed higher where sheep were grazed. Fire was used both for opening the areas and for keeping them so, and many of the fires that reached the upper levels both before and after the 1820 fire were caused by fire escaping from pasture burning. The repeated burning promoted the growth of blueberries, which I believe may have spread from lower pastures to the summit after the great fires. At present these are rather scarce.

Following abandonment of the pastures, these seeded into Red Spruce, and the process of reclothing the upper reaches of the mountain progressed rapidly at first, and ever slower on the more exposed parts of the mountain. Here denudation resulted in a worsening of the climate. Wind movement increased over the bare rock, and extremes of temperature and soil moisture retarded growth. Recently a cycle of retarded spread of spruce seems to have set in, since almost no spruce trees less than forty years old can now be found on the upper part of the mountain and a high percentage of the trees display dead tops and reduction in diameter and height growth.

The large area laid bare by the fires apparently provided a favorable habitat for a few arctic-alpine plants that may have been present before the fires or had been transported from other sources. In any case they were well-established at the time of Thoreau's first visit, little over twenty years after the great fire. Those recorded by Thoreau (*Journal,* August 8, 1860, 25-28; 1670-1671) were: *Arenaria groenlandica, Vaccinium Vitis-Idaea var. minus* and *Juncus trifidus.* Others with northern or high altitude affinities, not found generally in the lowland, especially in the vicinity of Mt. Monadnock were *Potentilla tridentata* and *Smilacina trifolia.* During the present survey *Lycopodium Selago var. Selago* and *var. appressum* as well as *L. annotinum var. pungens* have been added to the list.

Thoreau limited his observations to the "upper part of the mountain," and essentially all the taxa reported by him in 1858 "within 200 feet of the summit" were also collected in 1968. Less complete were the lists of Stone (1885), Deane (1890) and Emerson (1869), probably due to the restricted area that they examined. While almost all the taxa recorded earlier are present now (at least those easily discoverable), and a substantial number of new ones have been added, there are doubtless more to be found. There have been changes in distribution and abundance of the plants recorded by the early botanists. The encroachment of Red Spruce and more especially shrubs such as *Nemopanthus mucronata, Rhododendron canadense* and *Kalmia angustifolia* appears to have reduced the habitat available to the arctic-alpines. *Vaccinium Vitis-Idaea* can persist a long time under these shrubs, but fruiting is diminished. Some thirty years ago the proprietors of the Half Way House used to collect enough mountain cranberries on the mountain to supply hotel guests, while now only small quantities can be picked. This plant has almost disappeared from the southwest side where the hotel supply was largely obtained. The alpine flora seems to be increasingly restricted to the northern side of the peak where a cooler climate prevails. Further, observations indicate that there may be a successional change going on in the mats of *Vaccinium Vitis-Idaea*, that are invaded more and more by *Potentilla tridentata*. Another major change from 100 years ago is the vast reduction in *Cladonia* lichens. Thoreau remarks frequently how dense they were, crunching under foot, and dry so that fire would spread through them. *Cladonia* persists around the margins of shrubby hollows, but today does not cover extensive areas. Other lichens mentioned by Thoreau on the summit are now mostly confined to moist ravines.

Originally it was planned to limit collections to the area studied by Thoreau, "the upper part of the mountain". Because of the difficulty of determining just what this embraced, the area was extended to include land above 2,000 feet above sea level. (The Half Way House site is at 2,100 feet) Present collections have been supplemented by recent herbarium records kindly supplied by Mr. and Mrs. David E. Boufford of Keene State College. Where several collections of the same taxon were found, only the earliest record is given, in order to save space.* All records that stated Mt. Monadnock as the place of collection were included, although often the specific location was not given. Genera and species are listed in the order of Gray's Manual, 8th Edition (Fernald 1950). The following symbols are used:

(*) asterisk: reported by Thoreau 1858-1860.
(–) dash: collected 1968-1972.

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*Complete lists have been deposited in several New England herbaria.

(†) dagger: collected 1968-1972, not previously reported
(as far as known)

Most of the specimens collected in 1968-1972 were deposited in the University of New Hampshire and Franklin Pierce College herbaria. Abbreviations for all Herbaria consulted in this study are as follows: HNH Dartmouth College, FPC Franklin Pierce College, KSC Keene State College, NEBC New England Botanical Club, MASS University of Massachusetts, and NHA University of New Hampshire.

LIST OF THE VASCULAR FLORA OF MOUNT MONADNOCK

–*Lycopodium Selago L. var. Selago* L. *W. Deane,* Aug., 1891 (NEBC).

†–*L. Selago L. var. appressum* Desv. *H. I. Baldwin,* July, 1968 (FPC).

*–*L. lucidulum* Michx. *H. I. Baldwin,* Aug., 1968 (FPC. NHA).

†–*L. inundatum* L. *H. I. Baldwin,* Oct., 1968 (FPC).

*–*L. annotinum* L. *H. D. Thoreau,* Aug., 1869 (?) (NEBC).

†–*L. annotinum* L. *var. pungens* (La Pylaie) Desv. *H. I. Baldwin,* June, 1971 (FPC, NHA).

*–*L. clavatum* L. *T. L. Steiger,* Oct., 1935 (NHA).

L. clavatum L. *var. megastachyon* Fern. & Bissell, *C. Jenks,* Aug. 1883 (NEBC).

–*L. obscurum* L. *var. obscurum. A. W. Driggs.* Aug., 1916 (NEBC).

L. obscurum L. *var. dendroideum* (Michx.) D. C. Eat. *B. L. Robinson,* Aug., 1869 (NEBC).

*–*L. complanatum* L. *A. W. Driggs,* Aug., 1916 (NEBC).

Botrychium matricariaefolium A. Br. *E. L. Rand,* May, 1897 (NEBC).

†–*Osmunda cinnamomea* L. *H. I. Baldwin,* Aug., 1968 (FPC).

Woodsia ilvensis (L.) R. Br. *B. L. Robinson,* Aug., 1898 (NEBC).

–*Thelypteris Phegopteris* (L.) Slosson. *E. F. Williams.* June, 1894 (NEBC).

–*Dryopteris spinulosa* (O. F. Muell.) Watt. *var. americana* (Fisch.) Fernald. *E. F. Williams,* June, 1894 (NEBC).

–*D. marginalis* (L.) Gray. *D. S. Boufford*, June, 1971 (KSC).

†–*Polystichum acrostichoides* (Michx.) Schott. *H. I. Baldwin*, Aug., 1971 (FPC, NHA).

*–*Dennstaedtia punctilobula* (Michx.) Moore. *H. I. Baldwin*, Oct., 1968 (FPC).

†–*Pteridium aquilinum* (L.) Kuhn *var. latiusculum* (Desv.) Underwood. *H. I. Baldwin*, Aug., 1968 (FPC).

*–*Polypodium virginianum* L. *W. Deane*, Aug., 1889 (HNH).

*–*Abies balsamea* (L.) Mill., *J. R. Churchill*, May, 1895 (NEBC).

*–*Tsuga canadensis* (L.) Carr. *H. I. Baldwin*, July, 1968 (FPC).

*–*Picea rubens* Sarg. *E. F. Williams*, May, 1898 (HNH).

†–*Larix laricina* (DuRoi) K. Koch. *H. I. Baldwin*, July, 1968 (FPC). (one tree at 2,900 feet on west side, two in Thoreau Bog).

*–*Pinus Strobus* L. *A. R. Hodgdon et al.*, Aug., 1956 (NHA).

Poa compressa L. *W. Deane*, July, 1884 (HNH).

P. pratensis L. *E. F. Williams*, June, 1894 (NEBC).

P. palustris L. *J. R. Churchill*, July, 1890 (MASS, NEBC).

*–*Festuca ovina* L. *E. L. Dickinson* and *F. C. Seymour*, July, 1930 (MASS).

†–*F. rubra* L. *H. I. Baldwin*, July, 1968 (FPC).

*–*Deschampsia flexuosa* (L.) Trin. *H. D. Thoreau*, Aug., 1860 (NEBC).

*–*Danthonia spicata* (L.) Beauv. *H. D. Thoreau*, Aug., 1860 (NEBC).

–*D. compressa* Aust. *A. S. Goodale*, July, 1927 (MASS).

**Calamagrostis canadensis* (Michx.) Nutt. *H. D. Thoreau*, Aug., 1860 (NEBC).

*–*Agrostis scabra* Willd. *H. D. Thoreau*, Aug., 1860 (NEBC).

–*Scirpus atrovirens* Willd. *C. W. Jenks*, Aug., 1883 (NEBC).

–*S. atrocinctus* Fern. *A. S. Goodale*, July, 1927 (MASS).

*–*Eriophorum spissum* Fern., *H. D. Thoreau*, Aug., 1860 (?) (NEBC).

**E. gracile* W. D. J. Koch. *A. S. Goodale*, July, 1927 (MASS).

–*E. tenellum* Nutt. *R. M. Harper*, July, 1899 (NEBC). "3,150 feet".

E. viridi-carinatum (Engelm.) Fern. *C. F. Batchelder*, Sept., 1909 (NHA).

–*E. virginicum* L. *C. W. Jenks* and *C. W. Swan*, Aug., 1883 (NEBC, NHA).

Rhynchospora capitellata (Michx.) Vahl. *B. L. Robinson*, July, 1897 (NEBC).

†–*R. alba* (L.) Vahl. *H. I. Baldwin*, Oct., 1968 (FPC).

†–*Carex stipata* Muhl. *H. I. Baldwin*, June, 1969 (FPC).

**C. trisperma* Dew. *H. D. Thoreau*, Aug., 1860 (NEBC). "NE swamp".

†–*C. trisperma* Dew. *var. Billingsii* Knight, *H. I. Baldwin*, Oct., 1968 (FPC).

*–*C. canescens* L. *"E. F. Jr."* (?), 1838 (MASS).

C. canescens L. *var. subloliacea* Laested. *Sydney Harris*, June, 1894 (NEBC).

C. brunnescens (Pers.) Poir. *W. Deane*, July, 1889 (MASS).

C. brunnescens (Pers.) Poir. *var. sphaerostachya* (Tuckerm.) Kükenth. *A. W. Driggs*, Aug., 1916 (NEBC).

C. cumulata (Bailey) Mackenz. *C. W. Jenks*, Aug., 1883 (NEBC).

–*C. communis* Bailey. *L. Russell*, 1898 (NHA).

C. novae-angliae Schwein. *W. Deane*, July, 1891 (HNH, MASS). "Mt. road below house".

C. deflexa Hornem. *J. R. Churchill*, May, 1895 (NEBC).

C. umbellata Schkuhr. *J. R. Churchill*, May, 1896 (NEBC).

C. gracillima Schwein. *R. J. Eaton*, July, 1957 (NHA).

C. aestivalis M. A. Curtis. *J. R. Churchill*, July, 1890 (MASS, NEBC).

C. leptonervia Fern. *E. F. Williams*, June, 1894 (NEBC).

C. intumescens Rudge. *E. F. Williams*, June, 1894 (NEBC).

†–*C. nigra* L. *H. I. Baldwin*. July, 1971 (FPC, NHA).

†–*Arisaema triphyllum* (L.) Schott. *D. W. Allen*, May, 1968 (FPC).

–*Juncus bufonius* L. *A. W. Driggs*, Aug., 1916 (NEBC).

*–*J. trifidus* L. *C. W. Swan*, Aug., 1883 (NEBC).

J. Greenei Oakes and Tuckerm. *B. L. Robinson*, Aug., 1896 (NEBC).

–*J. brevicaudatus* (Engelm.) Fern. *A. W. Driggs,* Aug., 1916 (NEBC).

J. articulatus L. *C. A. and A. W. Cheever,* Sept., 1910 (NEBC).

†–*Luzula multiflora* (Retz.) Lejeune. *D. W. Allen,* May, 1968 (FPC, NHA).

*–*Uvularia sessilifolia* L. *D. W. Allen,* May, 1968 (FPC).

*–*Clintonia borealis* (Ait.) Raf. *T. L. Steiger,* May, 1937 (NHA).

†–*Smilacina racemosa* (L.) Desf. *H. I. Baldwin,* Sept., 1970 (FPC).

*–*S. trifolia* (L.) Desf. *Sydney Harris,* June, 1894 (NEBC).

†–*Maianthemum canadense* Desf. *D. W. Allen,* May, 1968 (FPC).

–*Streptopus roseus* Michx. *var. perspectus* Fassett. *W. Deane,* July, 1889 (NEBC).

†–*Polygonatum pubescens* (Willd.) Pursh. *H. I. Baldwin,* May, 1969 (FPC, NHA).

†–*Medeola virginiana* L. *D. W. Allen,* May, 1968 (FPC).

–*Trillium erectum* L. *J. R. Churchill,* May, 1883 (MASS).

*–*T. undulatum* Willd. *T. L. Steiger,* May, 1937 (NHA).

†–*Sisyrinchium montanum* Greene. *H. I. Baldwin,* July, 1968 (NHA).

†–*Cypripedium acaule* Ait. *D. W. Allen,* May, 1968 (FPC, NHA).

Habenaria Hookeri Torr. *Henry A. Purdie,* June, 1905 (NEBC).

Spiranthes lacera Raf. *Hodgdon and Ken Welsh,* July, 1957 (NHA). "2,500 feet".

Malaxis uniflora Michx. *F. Hunt,* Aug., 1946 (NHA).

**Salix Bebbiana* Sarg. *A. R. Hodgdon,* June, 1933 (NHA).

*–*S. discolor* Muhl. *D. W. Allen,* May, 1968 (FPC).

*–*Populus tremuloides* Michx. *H. I. Baldwin,* Aug., 1968 (FPC).

*–*Betula alleghaniensis* Britton. *Hodgdon and Welsh,* July, 1957 (NHA).

–*B. populifolia* Marsh. *Hodgdon et al.,* Aug., 1956 (NHA).

*–*B. papyrifera* Marsh. *Hattie Merrifield,* July, 1879 (NEBC).

–*B. papyrifera* Marsh. *var. cordifolia* (Regel) Fern. *Hodgdon and Welsh,* July, 1957 (NHA).

B. papyrifera Marsh. × *B. populifolia* Marsh. *Hodgdon et al.,* Aug., 1956 (NHA). "2,800 feet".

†–*Ostrya virginiana* (Mill.) K. Koch. *H. I. Baldwin,* Aug., 1971 (FPC).

–*Fagus grandifolia* Ehrh. *Hodgdon et al.,* Aug., 1956 (NHA, NEBC).

†–*Quercus rubra* L. *D. W. Allen,* May, 1968 (FPC).

Polygonum aviculare L. *var. angustissimum* Meisn. *B. L. Robinson,* July, 1897 (NEBC).

**P. cilinode* Michx. *W. Deane,* Aug., 1889 (HNH).

†–*P. scandens* L. *H. I. Baldwin,* Aug., 1972 (FPC, NHA). "one plant, Red Spot Trail".

†–*Claytonia caroliniana* Michx. *H. I. Baldwin,* June, 1971 (FPC).

*–*Arenaria groenlandica* Du Roi. *Thomas Hope,* Aug., 1879 (NEBC).

Ranunculus abortivus L. *Rand and Robinson,* June, 1898 (NEBC).

†–*R. acris* L. *H. I. Baldwin,* July, 1971 (NHA).

†–*R. bulbosus* L. *D. W. Allen,* June, 1968 (NHA).

†–*Thalictrum polygamum* Muhl. *H. I. Baldwin,* May, 1969 (NHA).

*–*Coptis groenlandica* (Oeder) Fern. *D. W. Allen,* May, 1968 (FPC).

†–*Actaea pachypoda* Ell. *H. I. Baldwin,* May, 1969 (FPC).

*–*Aquilegia canadensis* L. *Rand and Robinson,* May, 1897 (NEBC).

–*Berberis Thunbergii* DC. *W. H. Manning,* Oct., 1913 (NEBC).

–*Drosera intermedia* Hayne. *Fred M. Hunt,* Aug., 1946 (NHA).

†–*D. rotundifolia* L. *H. I. Baldwin,* July, 1968 (FPC, NHA).

†–*Chrysosplenium americanum* Schwein. *D. E. Boufford,* 1971 (KSC).

**Ribes cynosbati* L. *T. Otis Fuller,* June, 1883 (NEBC).

*–*R. glandulosum* Grauer. *J. R. Churchill,* May, 1883 (NHA).

R. triste Pall. *T. L. Steiger,* May, 1937 (NHA).

*–*Spiraea latifolia* (Ait.) Borkh. *A. W. Driggs,* Aug., 1916 (NEBC). "above timberline".

†–*S. tomentosa* L. *H. I. Baldwin,* July, 1968 (FPC).

*–*Pyrus melanocarpa* (Michx.) Willd. *C. F. Batchelder.* Sept., 1909 (NHA).

*–*P. americana* (Marsh.) DC. *J. R. Churchill,* July, 1890 (HNH).

P. decora (Sarg.) Hyland. *Hodgdon and Kenneth Welsh,* July, 1957 (NEBC). "2,500 feet".

P. americana L. × *P. decora* (Sarg.) Hyland. *Hodgdon and Kenneth Welsh,* July, 1957 (NEBC). "2,500 feet".

*–*Amelanchier laevis* Wieg. *Rand and Robinson,* May, 1897 (NEBC).

*–*A. Bartramiana* (Tausch.) Roemer. *J. R. Churchill,* May, 1885 (NEBC).

A. Bartramiana (Tausch.) Roemer. × *A. neglecta* (?) *Rand and Robinson,* May, 1897 (NEBC).

†–*Crataegus macrosperma* Ashe. *D. W. Allen,* May, 1968 (NHA).

†–*Fragaria virginiana* Duchesne. *D. W. Allen,* May, 1968 (FPC).

Potentilla fruticosa L. *J. A. Bates,* Aug., 1900 (NEBC).

*–*P. tridentata* Ait. *E. S. Hoar,* July, 1857 (NEBC).

P. norwegica L. *A. W. Driggs,* Aug., 1916 (NEBC). "summit".

†–*P. canadensis* L. *H. I. Baldwin,* June, 1969 (FPC, NHA).

†–*P. simplex* Michx. *H. I. Baldwin,* May, 1970 (FPC).

Geum aleppicum Jacq. *var. strictum* (Ait.) Fern. *Henry Purdie,* July, 1905 (HNH).

Rubus hispidus L. *J. P. Poole,* July, 1939 (HNH, NHA).

R. setosus Bigel. *A. W. Driggs,* Aug., 1916 (NEBC).

*–*R. vermontanus* Blanch. *B. L. Robinson,* July, 1897 (NEBC).

R. allegheniensis Porter. *A. W. Driggs,* Aug., 1916 (NEBC).

†–*R. frondosus* Bigel. *H. I. Baldwin,* July, 1968 (FPC).

*–*Prunus pensylvanica* L. f. *C. W. Jenks,* Aug., 1883 (NEBC).

†–*P. serotina* Ehrh. *H. I. Baldwin,* July, 1968 (FPC).

†–*Trifolium repens* L. *D. W. Allen,* June, 1968 (FPC).

–*Oxalis montana* Raf. *T. Otis Fuller,* June, 1883 (NHA).
Polygala sanguinea L. *R. H. Piper,* July, 1927 (MASS).
*–*Nemopanthus mucronata* (L.) Trel. *Rand and Robinson,* May, 1897 (NEBC).
*–*Acer spicatum* Lam. *Sydney Harris,* June, 1894 (NEBC).
*–*A. pensylvanicum* L. *C. W. Jenks,* Aug., 1883 (NEBC).
†–*A. saccharum* Marsh. *H. I. Baldwin,* June, 1968 (FPC).
*–*A. rubrum* L. *H. I. Baldwin,* June, 1968 (FPC, NHA).
Hypericum perforatum L. *J. P. Poole,* July, 1939 (HNH).
–*H. canadense* L. *Mary E. Gilbreth,* Aug., 1889 (NEBC). (one extremely small plant found in 1971, *H. I. Baldwin*)
†–*Viola papilionacea* Pursh. *H. I. Baldwin,* May, 1969 (NHA).
V. sororia Willd. *E. F. Williams,* May, 1898 (NEBC).
V. fimbriatula Sm. *E. F. Williams,* May, 1898 (NEBC).
–*V. pallens* (Banks) Brainerd. *A. W. Cheever,* Sept., 1910 (HNH).
V. blanda Willd. *J. R. Churchill,* July, 1890 (HNH, NEBC).
V. lanceolata L. *A. R. Hodgdon,* June, 1933 (NHA).
†–*V. rotundifolia* Michx. *H. I. Baldwin,* April, 1969 (NHA).
V. adunca Sm. *Rand and Robinson,* May, 1897 (NEBC).
†–*V. conspersa* Reichenb. *H. I. Baldwin,* May, 1971 (FPC).
Circaea alpina L. *Edward S. Hoar,* 1879 (NEBC).
*–*Epilobium angustifolium* L. *H. I. Baldwin,* Aug., 1971 (FPC).
E. leptophyllum Raf. *C. W. Jenks,* Aug., 1883 (NEBC).
Aralia racemosa L. *Hattie Merrifield,* July, 1879 (NEBC).
*–*A. hispida* Vent. *J. P. Poole,* July, 1939 (HNH, NHA).
–*A. nudicaulis* L. *A. S. Goodale,* May, 1926 (MASS).
†–*Panax trifolius* L. *D. W. Allen,* May, 1968 (FPC, NHA).
*–*Cornus canadensis* L. *C. W. Jenks,* Aug., 1883 (NEBC).
–*C. alternifolia* L. f. *Hodgdon et al.,* Aug., 1956 (NHA).
Chimaphila umbellata (L.) Bart. var. *cisatlantica* Blake. *J. P. Poole,* July, 1939, (HNH, NHA).
†–*Monotropa uniflora* L. *H. I. Baldwin,* Sept., 1968 (FPC). (rare).
*–*Ledum groenlandicum* Oeder. *Sydney Harris,* June, 1894 (NEBC).

*–*Rhododendron canadense* (L.) Torr. *Sydney Harris,* June, 1883 (NEBC).

*–*Kalmia angustifolia* L. *J. P. Poole,* July, 1939 (HNH).

†–*Cassandra calyculata* (L.) D. Don. *D. W. Allen,* May, 1968 (FPC).

*–*Epigaea repens* L. *H. I. Baldwin,* April, 1969 (FPC). "(one plant only, on cliff)."

**Gaultheria hispidula* (L.) Bigel. *C. G. Trow,* 1871 (MASS).

†–*Calluna vulgaris* (L.) Hull. *H. I. Baldwin,* May, 1965 (NHA). (one isolated colony (introd)).

–*Gaylussacia baccata* (Wand.) K. Koch. *A. W. Driggs,* Aug., 1916 (NEBC).

Vaccinium myrtilloides Michx. *Hodgdon et al.,* Aug., 1956 (NHA). "2,800 feet".

*–*V. angustifolium* Ait. *W. Deane,* Aug., 1889 (HNH).

–*V. angustifolium* Ait. *var. laevifolium* House. *B. L. Robinson,* July, 1897 (NEBC).

†–*V. augustifolium* Ait. × *V. corymbosum* L. *H. I. Baldwin,* Aug., 1969 (NHA).

V. angustifolium Ait. *var. nigrum* (Wood) Dole. *Fred M. Hunt,* Aug., 1946 (NHA).

V. corymbosum L. *A. S. Goodale,* May, 1926 (MASS).

*–*V. Vitis-Idaea* L. *var. minus* Lodd. *C. G. Trow,* Aug., 1864 (MASS).

†–*Asclepias syriaca* L. *H. I. Baldwin,* July, 1971 (FPC).

*–*Trientalis borealis* Raf. *D. W. Allen,* May, 1968 (FPC).

Lysimachia terrestris (L.) BSP. *J. P. Poole,* July, 1939 (HNH, NHA).

†–*Fraxinus americana* L. *H. I. Baldwin,* July, 1968 (FPC).

Hedeoma pulegioides (L.) Pers. *B. L. Robinson,* Aug., 1896 (NEBC).

†–*Veronica longifolia* L. *Hodgdon and Hehre,* Aug., 1969 (NHA).

†–*V. officinalis* L. *H. I. Baldwin,* June, 1969 (FPC, NHA).

Gerardia tenuifolia Vahl. *B. L. Robinson,* Aug., 1898 (NEBC).

*–*Melampyrum lineare* Desr. *var. americanum* (Michx.) Beauv. *D. W. Allen,* June, 1968 (FPC).

†–*Mitchella repens* L. *H. I. Baldwin,* Aug., 1968 (FPC, NHA). rare.

†–*Houstonia caerulea* L. *D. W. Allen,* May, 1968 (FPC, NHA).

*–*Diervilla Lonicera* Mill. *C. W. Jenks,* Aug., 1883 (NEBC).

*–*Viburnum alnifolium* Marsh. *C. W. Jenks,* Aug., 1883 (NEBC).

*–*V. cassinoides* L. *C. L. Canfield,* June, 1931 (NHA).

*–*Sambucus pubens* Michx. *W. Deane,* July, 1891 (NEBC).

†–*Solidago caesia* L. *H. I. Baldwin,* Sept., 1970 (FPC).

*–*S. macrophylla* Pursh. *W. Deane,* Aug. 1891 (HNH, NHA, MASS).

–*S. puberula* Nutt. *Mary E. Gilbreth,* Aug., 1889 (NEBC).

–*S. Randii* (Porter) Britt. *C. W. Jenks,* Aug., 1883 (NHA).

S. Randii (Porter) Britt. *var. monticola* Porter. *C. F. Batchelder,* June, 1919 (NHA).

S. juncea Ait. *Parsons and Seymour,* Aug., 1927 (MASS).

–*S. nemoralis* Ait. *Fred M. Hunt,* Aug., 1945 (NHA).

*–*S. rugosa* Ait. *var. rugosa H. I. Baldwin,* Oct., 1968 (NHA).

*–*S. graminifolia* (L.) Salisb. *H. I. Baldwin,* Sept., 1968 (FPC, NHA).

†–*Aster divaricatus* L. *H. I. Baldwin,* Sept., 1968 (FPC).

*–*A. acuminatus* Michx. *B. L. Robinson,* Aug., 1896 (NEBC).

†–*Erigeron pulchellus* Michx. *H. I. Baldwin,* July, 1968 (FPC).

*–*Anaphalis margaritacea* (L.) B.&H. *D. W. Allen,* May, 1968 (FPC).

Gnaphalium Macounii Greene. *C. W. Jenks,* Aug., 1883 (NHA).

G. obtusifolium L. *C. A. Cheever,* Sept., 1910 (HNH).

G. uliginosum L. *W. Deane,* Aug. 1891 (HNH).

*–*Achillea Millefolium* L. *D. W. Allen,* May, 1968 (FPC).

†–*Chrysanthemum Leucanthemum* L. *var. pinnatifidum* Lecoq and Lamotte. *H. I. Baldwin,* July, 1971 (FPC, NHA).

Taraxacum erythrospermum Andrz. *E. F. Williams,* May, 1898 (HNH).

–*T. officinale* Weber. *E. F. Williams,* May, 1898 (NEBC).

†–*Prenanthes trifoliata* (Cass.) Fern. *var. nana* (Bigel.) Fern. *D. W. Allen,* May, 1968 (FPC).

†–*P. altissima* L. *H. I. Baldwin,* Aug., 1968 (NHA).

Additional taxa reported by Thoreau in his journals of 1858 and 1860. The names, as given by Thoreau, including his question marks are at the left in the following list: Contemporary accepted binomials are listed at the right opposite the name he used if that name is no longer used or if only a common name were given by him.

Sensitive fern	*Onoclea sensibilis* L.
Black spruce	No *Picea mariana* (Mill) BSP. has been found since Thoreau's visits; this may be *P. rubens* Sarg.
Cinna arundinacea	
Glyceria elongata	*G. melicaria* (Michx.) F. T. Hubbard
Eleocharis tenuis	
Scirpus Eriophorum	*S. cyperinus* (L.) Kunth.
Carex straminea	*C. tenera* Desv.
C. scoparia ?	
C. debilis	
C. Deweyana	
Juncus acuminatus ?	*J. acuminatus* Michx. or *J. canadensis* J. Gay
J. parodoxus ?	perhaps *J. canadensis* or *J. acuminatus*
Salix lucida	
S. humilis	
Tiarella cordifolia	
Amelanchier canadensis var *Botryapium*	*A. arborea* (Michx. F.) Fern.
A. canadensis var *oblongifolia*	*A. canadensis* (L.) Medic.
Geranium Robertianum	
Epilobium palustre	
Water andromeda	*A. glaucophylla* Link or *Kalmia polifolia* Wang.
Checkerberry	*Gaultheria procumbens* L.
Chelone glabra	
Solidago virgaurea	?

Three-ribbed goldenrod (not *canadensis*)	*S. altissima* L. or *S. gigantea* Ait.
Aster thyrsoidea	?
Diplopappus umbellatus	*Aster umbellatus* Mill.

DISCUSSION

The present flora of the upper part of Mt. Monadnock is as noteworthy for the absence of certain plants as by the presence of unusual ones such as the arctic-alpines. Thus *Alnus* has not been found anywhere on the slopes of the mountain, nor has *Picea mariana* been recorded from the spruce-lined bogs. *Acer saccharum* is confined to a small area on the east side. Further there are many instances of lowland adventives that take root and may thrive for a time and then disappear. This may explain why some species recorded earlier have not now been found (aside from less keen observation). A total of 220 taxa are represented by specimens in herbaria, including 152 taxa collected from 1965 to 1972. Fifty-nine taxa collected during this period were not previously found in herbaria, and may possibly have been collected for the first time on the mountain. Of the 94 taxa reported by Thoreau, 68 of which are in herbaria, 62 were collected during the present survey.

Thoreau observed seeds of many lowland plants blowing over the summit, and reflected on the origin of adventives (and perhaps transitory taxa):

"I saw what I took to be a thistle-down going low over the summit, and might have caught it, though I saw no thistle on the mountain top, nor any other plant from which this could have come. (I have no doubt it was a thistle by its appearance and its season.) It had evidently come up from the country below. This shows that it may carry its seeds to higher regions than it inhabits, and it suggests how the seeds of some mountain plants, such as the *Solidago thyrsoidea* may be conveyed from mountain to mountain, also other solidagos, asters, epilobiums, willows, etc." Thoreau: *Journal* August 9, 1860, (p. 50) (page 1677 in the 1962 Dover edition).

It seems obvious that most of the wind-disseminated species that have restocked the mountain since the 1820 fire, including Red Spruce, have come by the aerial route, mostly probably from the adjacent lowland. Light-seeded arctic-alpines may be included. It is less easy to explain how heavy-seeded plants such as *Vaccinium* arrived. These may have been present before the fires, surviving the shade of spruce on some steep ledges, or they may have been carried by birds migrating from timberline areas in the White Mountains.

According to Pease (1964 p. 15) the following taxa collected or reported from Mt. Monadnock "may be listed as essentially alpine":

Lycopodium Selago (including *var. appressum*)
Lycopodium annotinum var. pungens
Juncus trifidus
Arenaria groenlandica
Solidago macrophylla var. thyrsoidea

Mt. Monadnock appears to be the southern limit for some of these.

The relation of fire to the occurrence of arctic-alpine plants needs more investigation. It is curious that they became so abundant on Mt. Monadnock 29-30 years after the great fire. Do the ashes from fire favor their establishment (Fernald (1907) thought alkaline soil most *unfavorable*) or is it open space, exposed rock crevices, or mineral soil alone? Many years ago, searching for *Vaccinium Vitis-Idaea* on Cape Breton, I could find it only on an area that had been swept by fire about ten years before.

There are thus at least two possible explanations for the presence on Mt. Monadnock of taxa usually found above timberline:

(1) They have survived since post-glacial times in refugia on the mountain itself possibly on lower slopes as proposed by Fernald (1907, 1925), and then survived the fires (which were very severe indeed), and then restocked the bare rock and open soil.

(2) The summit flora may have arisen from disseminules

carried from timberline areas by wind, animals or birds, or even men.

Steele and Hodgdon (1973) reached the same possible explanations for the presence of *Carex capitata* and *Carex Bigelowii* on Mt. Cardigan.

Regardless of the origin of the present flora, processes of change are at work, reducing the abundance and area occupied by some plants, while others are assuming dominance. Many lowland forms may invade and thrive for a time and then disappear. Neither the rate nor direction of succession is uniform. Invasion of spruce on the upper rocks has slowed to a temporary halt, even while the extent of arctic-alpine plants declines.

The Problem of the Source and Persistence of Arctic-Alpine Plants

How did arctic-alpine plants survive from post-glacial times on lower mountains and escape competition with the forest?

One explanation for the presence of arctic-alpine plants below timberline is that they survived in refugia, rock crevices or small exposed ledges since post-glacial times, and that these crevices and ledges did not become overgrown by other plants and that the microclimate remained favorable. Then, when more open habitat was exposed by fire, these plants re-invaded the bare summits and increased greatly. Fernald (1907) postulated that alpine plants, "forced to find temporary homes during the ice age on potassic, calcareous or magnesium areas, found in the alluvial deposits a mixed soil in which they were able to spread. As climate at low altitudes became warmer, these plants found on cold cliffs and exposed mountain summits the only habitats in which they have been able to persist within the temperate regions" It is fairly easy to understand that they were able to persist on alpine tundra above timberline, and indeed on some "cold cliffs" like those in Dixville Notch, New Hampshire, and possibly elsewhere. Some plants usually restricted to high altitudes and open tundra habitats are occasionally found below timberline, e.g. on talus and rock piles in Carter Notch (a cool place) and even in some open pastures (where they may be rather temporary residents). They cannot tolerate shade or root competition of lowland plants. A small colony of Mountain Cranberry is found along the Half Way House road on Monadnock (possibly introduced from the summit by berry pickers).

However, most steep rocky mountains that, like Monadnock, do not reach timberline and have not been burned recently, are densely forested with spruce and at higher levels, fir, with a heavy ground cover of moss, ferns and herbs. There are probably hundreds of such mountains in the Adirondacks and New England. Some of them have exposed rocky cliffs, but records showing these to be havens for alpine plants in undisturbed condition are few or wanting. Pease (*op. cit.*) reported finding some arctic-alpines on open ledges on secondary mountains in the White Mountains, "often caused by the destruction of the peaty humus by fires," but he did not specify just how often these cases were, nor did he give examples of such cases where there was no trace or history of fire. He ventured no theory as to how these plants reached the lowland habitat.

If arctic-alpine plants persisted in refugia in lower mountains after the latter became forest-covered, it should be possible to find these plants on unburned summits. They have not been found, aside from the cases cited by Pease, which were all close to high mountains supporting stable colonies of these plants, whence invasion of even small burned areas would be relatively easy compared to Mt. Monadnock, which is far more remote.

More examples of bona fide refugia from ice-age times need to be found, but even if these can be discovered and dated, it may be impossible to demonstrate that no fires occurred very long ago, or to prove how long the plants have been on the site. Arctic flora of the Pleistocene became adapted to the prevailing habitat conditions (Cf. Fernald, 1925) and it is still largely restricted to areas of open ground and a cool, moist climate.

Did Arctic-alpine Plants Survive Fire and Spread Over the Denuded Areas?

Assuming that these plants had succeeded in resisting the competition of shade-tolerant trees and other plants, and had remained in some secluded pocket since post-glacial times, did they then survive the very intense fires that burned these peaks, more destructive than any fires in modern times? Fire destroyed all organic matter, and what little mineral soil remained was then at the mercy of wind and water. It must be remembered that two great fires on Monadnock combined to make a tremendously hot and extensive burn. The 1800 fire consumed the humus and killed the trees. The 1815 hurricane completed toppling them, so that a formidible quantity of dry fuel was present. (It was after a long hot, dry summer.) No fires in recent times have approached it in heat and ferocity. Emerson (1896) remarked that the heat was so great that it "blasted the rock" into the ravines and caused slides.

How did Arctic-alpine Plants Come to Occupy Areas Denuded by Fire?

Such plants must have arisen from disseminules brought from nearby areas (refugia on the same mountain or in the lowland) or from more distant sources, probably stretches of alpine tundra on Mt. Moosilaukee or on the Presidential Range. Since the lowland and lower slopes around Monadnock were largely cleared and cultivated or pastured, it is possible that some of these plants had escaped from rocky crevices on the mountain before the fire and had become established on the lower open land. Here they might maintain themselves until forest succession once more eliminated them. At the time of the fire, this land was still open. Even if restocking of the burned mountain had proceeded from this source, it is hard to see how the spread of heavy-seeded species could have occurred uphill without the aid of birds or animals. The latter carry seeds in burs that cling to animal fur, but animals have not been found to be effective carriers of berries and similar hard seeds.

Were Birds Partly Responsible for the Spread of Plants From Alpine Tundra to Monadnock?

Birds are well-known to be active and efficient carriers of seeds. Ridley (1930) noted that birds are attracted by seed color. Red seems to be the most attractive. *Vaccinium* is a "bird-dispersed genus", he wrote. Forty-three species of birds have been recorded to disperse plants of this genus, and it seems likely that the red fruit of Mountain Cranberry would be very much sought by birds. Taylor (1954) suggested that birds are probably responsible for carrying seeds to Macquaric Island, a small sub-antarctic island far from any large land area that was severely glaciated during the Pleistocene. He believed it unlikely that any of the 35 plant species could have survived the ice. Most of these have relatively large seeds, but all have propagules suited to bird transport.

Birds are important agents in the natural dissemination of seeds of tree species having fleshy fruits, and presumably shrubs as well. Red Cedar, Black Cherry and Black Gum are examples. Seeds of *Juniperus* that have been eaten by birds are said to germinate more promptly. (Anon. 1948) Indeed such hard-seeded species that display seed coat dormancy may require the acid treatment received during passage through a bird's intestinal tract in order to germinate. Phillips (1910) made an especially thorough and wide-ranging study of bird dissemination of *Juniperus* seed, and concluded that birds are responsible for most of the spread of junipers, especially upwards on slopes and up stream courses.

It is possible that the most likely candidate for being a vector of seeds from alpine fell fields is the Slate-Colored Junco. Not only did Thoreau remark about its being the most common bird on Monadnock, but it is also abundant there today. Forbush (1929) states that it is probably the only bird that nests above tree limit in the White Mountains. (I have found a nest with eggs in late June on Boott Spur.) Forbush (*op. cit.* p. 90) reported that it eats many dried berries and seeds. Objections to the theory of bird transport include the questions concerning birds eating before migration, seeds passing undamaged, and limits set by the time to pass through the digestive tract. Egler (1972) questions the explanation "by having far-flying constipated birds eject over distant lands."

While there is thus evidence that some birds do carry seeds, and birds are present on Mt. Monadnock, and that seeds survive the treatment, or may be even benefited by it, it is still not proven that heavy-seeded arctic-alpine plants did actually become established on Monadnock by this means.

Since this was written, Steele and Hodgdon (1973) have examined these theories for the arrival on Mt. Cardigan of two alpine species of *Carex*. They suggest a third possibility, that man may have consciously or unconsciously introduced these plants to the bare rocky area. This appears least likely in the case of the plants found on Monadnock, because of the distance. It is also improbable that these plants should appear on Mt. Chocorua and other sites. It would be a very diligent Johnny Appleseed indeed. More important, a prolonged period must be assumed for establishment. Success probably did not come with the first seed.

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TAXONOMY OF PERITYLE SECTION PERITYLE
(COMPOSITAE — PERITYLINAE)[1]

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Section PERITYLE, with 27 species and three varieties, is the largest of three sections of the genus *Perityle* (Powell, 1968a). The distributional center of sect. PERITYLE is in northwestern Mexico and the Baja Californian peninsula, but the total natural range is extended by several taxa that occur in the southwestern United States, Guadalupe Island, the Revillagigedo Islands, and west-central Mexico (Jalisco). One weedy taxon, *P. emoryi,* has bicontinental distribution in North America and in Chile and Peru in South America. Separate taxonomic works have been prepared for the other two sections of the genus; *Pappothrix* (Powell, 1969) and *Laphamia* (Powell, 1973).

The species of sect. PERITYLE comprise a taxon that was recognized as the genus *Perityle* by Everly (1947) who compiled a taxonomic treatment of the group. In connection with her morphologically oriented investigations of *Perityle,* Everly also studied the closely related taxa *Pappothrix* and *Laphamia,* which she regarded as genera. These taxa are distinguished primarily by somewhat variable pappus and achene characteristics, and several workers have questioned their status as genera. Shinners (1959) merged *Pappothrix* and *Laphamia* with *Perityle,* noting their close morphological relationship and contending that pappus differences were not sufficient to warrant separate generic status. In recognizing *Pappothrix* and *Laphamia* as sections of *Perityle,* I have followed Shinners' congeneric disposition of the taxa (Powell, 1968a). My systematic judgements were based upon the evaluation of new information from cytological, chromatographic, and hybridization techniques, as well as a re-evaluation of morphological features. The re-

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sults have suggested that *Pappothrix, Laphamia,* and *Perityle* are closely related, essentially natural phylads, and that they are best treated as sections of a single genus. Niles (1970), however, has maintained *Perityle* and *Laphamia* as distinct genera, while combining *Pappothrix* with *Laphamia.* Niles did not conduct a comprehensive study of the sect. PERITYLE species. A more complete review of the taxonomic history concerning *Perityle* is available elsewhere (Shinners, 1959; Powell, 1968a; Niles, 1970).

Perityle is closely allied to *Pericome, Amauria,* and *Eutetras* of the subtribe Peritylinae (Helenieae). Rydberg (1914) assigned *Perityle* and *Pericome* to the Peritylinae and *Amauria* and *Eutetras* to the subtribe Amaurinae. Turner (1966) and Powell (1972a) have suggested that Amaurinae (in part) should be combined with Peritylinae. Presently the Peritylinae is being re-evaluated with reference to Rydberg's concepts, and the proper tribal position of the subtribe is also being investigated (Powell & Turner, unpublished).

CHROMOSOMAL CONSIDERATIONS

A discussion of the chromosome numbers of *Perityle* and related genera is presented elsewhere (Powell, 1968b). Additional counts for the species of sect. PERITYLE are reported in Powell and Sikes (1970) and Powell (1972b). Chromosome numbers have been obtained for 20 of the 27 species of sect. PERITYLE. The counts for specific taxa are included with a list of the species under Phylogenetic Considerations (Table 1), and they are also included with species discussions in the taxonomic portion of this paper.

In Powell (1968b), a few changes must be noted with regard to the counts for sect. PERITYLE. When the 1968 paper was compiled, the taxonomic studies of sect. PERITYLE were in early stages. The reports of $n = 16$ for *P. californica* should be attributed to *P. cuneata* var. *marginata. Perityle incompta* is now considered as synonymous with *P. crassifolia* var. *robusta,* and the counts listed for the former ($n = 19$, 18) should be attributed to the latter taxon. The diploid *P. microglossa* (*Sikes and Babcock 185 a,b,c,f,*) is *P. microglossa* var. *saxosa,* and the polyploid *P. microglossa* (*Sikes and Babcock 177 192 a-d, 152, 157 a, 206 a,b,*) is var. *microglossa. Sikes and Babcock 188 a,b,d,f,* and *190 a,b,* listed as *P. palmeri,* are *P. cordifolia* ($n = 17$). *Perityle* cf. *spilanthoides* is *P. turneri* ($n = 17$) and *P. vaseyi* (*Sikes 116*) is *P. parryi* ($n = 17$).

Most species of sect. PERITYLE are diploid, with counts of $n = 19$, 18, 17, 16, 13, 12, and 11 having been reported for the various taxa (Powell, 1968b; 1972b). Only *P. microglossa* var. *microglossa* ($n = 34$, 51), *P. emoryi* ($n = 32$-36, 50-57), and *P. incana* ($n = 50$-57) are known to be polyploid. The first two taxa are relatively well established as exclusively polyploid, while only one count for the Guadalupe Island endemic *P. incana* (Powell, 1972b) has been recorded. Turner and Flyr (1966) reported $n =$ ca. 46 for *P. crassifolia* var. *robusta* (*Cowan 2265*), but I have since identified this collection as *P. emoryi.* A base number for *P. emoryi* has not been determined in spite of numerous attempts to obtain exact counts (Powell, 1968b).

The ancestral base number for sect. PERITYLE has not been established. Subsequent to an earlier discussion of the subject (Powell, 1968b), all attempts to resolve the question have been unsuccessful, including those which involved the analysis of experimental hybrids (Powell, unpublished). Most chromosomal and distributional evidence suggest a base of $x = 17$ for sect. PERITYLE, and the genus as a whole (see Phylogenetic Considerations). Fourteen species of sect PERITYLE are $n = 17$, and both sect. PAPPOTHRIX (5 spp.) and sect. LAPHAMIA (21 spp.) are $x = 17$ (Powell, 1969; 1973). The taxa of sect. PERITYLE with chromosome numbers below $n = 17$, *P. californica* ($n = 13$, 12, 11) and *P. cuneata* ($n = 16$, 12), are clearly aneuploid derivatives, probably of the $n = 17$ line. However, the origin of taxa with $n = 19$ (*P. crassifolia* and allies) is of prime concern in evaluating the phylogeny of sect. PERITYLE. Distributionally, the $n = 19$ "alliance" ((southern Baja California peninsula and neighboring islands) is peripheral to the group where $n = 17$, which is centered on the mainland of Mexico (see Phylogenetic Considerations). The $n = 19$ group may be either ancestral to or derived from the $n = 17$ group (Powell, 1968b), but I now believe that the species with $n = 19$ and the species with $n = 17$ both evolved as separate lineages from a common "mainland" ancestor that had a chromosome number of $n = 19$ (or 18). Consideration of the latter hypothesis in a broader sense is supported by the base numbers of the related genera *Pericome* ($x = 18$), *Eutetras* ($x = 18$), and *Amauria* ($x = 18$).

ARTIFICIAL HYBRIDIZATIONS

Artificial hybridizations have been conducted with 16 species of sect. PERITYLE. Many of the crosses were of intergeneric and intersectional nature, although several interspecific combinations have been obtained. The results of most of these crosses are discussed in another paper (Powell, 1972c) where emphasis was placed upon evaluation of the intergeneric and intersectional relationships of *Perityle*. A hybridization program aimed at the evaluation of interspecific relationships within sect. *Perityle* is still in progress (Powell, unpublished). Where appropriate, some of the preliminary information derived from artificial crosses will be brought into species discussions in the taxonomic portion of this paper.

Natural hybridization is rare in sect. PERITYLE, and only one such occurrence has been documented (Powell, 1970). Most of the species are geographically isolated, but a few taxa do have overlapping ranges and may occasionally hybridize.

CHROMATOGRAPHIC CONSIDERATIONS

Nineteen species of sect. PERITYLE were analyzed by 2-dimensional paper chromatography of leaf extracts. In general, the techniques outlined by Alston and Turner (1963) were utilized. The procedures for sampling populations and analyzing chromatograms have followed those discussed elsewhere (Powell, 1973). The major components of chromatographic patterns were characterized as flavonoids (Powell and Tsang, 1966; Powell and Averett, unpublished), although the specific identity of only one compound is known (Southwick et al., 1972).

The use of chromatographic techniques has been a valuable asset to previous taxonomic studies in the Peritylinae (Powell and Tsang, 1966; Powell, 1968a; 1969; 1973). Intergeneric and infrageneric relationships have been clarified through the comparative analysis of pattern data. In previous work I treated the crude chemical information from a chromatographic pattern as a single taxonomic character, and pattern data have not been given more weight than any other chraacter.

The results of chromatographic studies in sect. PERITYLE have revealed two strikingly different chemical patterns based upon the presence or absence of yellow compounds as seen under ultraviolet light. The white-flowered species centered in the Sierra Madre Occidental (e.g., *P. turneri*), and the yellow-flowered species of northwestern Mexico and Baja California (e.g., *P. cordifolia* and *P. californica*) have simple patterns consisting of a few dark purple spots. The Baja Californian white-flowered species (e.g., *P. crassifolia*), and the Texas yellow-flowered species (e.g., *P. parryi*) have relatively complex patterns that include prominent yellow spots. Yellow compounds are considered important because they comprise the basic chromatographic profile of sect. PAPPOTHRIX, sect. LAPHAMIA, and the genera related to *Perityle*. The actual chromatographic data are not presented here in the form of figures or tables. Instead, where appropriate, the data are included in succeeding discussions concerning relationships of species and species groups.

ECOLOGICAL AND REPRODUCTIVE CONSIDERATIONS

The species of sect. PERITYLE occur in rock and in soil habitats, unlike the species of sect. PAPPOTHRIX and LAPHA-

MIA, which are exclusively rock-dwelling (Powell, 1969; 1973). Certain species of sect. PERITYLE are obligate, rock-dwelling perennials, while several perennial and annual taxa are soil-obligates. In addition, a few taxa display facultative existence in rock and soil habitats.

The rock-dwelling members of sect. PERITYLE occur under a wide range of climatic conditions and at various elevations. About half of the petrophilic taxa are occupants of protected canyons and exposures in relatively xeric desert mountains at altitudes of 1000-4000 feet or less, and the others thrive under relatively mesic conditions at altitudes of 4000-8000 feet. *Perityle turneri* also occurs under mesic conditions, at 7000-9500 feet in and near Durango, Mexico, but may be rooted primarily in matted soils. The other soil-dwelling taxa occur almost exclusively under desert conditions.

Perityle is essentially a genus of self-incompatible species (Powell, 1972c). Only two of the taxa, *P. emoryi* and *P. microglossa* var. *microglossa*, are known to be self-compatible, and these are members of sect. PERITYLE. Ten species have not been tested for the compatibility factor, two of sect. LAPHAMIA and eight of sect. PERITYLE, but these taxa are also probably self-incompatible. Both of the self-compatible taxa are widespread polyploids (Powell, 1968b; 1972c) that are "weedy" and annual in habit. *Perityle emoryi* is the most widespread species of the genus, having bi-continental distribution in North and South America, and *P. microglossa* var. *microglossa* probably ranks second in distributional range. Several other species of the genus are polyploid, and a few others are annual, thus suggesting that the capacity for reproductive self-compatibility has allowed for the "weedy" nature of two taxa.

PHYLOGENETIC CONSIDERATIONS

Speculation concerning phylogeny of the subtribe Peritylinae and the genus *Perityle* has been discussed generally elsewhere (Powell, 1973), and will not be repeated in detail here. Essentially, it was proposed that Peritylinae originated in the southern Sierra Madre Occidental of Mexico. *Perityle* is by far the most successful genus of the subtribe, in terms of number of species, with only 2 or 3 species being recognized for each of the other genera (Powell, 1972a; 1972d; and Turner, 1966). Section PERITYLE is assumed to be ancestral to the other two sections of the genus. Based upon distributional, morphological, chromosomal, and other considerations, it is believed that sects. PAPPOTHRIX and LAPHAMIA underwent rapid evolution in late Pliocene or Pleistocene emanating from an ancestral sect. PERITYLE complex (Powell, 1973).

Modes of speciation in the subtribe Peritylinae, and *Perityle* in particular, have been discussed elsewhere (Powell, 1969; 1972c; 1973). In sects. PAPPOTHRIX and LAPHAMIA, speciation is believed to have occurred mostly, if not entirely, as a result of geographic isolation. In sect. PERITYLE, speciation probably has occurred as a result of geographic isolation and other, more nearly reproductive phenomena (Powell, 1972c). This subject wil be discussed further below.

In Table 1 the list of sect. PERITYLE species is presented as an aid to discussing phylogenetic considerations. The list has been organized to depict the hypothetical evolutionary groupings within the section. The arrangements are based upon morphological, chromosomal, experimental, chromatographic, and eco-geographical data. Additional discussions of species relationships, including the evidence upon which such judgements are based, are included in the taxonomic portion of this paper.

The total data suggest that sect. PERITYLE comprises at least two distinct evolutionary series. One series, including the first 19 taxa, is marked by white ligules and yellow (or cream-white) disc corollas, with a few exceptions, as indicated in Table 1. *Perityle incana* and the *P. jaliscana* group are relatively anomalous in the "white-flowered series" and they may comprise separate and equal phyletic entities. A second major series can be delimited by its exclusively yellow flowers.

Table 1. Section Perityle species and summary of gametic chromosome numbers
Taxa listed according to flower color and presumed related-species groups.

WHITE-FLOWERED GROUPS		
White Rays and Yellow Disc		
1a.	*P. crassifolia* var. *crassifolia*	19
1b.	*P. crassifolia* var. *robusta*	19
2.	*P. socorrensis*	19
3.	*P. emoryi*	32-36, 50-57
4.	*P. aurea* (yellow rays)	17
5.	*P. incana* (discoid)	50-57
6.	*P. turneri*	17, ca. 17
7.	*P. lineariloba*	not counted
8.	*P. microcephala*	not counted
9a.	*P. microglossa* var. *microglossa*	34, 51
9b.	*P. microglossa* var. *saxosa*	17, 18
10.	*P. canescens*	not counted
11.	*P. ciliata*	17
12.	*P. coronopifolia*	(16)* 17
13.	*P. hofmeisteria*	ca. 17
White Rays and Cream-White Disc		
14.	*P. jaliscana* (discoid)	17
15.	*P. rosei*	not counted
16.	*P. trichondonta*	not counted
17.	*P. feddemae* (discoid)	not counted
YELLOW-FLOWERED GROUPS		
18.	*P. parryi*	17
19.	*P. vaseyi*	17 (19)
20.	*P. aglossa* (discoid)	17
21.	*P. cordifolia*	17
22.	*P. leptoglossa*	17
23.	*P. lloydii*	not counted
24.	*P. lobata*	17
25.	*P. palmeri*	17 (19)
26.	*P. californica*	11, 12, 13
27a.	*P. cuneata* var. *cuneata*	12
27b.	*P. cuneata* var. *marginata*	16

*Numbers in parentheses have been reported for the respective taxa, but are thought to be erroneous.

Several related-species groups are further delimited within both the "white-flowered series" and "yellow-flowered series" (Table 1). The groupings themselves comprise clearly related taxa, but the phyletic unity of the related-species groups within monophyletic white- or yellow-flowered series is indefinite. For example, origin of the Baja Californian *P. crassifolia* group has not been connected resolutely with the Sierra Madre Occidental *P. turneri* group, even though both exhibit white ligules. And the anamalous nature of *P. incana* and the *P. jaliscana* group is indicated above. Also, there is no certainty that the *P. parryi* group of Texas and the aneuploid *P. californica* group of Baja California have monophyletic ties within a yellow-flowered series.

White-Flowered Groups (Table 1). Three subgroups of the white-flowered series are recognized. These are designated as the *Perityle crassifolia*, *P. turneri*, and *P. jaliscana* related-species groups. Distributional information, habitat preferences, and life form habits are given in the following discussions because of their supposed importance in understanding speciation in the genus.

The *Perityle crassifolia* group, also including *P. socorrensis*, *P. emoryi*, and *P. aurea*, is distributed in southern Baja California and nearby islands, except for *P. emoryi* which is a widespread weed. Also, *P. socorrensis* is found only in the Revillagigedo Islands, which are over 200 miles south of Baja California.

Perityle emoryi ($n = 32$-36, 50-57) is believed to be a polyploid derivative of *P. crassifolia* var. *robusta*. Morphological and chromatographic data strongly suggest that *P. aurea* belongs with the P. crassifolia ($x = 19$) group even though this taxon has yellow-ligules and a chromosome number of $n = 17$.

Both *Perityle emoryi* and *P. aurea* are annual in habit, while the other taxa of the *P. crassifolia* group are essentially soil-dwelling perennials. All of the taxa, however, with the exception of *P. crassifolia* var. *crassifolia* which seems restricted to sand, might also occur in soil-filled crevices of rocks especially at sea side. The Guadalupe Island endemic *P. incana*, is possibly allied with the *P. crassifolia* group, but evidence as to its true relationship has not been conclusive.

The base chromosome number of the *Perityle crassifolia* group is presumed to be $x = 19$, a number that might be ancestral in sect. *Perityle*. On morphological and distributional grounds, however, it is practically impossible to envision the other related species groups as having been derived from the *P. crassifolia* line. I believe that the *P. crassifolia* line was an early offshoot from ancestral Peritylinae.

The largest related-species group of the white-flowered series is distributionally centered in the Sierra Madre Occidental of mainland Mexico. Two assemblages of four species each are further distinguishable among this *Perityle turneri* group, primarily on the basis of floral characters. *Perityle turneri, P. microcephala,* and *P. lineariloba* are clearly allied taxa which occur at relatively high altitudes from Durango to central Chihuahua. The fourth member of this assemblage is *P. microglossa,* which ranges from northern Sonora along the west coast of Mexico south to Colima, into the foothills of the Sierra Madre Occidental, and east to San Luis Potosi and Texas. Habit and distributional considerations (see Taxonomy) strongly suggest that *P. microglossa* is derived from *P. microcephala*. I believe that *P. turneri* is primitive in this assemblage, on the basis of features discussed elsewhere (Powell, 1972e).

Perityle coronopifolia, P. ciliata, P. hofmeisteria, and *P. canescens* are also clearly allied members of the *P. turneri* group. *Perityle coronopifolia* extends from northern Chihuahua into the mountains of southern Arizona and southern New Mexico. *Perityle ciliata* is restricted to central Arizona, while *P. hofmeisteria* and *P. canescens* apparently are endemics respectively in Durango and in Sinaloa, Mexico.

Most members of the *Perityle turneri* group are hardy, suffrutescent perennials that live in crevices of rock bluffs.

Perityle turneri is a rhizomatous perennial, apparently occurring typically in thin soil covering rocky outcrops, but according to label data, the taxon might also be rock-dwelling. *Perityle microglossa* is a soil-dwelling annual, also found occasionally among rocks, and one collection of *P. hofmeisteria* (*Flyr 332*) is said by the collector to be "seemingly an annual." Judging from known distributional data, these species are strictly allopatric, suggesting that they have undergone the type of geographic speciation that is considered typical for sect. PAPPOTHRIX and sect. LAPHAMIA (Powell, 1969; 1973).

The white-rayed (or discoid) *Perityle jaliscana* group with cream-white discs comprises very closely related rock-dwelling perennial taxa that are restricted to Jalisco, Mexico. These taxa represent a third distinct assemblage within the white-flowered species of sect. PERITYLE.

The three white-flowered subgroups are clearly delimited morphologically, with perhaps the most useful distinguishing features being those of the habits, achenes, and pappus (see Taxonomy). The yellow-flowered species are quite different superficially, but the generic unity of both white- and yellow-flowered assemblages is evident.

Yellow-Flowered Groups (Table 1). Geographically, the yellow-flowered species are divided into two major assemblages separated by the Sierra Madre Occidental. One assemblage, designated as the *Perityle parryi* group, has a limited distribution in the Big Bend area of western Texas and adjacent Mexico, and the other geographic assemblage, including the *P. cordifolia* and *P. californica* groups, is more widely distributed in Sonora, Sinaloa, and Baja California, Mexico.

The three species of the *Perityle parryi* group are closely related perennials, being distinguished on the basis of a few morphological characters. One of the taxa, *P. aglossa*, apparently is exclusively rock-dwelling in habit, while *P. vaseyi* seemingly occurs only in desert soils. *Perityle parryi*, however, is facultative in its existence in rocks and soils.

There are interesting biological parallels between the

Perityle parryi group and the *P. cordifolia* group of western Mexico, and despite their geographic separation, most evidence suggests that both groups had common origin. Both alliances comprise closely related taxa, their vegetative and floral morphologies are strikingly similar, and species of both groups have chromosome numbers of $n = 17$ with no polyploidy having been discovered in any of the taxa. Additionally, and most remarkably, the evolutionary pattern of the disjunct groups seems to be that soil forms were established when woody perennials "came down out of the rocks and adapted to life in the soil." *Perityle cordifolia*, *P. leptoglossa*, and *P. lloydii* seem to be obligately (at least typically) rock-dwelling, while *P. palmeri* and *P. lobata* apparently are facultative in their tolerance for existence in rocks or in soils.

The presumed "close" phylogenetic relationship between the *Perityle parryi* and *P. cordifolia* groups is not supported by their chemical profiles. Members of the *P. parryi* group produce abundant yellow components, as do *P. crassifolia* and allies, while chromatographic samples of the *P. cordifolia* group have revealed only simple patterns of purplish spots. The chemical indication of affinity between the *P. parryi* and *P. crassifolia* groups is complemented by a tenuous morphological feature they have in common. *Perityle vaseyi* (rarely *P. parryi*, also) of the former alliance and pappose members of the *P. crassifolia* group are the only taxa of the genus which have awns with retrorsely-barbed tips. In view of the morphological dissimilarity and geographic distance between these groups, however, I believe that the crude chemical data and pappus structure merely reflect an ancestral connection between the *P. crassifolia* and yellow-flowered alliances. If this is true, then the *P. cordifolia* group must have lost its ability to produce the prominent yellow flavonoids.

Both species of the *Perityle californica* group are soil-dwelling annuals. The taxa are of special systematic interest in sect. PERITYLE because of their reduced chromosome numbers. All other yellow-flowered taxa have $n = 17$.

Perityle californica ($n = 13,12,11$) is distributed in Sonora and Sinaloa of mainland Mexico and along most of the Baja California peninsula to just south of La Paz. *Perityle cuneata* ($n = 16,12$) is restricted to the southern tip of Baja California with northern limits to about the latitude of La Paz.

Judging from overall morphological similarity and distributional considerations, it is assumed that *Perityle californica* and *P. cuneata* are aneuploid derivatives of the *P. cordifolia* line. With the exception of the *P. parryi* group, which seemingly would be ruled out on distributional grounds, only the *P. cordifolia* group bears any close resemblance to the aneuploids. *Perityle californica* occurs sympatrically with *P. cordifolia* and *P. palmeri* in Sonora and Sinaloa, apparently without hybridization. Since most species of *Perityle* are allopatric, but artificially interfertile (Powell, 1972c), it is reasonable to conclude that *P. californica* achieved reproductive isolation and speciation through reduction in chromosome number.

Summary of Phylogenetic Considerations. Species of the genus *Perityle* are distributed primarily in the arid to semimesic mountains of desert North America, but also in the higher mountains, for example in the Sierra Madre Occidental. The majority of the species are obligate rock-dwellers. All five species of sect. PAPPOTHRIX and all 21 species of sect. LAPHAMIA occur as perennials in crevices of rock bluffs, apparently never growing in soil at the base of bluffs. That these species can survive only in such restrictive habitats surely imposes upon them evolutionary limitations. The basic evolutionary trends of sect. PAPPOTHRIX and LAPHAMIA have followed a pattern of speciation by geographic isolation; thus evolved the groups of closely related, mostly endenmic species, characteristic of the above sections.

Greater evolutionary diversity is exhibited among the species of sect. PERITYLE. Indeed, some species of this section are obligate, rock-dwelling perennials that presumably underwent the type of geographic speciation mentioned above. But several taxa have adapted to a facultative existence in rocks and in soils, and a few species are exclusively soil-dwelling with perennial or annual habits. For certain taxa, the adaptation to life in the soil apparently has been facilitated by two evolutionary mechanisms, polyploidy and aneuploidy. Emanating from the white-flowered groups, the widespread weeds *Perityle microglossa* var. *microglossa* ($n = 34, 51$) and *P. emoryi* ($n = 32\text{-}36, 50\text{-}57$) exemplify the adaptive success of polyploidy. *Perityle californica* ($n = 11, 12, 13$) and *P. cuneata* ($n = 12, 16$) are successful aneuploid species of yellow-flowered lineage. Thus, along with the annual habit displayed by the above species, the phenomena of polyploidy and aneuploidy have independently advanced the adaptive capacity of species belonging to distinct evolutionary units of sect. PERITYLE.

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TAXONOMY

PERITYLE Benth. Bot. Sulph. 23. 1844.
Perityle section **Perityle,** see Powell, Sida 3: 277. 1968.

Galinsogeopsis Schultz-Bip. in Seem. Bot. Herald. 306. 1856.
Nesothamnus Rydb. N. Amer. Fl. 34: 12. 1914.
Leptopharynx Rydb. N. Amer. Fl. 34: 21. 1914. (in part).
Closia Remy in Gay, Fl. Chile 4: 120. 1849. (in part).

Plants shrubby, suffruticose, or herbaceous perennials, or delicate to robust annuals, (2) 10-80 cm high, growing in rock crevices or various soils, variously pubescent, tomentulose to nearly glabrous, frequently glandular-pubescent; leaves opposite or alternate, variable in size and shape, 0.7-14 cm long including the petiole, 0.2-7.0 cm wide, ovate, cordate, deltoid, subhastate, reniform, or suborbicular in outline, the margins subentire, serrate to doubly so, or shallow to deeply lobed or divided, frequently 3-5 lobed, pedate, subcruciform, or pinnatifed with narrow segments, nearly glabrous, puberulent, to arachnoid-villous, often glandular-pubescent, thick and semisucculent to thin in texture, viscid, bitter tasting, usually aromatic; capitulescence of solitary heads, or heads loosely to tightly aggregated in clusters of 3 or more; peduncles short or long; involucres subcylindric to hemispheric; heads 3-12 mm high, 4-15 mm wide; involucres of 2(3) subequal series, bracts ovate or obovate to narrowly oblanceolate, obtuse to attenuate at the apex, flattened, ribbed, or keeled, usually spreading or reflexing at maturity; heads radiate or discoid (in 4 spp.), ligules yellow or white, showy or rudimentary; disc flowers numerous, corollas 4-lobed, yellow or creamwhite (in 3-4 spp.), throats tubular to broadly funnelform or narrowly campanulate; style branches, flattened, linear, usually tapering to a fine, minutely pubescent tip; achenes black when mature, 1.3-5.0 mm long, distinctly flattened radially, outer achenes often 3-angled, slightly curved and clasped by bracts, linear, oblong, oblong-elliptic, or oblanceolate, the margins densely ciliate, rarely merely puberulent, prominently calloused or the margins thin and not calloused, the faces glabrous and shiny or short-pubescent; pappus of a conspicuous, rarely inconspicuous, crown of laciniate, hyaline, squamellae, and 0-2 (rarely 3-4) delicate or rather stout bristles, 0.5-7.0 mm long, the bristles naked, barbellate, or subplumose throughout or only at the tips, the barbs antrorse, lateral, or retrorse; base chromosome number, $x = 17$ or 19.

Type: *P. californica* Benth.

Key to the Species

1. Heads discoid. . . . . 2.
  2. Leaves canescent; Guadalupe Lsland, Mexico. . . . . 5. *P. incana.*
  2. Leaves not canescent; Texas or Jalisco, Mexico . 3.
    3. Pappus bristle 1, 3.7-5.5 mm long; disc corollas yellow; Texas. . . . . 20. *P. aglossa.*
    3 Pappus bristles 2(3), 0.5-1 mm long; disc corollas cream-white or pale yellow; Jalisco. . . . . . . 4.
      4. Leaves dissected. . . . . 17. *P. feddemae.*
      4. Leaves deltoid to subhalberd. 14. *P. jaliscana.*
1. Heads radiate. . . . . 5.
  5. Ray and disc corollas yellow. . . . . 6.
    6. Plants distinctly annual; pappus bristles 1 or 2 (or rarely absent). . . . . 7.
      7. Achene margins thin, not calloused; single pappus bristle delicate (rarely absent), and retrorsely barbellate only at the tip. . . . . 4. *P. aurea.*
      7. Achene margins usually prominently calloused; single pappus bristle rather stout and antrorsely subplumose, or 2 delicate bristles. . . . . 8.
        8. Pappus bristle 1, subplumose, 1.5-3.5 mm long. . . . . 26. *P. californica.*
        8. Pappus bristles 2 (rarely absent), delicate, 0.5-2.0 mm long. 9.
          9. Achenes (2.5) 3-3.8 mm long, obcordate-cuneate, with broad, callous margins. . . . 27a. *P. cuneata* var. *cuneata.*
          9. Achenes 1.5-2 (2.5) mm long, obovate to subcuneate with prominent callous

margins. . . . . 27b. *P. cuneata* var. *marginata.*

6. Plants perennial, with woody bases, or herbaceous with fleshy taproots or rather thin branch roots. . . . . 10.
    10. Plants of West Texas and adjacent Mexico. . . . . 11.
        11. Leaves typically 3-lobed or subcruciform; taprooted perennials in soil. . . . . 10. *P. vaseyi.*
        11. Leaves typically 3-lobed but not divided; woody-based perennials in rock crevices, or taprooted in soil. . . . . . 18 *P. parryi.*
    10. Plants of Sonora and Sinaloa, Mexico, and Baja California Sur. . . . . 12.
        12. Plants subshrubs or suffrutescent perennials. . . . . 13.
            13. Leaves densely puberulent and subcanescent. . . . . . 22. *P. leptoglossa.*
            13. Leaves pilose and green. . . . . . . 14.
                14. Leaves 3.5-11 cm long; involucral bracts 10-13 mm long. . . . . 21. *P. cordifolia.*
                14. Leaves 2.5-4.5 cm long; involucral bracts 5-7 mm long. . . . . 23. *P. lloydii.*
        12. Plants herbaceous perennials with rather thin, fleshy roots. . . . . 15.
            15. Leaf blades 3-5 lobed, cleft, parted or rarely divided, the margins dentate-lobed and acuminate; Baja California Sur. . . . . . 24. *P. lobata.*
            15. Leaf blades shallowly or strongly 3-lobed, the margins serrate-dentate; Sonora and Sinaloa, Mexico. . . . . 25. *P. palmeri.*

5. Ray corollas white, disc corollas yellow, except disc corollas cream-white in *P. rosea* and *P. trichodonta.* . . . . 16.

16. Disc corollas cream-white. .... 17.

17. Leaves 1.8-3 cm long, 1-1.5 (2) cm wide; ligules 2-2.5 mm long. .... 15. *P. rosei.*

17. Leaves 0.7-0.9 cm long, 0.25-0.5 cm wide; ligules 1-1.5 mm long. .. 16. *P. trichodonta.*

16. Disc corollas yellow. .... 18.

18. Achene margins thin, not calloused; heads 0.6-1 cm high, 0.6-1.5 cm wide, but possibly smaller in *P. emoryi;* Baja California Sur and islands, except *P. emoryi* widespread. .... 19.

19. Ligules 6-10 mm long. .... 20.

20. Leaves usually thick and crisped, arachnoid-villous; Baja California Sur, coastal dune sand. . . . 1a. *P. crassifolia* var. *crassifolia.*

20. Leaves usually rather thin and not crisped, densely short-pubescent to glabrous; Baja California Sur, in various soils. .... 1b. *P. crassifolia* var. *robusta.*

19. Ligules 1.5-4 (6) mm long (rarely absent). .... 21.

21. Plants suffruticose perennials; Revillagigedo Islands. .... 2. *P. socorrensis.*

21. Plants delicate or robust annuals; widespread weed. .. 3. *P. emoryi.*

18. Achene margins thin or prominently calloused; heads 3-7 mm high, 4-8 mm wide, but may be wider in *P. turneri;* Sierra Madre Occidental, Mexico, and foothills, and Arizona, except *P. microglossa* widespread. .... 22.

22. Achenes 1.8-3.5 mm long; pappus bristles 2 (3), 1.5-3 mm long. .... 23.

23. Leaves deltoid-ovate to ovate-rhombic, the margins serrate,

shallow-lobed, or serrate-crenate; central Arizona. . . . 11. *P. ciliata.*

23. Leaves ovate to subspathulate and entire to shallow-lobed, or ovate-cordate and serrate to serrate-lobed, or 2-3-pinnatifid to pedately divided; southern Arizona and Mexico. . . . . 24.
    24. Leaves entire, shallow-lobed or serrate; Durango, Mexico. . . . . 13. *P. hofmeisteria.*
    24. Leaves pinnatifid or pedately divided with spathulate or linear segments; southern Arizona and adjacent Mexico. . . . . 25.
        25. Capitulescence of several heads clustered on short peduncles; achene margins typically long-ciliate. . . . 12. *P. coronopifolia.*
        25. Capitulescence essentially of solitary heads; achene margins merely puberulent. 10. *P. canescens.*

22. Achenes 1.3-2 mm long; pappus bristles 2 (or 0-2), 0.5-1.5 mm long. . . 26.
    26. Leaves pinnately 3-5 divided, the divisions linear or nearly so. . . . . 7. *P. leariloba.*
    26. Leaves otherwise. . . . . 27.
        27. Heads 0.7-1.4 cm wide. . . . . 6. *P. turneri.*
        27. Heads 4-7 mm wide. . 28.
            28. Plants suffrutescent perennials; leaves densely grayish-puberulent. . . . . 8. *P. microcephala.*

28. Plants delicate or robust annuals; leaves puberulent, glandular-puberulent, or glabrous. 29.
    29. Ligules 1.5-3.5 mm long; upper peduncles usually copiously glandular-puberulent. . . . . . . 9a. *P. microglossa* var. *microglossa*.
    29. Ligules 3.5-4.5 mm long; upper peduncles usually sparsely to densely puberulent, rarely moderately glandular-puberulent. . . . . . 9b. *P. microglossa* var. *saxosa*.

1. **Perityle crassifolia** Brandeg. Proc. Calif. Acad. II, 3: 147. 1891. TYPE: **Mexico:** BAJA CALIFORNIA: San Jose del Cabo, 6 Oct. 1890, *T. S. Brandegee* (Holotype, UC; isotypes, GH!, US(2)!).

1a. **Perityle crassifolia** var. **crassifolia.**

Plants perennial, 10-75 cm high, younger plants with slender taproots, older plants with fleshy-woody taproots, younger plants erect and branching toward the top, older plants branching at the base, tending to be decumbent, stems pilose-villous to hirsute and glandular-pubescent; leaves mostly alternate, felty to touch, arachnoid-villous to short pilose-hirsute and glandular-pubescent, 2-3 (5) cm long, 1.5-2.0 (3.0) cm wide, reniform to cordate in outline, thick and crisped, crenate to 3-5 lobed or dissected; subsessile to petiolate, the petioles 0.5-2.0 cm long; capitulescence of 1-3 heads borne on peduncles 1-4 (6) cm long; heads radiate, ca. 1.0 cm high, 1.0-1.5 cm wide, involucres hemispherical; bracts numerous, ovate-lanceolate; ray flowers 12-16, ligules white, 6-8 mm long often pinkish-tinged, oblong to elliptic or subspathulate; disc flowers numerous, corollas yellow, 3.0-3.5 (4.0) mm long, throats tubular-funnelform; achenes 2.5-3.0 (4.0) mm long, lanceolate-obovate and curved, callous margins absent or very thin, the margins densely ciliate, ray achenes 3-angled and pubescent on faces, disc achenes 2-angled and glabrous on faces; pappus of a short crown of squamellae and 1 (rarely 2) slender, barbellate bristle, 2-3 mm long, the distal barbs retrorse; chromosome number, $n = 19$.

Apparently restricted to deep coastal sand from Punta Arena to San Jose del Cabo, Cape Region of Baja California Sur, and Isla Coronados. Flowering year around. (Fig. 1).

REPRESENTATIVE SPECIMENS:

Mexico: BAJA CALIFORNIA SUR: Los Frailes, S of Cabo Pulmo, *Arnaud* (DS); San Jose del Cabo, *Brandegee* (DS, GH, NY); SW end of Isla Coronados, *Carter* 4274 (DS, SD, UC, US); Punta Frailes, *Dawson* 1140 (US); 3 mi N of Los Frailes, *Hastings and Turner* 64-279 (ARIZ); sand near shore, Isla Coronados, *Moran* 9121 (SD, US); 0.5 mi E of Eureka, *Powell and Turner* 1849 (SRSC, TEX); San Jose del Cabo, *Purpus* 444 (US) 274, 446 (UC); 0.6 mi S of Buena Vista, *Wiggins* 14747 (CAS, DS, GH, TEX).

This taxon is best distinguished from var. *robusta* by its arachnoid-villous pubescence, distinct perennial habit with fleshy to woody taproots in older plants, and habitat in coastal sand.

Some considerations suggest that var. *crassifolia* and var. *robusta* should be accorded specific rank. Plants from one collection of var. *crassifolia* (*Powell and Turner 1849*) and several collections of var. *robusta* have been grown from seed under identical greenhouse conditions. The characteristic morphologies of both taxa persisted under artificial conditions, but var. *crassifolia* flowered rarely while var. *robusta* flowered profusely. Vigorous intervarietal hybrids were obtained, but only two flowering heads were produced on only one of several plants. Meiosis was regular and pollen stainability was ca. 3%. The reproductive data are too meager to allow speculation about relationships. Also, I have seen specimens of var. *robusta* (among borrowed material) which approach var. *crassifolia* morphologically. I believe that it is best to retain varietal status for the taxa, following Everly (1947), pending populational study of the habit and habitat of var. *crassifolia.*

1b. **Perityle crassifolia** var. **robusta** (Rydb.) Everly, Contrib. Dudley Herb. **3**: 382. 1947.

Perityle robusta Rydb. N. Amer. Fl. **34**: 16. 1914. TYPE: **Mexico:** BAJA CALIFORNIA: Cerralvo Island, 19 April 1911, *J. N. Rose* 16880 (Holotype, NY!; isotype, US!; isotype fragments UC (2)!).

Perityle incompta Brandeg. Univ. Calif. Pub. Bot. **6**: 503. 1919. TYPE: **Mexico:** BAJA CALIFORNIA: Los Dolores, *W. E. Bryant* (UC!).

Perityle macromeres Blake, Proc. Biol. Soc. Wash. **37**: 59. 1924. TYPE: **Mexico:** BAJA CALIFORNIA: La Paz 3 Feb 1906, *E. W. Nelson* and *E. A. Goldman* 7483 (US!).

Plants perennial or annual, with fleshy taproots to slender branching roots, erect with few branches to spreading in large clumps with many branches, stems short-hirsute to glabrous; leaves densely short-hirsute and glandular-pubescent to glabrous, 2-10 cm long, 1-7 cm wide, ovate to cordate in outline, rather thick and crisped to thin and not crisped, typically deeply 3-5 lobed with the lobes also indented or with somewhat irregularly dissected margins; heads 0.6-1.0 cm high, 0.6-1.5 cm wide, involucres hemispherical to campanulate; ligules 6-10 mm long; disc corollas 2-3 (4) mm long; pappus bristle usually 1, rarely 0-3; chromosome number, $n = 19, 18$.

Growing in various soils, including those which are sandy or saline near the sea and occasionally among rocks, rather common in southern Baja California Sur and neighboring islands. Flowering year around. (Fig. 1).

REPRESENTATIVE SPECIMENS:

Mexico: BAJA CALIFORNIA SUR: Isla Espiritu Santo, *Berry* (CAS); Isla Magdalena, *Brandegee* (NY, UC, US); Isla Santa Margarita,

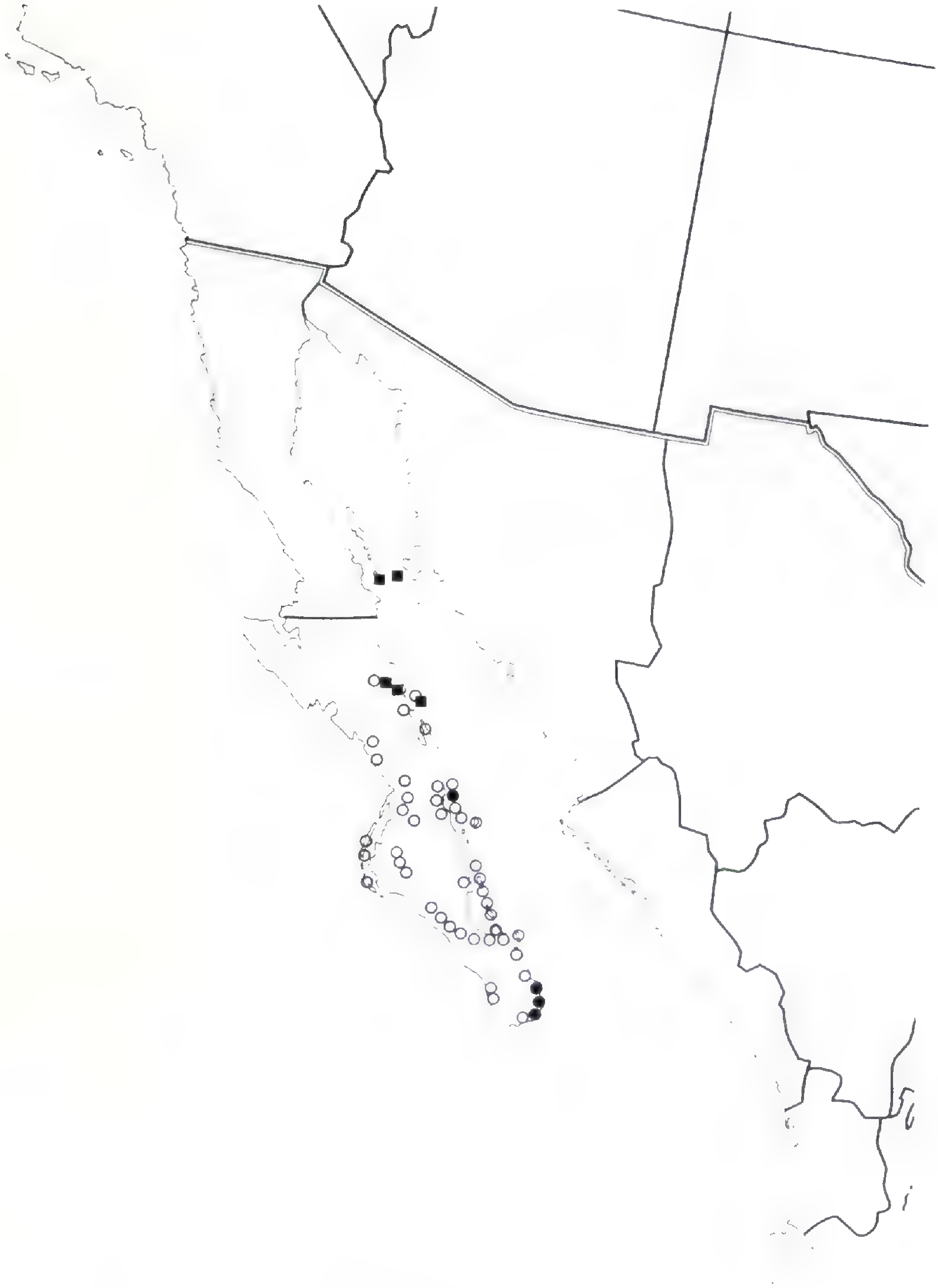

Fig. 1. Distribution of *P. crassifolia* var. *crassifolia* (closed circles); *P. crassifolia* var. *robusta* (open circles); *P. aurea* (closed squares); not plotted are *P. socorrensis* of the Revillagigedo Islands, and *P. incana* of Guadalupe Island.

Brandegee (UC, US); San Jose del Cabo, *Brandegee* (POM); El Mogote Peninsula, La Paz Bay, *Carter* 2729 (CAS, DS, GH, UC, US); 4.5 km N of El Refugio, *Carter, Alexander, and Kellogg* 2152 (DS, UC, US); Puerto Escondido, *Carter and Kellogg* 2875 (ARIZ, DS, GH, SD, UC, US); Isla Partida, *Collins, Kearney, and Kempton* 166 (US); Isla San Francisco, *Collins, Kearney, and Kempton* 198 (US); 10 mi W of Comondu, *Gentry* 4083 (ARIZ, DS, GH, UC); dunes, San Nicholas Bay, *Johnston* 3720 (CAS, GH, UC, US); Isla Coronados, *Johnston* 3756 (CAS, DS, GH, NY, UC, US); dunes, Isla Monserrate, *Johnston* 3865 (CAS, GH, UC, US); beach, Agua Verde Bay, *Johnston* 3893 (CAS, GH, NY, UC, US); dunes, Isla San Francisco, *Johnston* 3946 (CAS, DS, GH, NY, UC, US); Isla Cerralvo, *Johnston* 4046 (CAS); Isla Espiritu Santo, *Johnston* 4081 (CAS, GH, NY, UC, US); Guadalupe Point, Concepcion Bay, *Johnston* 4150 (CAS, DS, NY, UC); E base of San Lazaro, Santa Maria Bay, *Moran* 3537 (DS, UC); Ensenada de los Muertos, *Moran* 3560 (DS, SD); S end of Isla Cerralvo, *Moran* 3616 (DS, UC); Isla San Jose, *Moran* 3751 (DS, UC); Isla San Marcos, *Moran* 3948 (DS, UC); Isla Danzante, *Moran* 9209 (DS); W side of Isla Catalina, *Moran* 9329 (SD, UC); NE side of Isla San Jose, *Moran* 9387 (SD); Isla Las Animas Rock, *Moran* 9433 (SD, UC, US); Isla San Diego, *Moran* 9593 (SD); Isla Carmen, *Palmer* 1 (GH, NY, US); 10 mi N of Loreto, *Powell and Sikes* 1662 (SRSC, TEX); 2 mi NE of La Paz, *Powell and Sikes* 1681 (SRSC, TEX); 33 mi W of San Javier, *Powell and Turner* 1847 (SRSC, TEX); Isla Magdalena, *Rose* 16319 (NY, US); Isla Pichilinque, *Rose* 16529 (GH, NY, US); 8 mi W of San Miguel, *Shreve* 7125 (ARIZ, DS, GH, US); 17 mi N of La Paz, *Sikes and Babcock* 270 (SRSC, TEX); 2 mi S of Villa Constitucion, *Sikes and Babcock* 276 (SRSC, TEX); ca. 29 mi N of Villa Constitucion, *Thomas* 8403 (CAS, DS, GH, US); 9 mi E of San Ignacio *Wiggins* 11360 (CAS, DS, GH, UC, US); San Gregoria, 12 mi NW of La Purisima, *Wiggins* 11467 (DS, GH, UC); 0.6 mi S of Buena Vista, *Wiggins* 14748 (CAS, DS, TEX, UC); Salino Flat, near S end of Isla Espiritu Santo, *Wiggins* 15595 (DS); Isla Partida, *Wiggins* 16160A (DS).

Perityle crassifolia var. *robusta* is more widespread than is var. *crassifolia*, and occupies a variety of edaphic conditions in coastal, insular, and inland areas in the southern portion of Baja California Sur. Two extreme forms of the morphologically variable var. *robusta* can be recognized. The plants of coastal habitats (e.g., near La Paz) usually are robust with fleshy, perennial taproots, while plants of the inland forms (e.g., near Commondu) are typically smaller with annual or weak perennial habits. Also, the inland form tends to be less pubescent and has thinner, less crisped leaves than coastal plants. According to my interpretation, the "inland form" corresponds to *P. incompta* which Everly (1947) recognized as a distinct species. The "coastal form" conforms with Everly's *P. crassifolia* var. *robusta.* Although the extremes of coastal and inland forms are evident, the existence of separate taxonomic entities has not been indicated. Instead, examination of exsiccata material and field studies have shown a rather complete morphological intergradation (e.g. *Johnston* 3946) between the two extremes. Hence *P. incompta* is treated here as synonymous with var. *robusta.*

Further study is needed to clarify the adaptable habit of *var. robusta,* i.e., the perennial vs. annual conditions. Also, particular attention should be given to the habitats in which life forms occur. Those plants at La Paz grow in crusty saline soils, while plants of other populations may be in crevices of granite rocks, in rocky soil, or in fine sand.

Another aspect of variability in var. *robusta* is presence or absence of pappus bristles, which seemingly is not taxonomically significant. As a generality, however, awnless forms occur on islands while awned forms are peninsular, but there are exceptions.

2. **Perityle socorrensis** Rose, Bot. Gaz. **15:** 118. 1890. TYPE: **Mexico:** Socorro Island, Revillagigedo Islands, Mar. 1889, *C. H. Townsend* (Holotype, US!; isotypes, GH!, NY!, US!).

Plants suffruticose perennials, 10-40 cm high, many branched and densely leafy; leaves typically alternate, densely short-hirsute and glandular-pubescent, semisucculent, 2-6 cm long, 0.8-3.0 cm wide, ovate, deltoid-ovate, cordate to subhastate, 3-5 shallow-lobed and serrate to crenate; petioles 1.5-3.0 cm long; capitulescence of 1-2 (3-5) heads borne on peduncles 1.0-3.5 (6.0) cm long; heads typically radiate, rarely discoid, ca. 6 mm high, 7-10 mm wide, involucres campanulate to narrowly so; bracts lanceolate to oblanceolate or oblong-lanceolate; ray flowers ca. 10 or fewer, ligules white, 2-4 mm long, oblong to oblong-elliptic, rarely with a prominent inner lobelet; disc corollas yellow

(?), 2.0-2.5 mm long, throats tubular-funnelform; achenes 2.2-3.0 mm long, oblanceolate-obiconical, oblong-oblanceolate, to narrowly obconical typically curved, callous margins absent or very thin, the margins ciliate, ray achenes sparsely and minutely pubescent on faces, disc achenes glabrous or nearly so; pappus of a short to vestigial crown of squamellae and typically 2 (0-1) bristles, 1.5-2.0 mm long, the bristles retrorse barbellate (rarely lateral or antrorse) distally; chromosome number, $n = 19$.

Endemic to the Revillagigedo Islands, growing on sea cliffs and in soils near the shore. Flowering mostly in winter and spring.

REPRESENTATIVE SPECIMENS:

Mexico: REVILLAGIGEDO ISLANDS: Isla San Benedicto: *Anthony* 372 (CAS, DS, GH, NY, UC, US); *Barkelew* 175 (ARIZ, DS, GH, NY, POM, UC, US); *Mason* 1684 (CAS, GH, UC, US); Isla Clarion: *Anthony* 415 (CAS, DS, POM, UC, US); Sulfur Bay, *Howell* 8347 (CAS, DS, NY, POM, US); W end of island, *Mason* 1578 (CAS, DS, GH, NY, POM, UC, US); Isla Socorro: *Anthony* 383 (ARIZ, CAS, DS, GH, POM, SD, UC, US); *Barkelew* 192 (ARIZ, DS, GH, NY, POM, UC, US); Academy Bay, *Carlquist* 368 (CAS, RSA, UC); Brenner's Cove, *Howell* 8423 (CAS, DS, GH, UC, US); Graysons Cove, *Moran* 5922 (ARIZ, CAS, DS, GH, NY, RSA, SD, UC, US).

Perityle socorrensis is a distinct species closely related to *P. crassifolia* from which it is distinguished by its typically 2 pappus bristles, reduced squamellae, generally smaller floral features, short ligules (or absent), woody bases, leaf morphology, and its distribution.

As discussed by Everly (1947), *Perityle socorrensis* is notably variable in ligule and pappus features. The ligules, typically short at 2-4 mm, are even shorter and aberrant-looking in many collections, while other specimens are without ligules. According to label data, discoid individuals may occur in populations with radiate forms, and thus no taxonomic significance is attributed to ligule variability. Typically, the number of pappus bristles per achene in *P. socorrensis* is two, but some individuals or populations may have only one bristle or none. Bristle number is correlated with the island to island distribution: plants with two bristles on Socorro and San Benedicto Islands, and awnless forms on Clarion Island. No taxonomic significance is attached to bristle variability since exceptions are found on all the islands, and because other features are not correlated with the pappus differences.

3. **Perityle emoryi** Torr. in Emory, Notes Mil. Rec. 142. 1848. TYPE: **California:** mountains E of San Diego, 29 Nov. 1846, *Emory* (NY!).

Perityle nuda Torr. Pacif. R. Rep. 4: 100. 1857. TYPE: **California:** Williams' River, 7 Feb. 1853-4, *J. M. Bigelow* (NY!).

Perityle emoryi var. *nuda* A. Gray, Bot. Calif. 1: 397. 1876.

Perityle emoryi S. Wats. Proc. Amer. Acad. **11**: 116. 1876. Not *P. emoryi* Torr. 1848.

Perityle californica A. Gray, Syn. Fl. N. Amer. **1**: 321. 1884. Not *P. californica* Benth. 1844.

Perityle californica var. *nuda* A. Gray, Syn. Fl. N. Amer. **1**: 321. 1884.

Perityle fitchii var. *palmeri* A. Gray, Syn. Fl. N. Amer. **1**: 321. 1884.

Perityle fitchii Green, Bull. Calif. Acad. **2**: 403. 1887. Not *P. fitchii* Torr. 1857.

Perityle californica Vasey, Proc. U. S. Nat. Mus. **11**: 368. 1889. Not *P. californica* Benth. 1844.

Perityle rothrockii Rose, Bot. Gaz. **15**: 114. 1890. TYPE: **Nevada:** 1872, *Wheeler* (US!).

Perityle greenei Rose, Bot. Gaz. **15**: 117. 1890. TYPE: **California:** Santa Cruz Isl., July-Aug. 1886, *E. L. Green* (Holotype, ND?; isotypes, DS!, NY!, UC!, US!).

Perityle emoryi var. *orcuttii* Rose, Bot. Gaz. **15**: 117. 1890. TYPE: **Mexico:** BAJA CALIFORNIA. Canyon Cambellos (?) July, 1884, *C. R. Orcutt* (Holotype, US!; isotype GH!).

Perityle grayi Rose, Bot. Gaz. **15**: 118. 1890. TYPE: **Mexico:** Guadalupe Isl., 1875, *E. Palmer* 44 (Holotype, US?; isotypes, GH!, NY!).

Laphamia nuda Benth & Hook. ex Jacks. Ind. Kew. 2: 30. 1895.

Laphamia emoryi Benth & Hook, ex Jacks. Ind. Kew. 2: 30. 1895. Partial Synonomy of South American *P. emoryi* (= *Closia*).

Closia elata Phil Fl. Atac. 31 and Viage Des. Atac. 19, 205. 1860. Type not examined.

Closia discoidea Phil. Fl. Atac. 31 and Viage Des. Atac. 205. 1860. Type not examined.

Perityle emoryi Torr. var. *elata.* (Phil.) I. M. Johnston, Contr. Gray Herb. 85: 127. 1929.

Perityle discoidea (Phil.) I. M. Johnston, Contr. Gray Herb. 85: 128. 1929.

Plants delicate or robust annuals, 2-60 cm high, usually herbaceous or the lower stems woody, erect or spreading with few to many stems, puberulent to hirsute and glandular-pubescent; leaves mostly alternate, hirsute to glandular-pubescent, 2-10 cm long 1-5 cm wide, ovate, cordate, suborbicular, to triangular in outline, the margins deeply toothed, lobed, cleft, or divided, with the segments also indented to irregularly dissected; petioles 0.3-4.0 cm long; capitulescence of 1 to many heads borne on peduncles 0.1-7.0 cm long; heads radiate (rarely discoid), 0.4-1.0 cm high, 0.4-1.0 cm wide; involucres hemispherical or campanulate; bracts numerous, lanceolate, oblanceolate, to ovate-lanceolate; ray flowers 8-12 (14), ligules white, usually oblong, 1.5-4.0 (6.0) mm long, 1.5-3.0 mm wide, rarely rudimentary; disc flowers numerous, corollas yellow, 2.0-2.5 (3.8) mm long, throats tubular to tubular-funnelform; achenes (1.5) 2-3 mm long, suboblong, oblanceolate, or subcuneate, the outer ones often curved, margins thin, not calloused, the margins long- or short-pubescent (ciliate), outer achenes 2-3 (4) angled and often pubescent on the faces. inner achenes 2-angled with glabrous (rarely puberulent) faces; pappus of a vestigial or conspicuous crown of squamellae and 1 slender bristle, (0.8) 1.0-2.5 (3.5) mm long, antrorse-, lateral-, or retrorse-barbed especially at the tip,

Fig. 2. Generalized distribution of *P. emoryi* (stippled); South American distribution in Chile and Peru not plotted.

or the bristle absent; chromosome number, tetraploid ($n = 32\text{-}36$) or hexaploid ($n = 50\text{-}58$).

Widespread weed of desert southwestern United States, Sonora, Mexico, Baja Californian peninsula, and neighboring islands; continental disjunct in Chile and Peru. Fowering mostly in winter and spring, but also year around, depending upon latitude. (Fig. 2).

REPRESENTATIVE SPECIMENS:

MEXICO: **Baja California**: Ensenada, *Anthony* 180 (CAS, DS, UC, US); 8.2 mi S of Socorro, *Constance* 3119 (DS, GH, LL, UC, US); Bahia de los Angeles, *Cowan* 2265 (TEX); 14 mi S of Santa Rosalillita, *Powell and Sikes* 1647 (SRSC, TEX); 41.6 mi S of Mexicali, *Powell and Turner* 1710 (SRSC, TEX); Arroyo Calmalli, *Purpus* 23 (CAS, NY, POM); 14 km NW of Colonia Guerrero, *Raven, Lewis, and Thompson* 12193 (GH); 8.5 km E of El Rosario, *Raven, Mathias, and Turner* 12433 (ARIZ, GH); 15.9 mi N of San Felipe, *Raven* 14775 (DS, UC); N side of El Arco, *Sikes and Babcock* 295 (SRSC, TEX); 2 mi N of Miission de San Borja, *Wiggins and Wiggins* 14851 (DS); 9 mi S of Puertocito, *Wiggins and Wiggins* 15877 (DS, US). **Baja California Sur**: Sierra de la Trinidad, Cape Region, *Brandegee* (UC, US); near Santa Rosalia, *Ferris* 8702 (DS); Santo Domingo, *Gander* 9792 (SD); 10 mi W of Comondu, *Gentry* 4083 (ARIZ, UC); San Francisquito Bay, *Johnston* 3566 (CAS, GH, US); Concepcion Bay, *Johnston* 4150 (GH, US); E base of San Lazaro, Santa Maria Bay, *Moran* 3537 (SD); 13.6 mi. S of Mulege, *Powell and Turner* 1836 (SRSC, TEX); ca. 20 mi N of Santa Rosalia, *Sikes and Babcock* 285 (SRSC, TEX); 3 mi NW of San Ignacio, *Sikes and Babcock* 288 (SRSC, TEX); San Ignacio, *Wiggins* 16233 (DS); 3 mi N of El Barril, *Wiggins* 16864 (DS); Mulege, *Wiggins and Wiggins* 18070 (US); 4 mi S of El Arco, *Wiggins and Wiggins* 18191 (CAS, DS). **Islands**: ISLA ANGEL DE LA GAURDA: *Wiggins* 17010 (DS). ISLA CARMEN: *Moran* 9181 (SD). ISLA CEDROS: *Anthony* 283 (CAS, DS, GH, NY, POM, UC, US); *Haines and Hale* (CAS, GH, LL, NY, SD, UC, US); *Howell* 10684 (CAS, DS, GH, NY, POM, US). ISLA CORONADOS: *Moran* 6556 (SD); *Palmer* 16 (GH, NY, US). ISLA GUADALUPE: *Anthony* 233 (CAS, DS, GH, UC, US); *Carlquist* 439 (RSA); *Mason* 1502 (CAS, GH, US); *Moran* 2900 (DS, GH), 5628 (DS, RSA, SD, UC); *Palmer* 891 (NY, UC, US); *Rose* 16003 (GH, NY, US). ISLA ILDEFONSO: *Moran* 9062 (SD); Wiggins 18254 (CAS, DS). ISLA NATIVIDAD: *Brandegee* (UC); *Moran* 10797 (SD). ISLA PARTIDA: *Johnston* 3235 (CAS, US); *Wiggins* 17268 (DS). ISLA PARTOS: *Johnston* 3240 (CAS, GH, NY, UC, US). ISLAS REVILLAGIGEDO: *Mason* (CAS, US). ISLA SALSIPUEDES: *Moran* 8871 (SD, US). ISLA SAN BENITO: *Anthony* 271 (DS, GH, POM, UC); *Palmer* 914 (ARIZ, CAS, DS, NY, US). ISLA SAN ESTEBAN: *Wiggins* 17218 (DS). ISLA SAN LORENZO: *Moran* 8895 (SD). ISLA SAN MARCOS: *Johnston* 3622 (CAS, GH, UC, US). ISLA SAN PEDRO MARTIR: *Johnston* 3148 (CAS, GH, UC, US); *Moran* 8810 (SD). ISLA TIBURON: *Johnston* 3268 (CAS, US). ISLA TODOS SANTOS: *Moran* 16214 (SD). ISLA TORTUGA: *Wiggins* 17367 (DS). **Sonora:** Puerto Penasco, *Breedlove* 1397 (DS); 27.4 mi S of Sonoyta, *Breedlove* 1389 (DS, TEX); vicinity of Libertad, *Graham* 3803 (DS); 3 mi W of Kino, *Heckard* 1575 (JEPS); 1 mi E of San Carlos Resort, *Powell and Sikes* 1685 (SRSC, TEX); Empalme, *Rose, Standley, and Russell* 12636 (GH, NY, US); 5 mi NW of Caborea, *Shreve* 7532 (ARIZ); 4 mi NW of Caborca, *Wiggins* 8233 (DS, GH, UC, US).

U.S.A.: **Arizona:** COCONINO CO.: Havasu Canyon, Grand Canyon, *Howell* 26537 (ARIZ, CAS, SMU); GILA CO.: Roosevelt Dam, *Eastwood* 6247A (CAS). MARICOPA CO.: Phoenix, *Eastwood* 6159 (CAS); near Tempe, *Gillespie* 8808 (DS, GH, POM, UC, US); 2 mi NW of Scottsdale, *Russell* 10911 (SMU, UC). MOHAVE CO.: 7 mi NW of Alamo, *Benson* 10074 (POM); 3.4 mi SE of Boulder Dam, *Carter and Chisaki* 3230 (ARIZ, DS, LL, NY, RSA, SMU, UC, US); Toroweap, Grand Canyon, *Cottam* 13001 (UT); 62 mi N of Wickenburg, *Sikes* 106 (SRSC). PIMA CO.: 10 mi W of Bates Well, Growler Mts., *Benson* 9926 (POM); Gunsight Peak, *Fosberg* 7865 (POM); ca. 5 mi N of Ajo, *Gould and Macbride* 4130 (ARIZ, GH, NY, UC); Alamo Canyon, Ajo Mts., *Huey* 24351 (GH, SD); Dripping Spring, Organ Cactus Natl. Mon. *McClintock* 52-37 (CAS). PINAL CO.: Sacaton, *Gilman* 350 (ARIZ); 10 mi W of Maricopa, *Russell* 11343 (SMU). YUMA CO.: Gila Mts., near US 80, *Barr and Lange* 64-174 (ARIZ); S end of Castle Dome Mts., *Parker, Wright* and Lowe 7789 (ARIZ, DS, NY, RSA, US); 15.6 mi E of Yuma, *Powell and Turner* 1704 (SRSC, TEX); S end of Cunningham Pass, Harcuvar Mts., *Wiggins* 8452 (DS, GH, UC, US). **California:** IMPERIAL CO.: 8 mi from Niland to Blythe, *Balls* 12921 (RSA); 7 mi N of All American Canal spillway, *Wiggins* 8613 (DS, NY, POM, UC, US). INYO CO.: Furnace Creek, Death Valley, *Carpenter* (JEPS); Funeral Mts., *Coville and Funston* 324 (US); Hanaupah Canyon, *Coville and Gilman* 392 (US); Darwin Falls, *Hitchcock* 6219 (UC); Surprise Canyon, *Howell* 3964 (CAS); Panamint Valley *Smith* 86 (JEPS). KERN CO.: Last Chance Canyon, El Paso Range, *Twisselman* 11863 (JEPS). LOS ANGELES CO.: Santa Catalina Isl., *Brandegee* (UC); Santa Monica Mts., *Epling* (DS, NY, RSA); Anacapa Isl., *Howell* 3816 (JEPS); San Clemente Isl., *Raven* 17345 (RSA, UC). RIVERSIDE CO.: Palm Springs, *Abrams* 11012 (DS); San Jacinto Range, *Benson* 4167 (POM): 8 mi NE of Desert Center, *Wiggins* 9675 (DS, GH, RSA, UC). SAN BERNARDINO CO.: 29 Palms, *Alexander and Kellogg* 870 (UC); near Parker Dam, *Brenckle* 51140 (SMU, UC); 39 mi N of Needles, *Ferris* 7224 (DS); between Kelso and Baker, *Jepson* 20590 (JEPS). SAN DIEGO CO.: 23.1 mi NW of Coyote Wells, *Breedlove* 1856 (DS);

Yaqui Wells, *Eastwood* 2644 (CAS, GH, UC, US); Jacumba, *Nelson* 11182A (DS, GH, NY, POM, UC); Borego Park, *Wolf* 8462 (ARIZ, GH, NY, RSA). SANTA BARBARA CO.: Santa Cruz Isl., *Balls and Blakley* 23727 (RSA, UC). VENTURA CO.: Point Mugu, *Howell* 3733 (CAS). **Nevada:** CLARK CO.: between Las Vegas and Boulder Beach, *Cronquist* 9844 (NY, UC); 1 mi below Boulder Dam, *Grater* 51 (UC); 8 mi SW of Davis Dam, *Gullion* 258 (UC).

CHILE: **Atacama:** Chanaral, *Beetle* 26164 (GH, UC); vicinity of Caldera, *Gigoux* (GH); below Agua El Huerto, *Johnston* 3678 (US); vicinity of Potrerillos, *Johnston* 4740 (GH, US); vicinity of Puerto de Chanaral, *Johnston* 4794 (GH, US); vicinity of Copiapo, *Johnston* 5023 (GH); Caldera, *Johnston* 5056 (GH); vicinity of Caleta Pan de Azucar, *Johnston* 5829 (US); Vallenar, *Werdermann* 160 (GH); Tierra Amarilla, *Werdermann* 406 (GH, NY); Quebrada Paipote, *Werdermann* 448 (GH, NY). **Antofagasta:** Taltal, *Jaffuel* 984 (GH); Tocopilla, *Jaffuel* 1014 (GH); Antofagasta, *Jaffuel* 1126 (GH); 6 km N of Puerto Tocopilla, *Johnston* 3585 (US).

ECUADOR: **Galapagos Isles:** Cerros Isl., *Stewart* 40 (CAS).

PERU: Mts. near Chosica, Lima-Oroya Railroad, *Weberbauer* 5320 (GH, US).

The morphological variation of *Perityle emoryi* is attested to by its considerable synonymy. This widespread annual, polyploid weed exhibits variation in nearly all aspects of plant form. I have carefully examined the bulky exsiccatae available to me, giving particular attention to plant size, leaf morphology, head size, presence or absence of ligules and pappus bristles, and geographic distributions. None of the variable morphological aspects appear to have populational significance, and thus, in my judgement, do not require taxonomic recognition. I do note, however, that several atypical collections of *P. emoryi* from Magdalena Island resemble *P. crassifolia* and *Amauria brandegeana*, and thus the desirability of further study of *Perityle* from this locality is indicated.

Perityle emoryi is related to and probably derived from the diploid *P. crassifolia* var. *robusta*, from which it is delimited by habit, smaller heads, shorter ligules, usually shorter disc corollas, and chromosome number. With poorly preserved specimens it is often difficult to distinguish these taxa, but I have not had difficulty recognizing them in the field. *Perityle emoryi* is also remarkably similar to *Amauria* *brandegeana* in superficial morphology. A discussion of the later similarity and distinguishing traits is to be found elsewhere (Powell, 1972a).

It is assumed that *P. emoryi* achieved wide distribution as a result of the increased adaptability provided through a combination of polyploidy, reproductive self-compatibility and annual habit. That polyploids often exceed their diploids in distribution is well-known (Stebbins, 1950), and the advantage of self-compatibility in the establishment of disjunct colonies is clear. Indeed, Raven (1963) has suggested that *P. emoryi* might have attained bicontinental distribution as a result of long-distance dispersal from the Sonoran Desert, and he indicated the advantage of self-compatibility to such long-distance dispersal. More specifically, I believe that the South American *P. emoryi* originated from the vicinity of southern Baja California. It is in southern Baja California that the ancestors of *P. emoryi* are found. Furthermore, geographic variation in length of pollen spines (the spines ornamenting pollen walls) suggests that South American and Mexican *P. emoryi* had common areal origin. In measuring the pollen spines of some 20 populations of *P. emoryi*, it was found that the spine length of South American populations averaged the same or slightly longer than that of Mexican populations, while the spine length of United States populations was nearly twice as short as the others (Powell & Miller, unpublished). From this information it can be postulated that *P. emoryi* originated and became established in Baja California, migrated to South America by long-distance dispersal in late Pliocene or Pleistocene (Raven, 1963), and subsequently advanced to the north, occupying desert areas in southwestern United States.

Further study of the South American *Perityle emoryi* is needed, particularly chromosomal analyses and living plant comparisons. At least two forms can be recognized among the South American specimens I have seen, and this was discussed to some extent by Johnston (1929). One form (= *P. discoidea* (Phil.) I. M. Johnst.) deviates from North

American *P. emoryi* in smaller habit, numerous, smaller and tightly clustered heads with no conspicuous ligules, and a pappus bristle on the achenes. Another form (= *P. emoryi* var. *elata* (Phil.) I. M. Johnst.) is variable in habit, has large and small heads, longer and short ligules, and awnless achenes. I have not been able to make taxonomic distinctions between the South American and North American forms, pending further study, and thus have placed Johnston's combinations in synonymy. It should be noted that only a partial synonymy of South American *P. emoryi* (*Closia,* in part?) is included since I have not seen specimens or types upon which several other *Closia* names are based. A few other collections from South America closely resemble *P. crassifolia* (e.g., *Johnston* 5023) or *Amauria brandegeana* (e.g., *Werdermann* 160; *Morong* 93). As mentioned above, these similarities are also seen in a few Mexican specimens. But it is also possible that both *P. crassifolia* and *Amauria brandegeana* once made their way to South America even though they have not become established there.

4. **Perityle aurea** Rose, Contr. U. S. Nat. Herb. **1**: 84. 1890. TYPE: **Mexico:** BAJA CALIFORNIA: Santa Rosalia, 24 Feb.-3 Mar. 1889, *E. Palmer* 185a (Holotype, US!; isotypes, CAS!, GH!, NY!).

Plants annual, 10-60 cm high, erect or spreading, stems of larger plants succulent, reddish, nearly glabrous; leaves alternate, puberulent to glabrous, slightly thick in texture, 1.7-9.0 cm long, 1-4 cm wide, subreniform to ovate in outline, basically 3-lobed with dentate-serrate lobes and margins; petioles 0.6-5.0 cm long; capitulescence of 1-3 heads borne on rather short peduncles 1-2 (3) cm long; heads radiate, 5-8 mm high, 5-8 mm wide, involucres campanulate to narrowly so; bracts broadly lanceolate; ray flowers ca. 10, ligules yellow, oblong-elliptic to obovate; disc corollas yellow, 2-3 mm long, throats tubular to funnelform; achenes 2-3 mm long, narrowly oblanceolate to suboblong, with thin callous margins, the margins densely white-ciliate, ray achenes pubescent on faces, disc achenes glabrous or nearly so on faces, pappus of a conspicuous crown of squamellae and 1 bristle (rarely 0) 1.5-2.5 mm long, the bristle retrorse barbelate with few barbs at tip; chromosome number, $n = 17$.

Restricted in soils and among rocks, near Santa Rosalia of Baja California Sur and a few islands in the Sea of Cortez. Flowering Jan-April. (Fig. 1).

SPECIMENS EXAMINED:

Mexico: BAJA CALIFORNIA: summit and N slope of high peak near SE corner of Isla San Esteban, *Moran* 8845 (SD, US); summit of NE peak, Isla San Esteban, *Moran* 13044 (SD); arroyo on S Isla San Lorenzo, *Moran* 13060 (SD). BAJA CALIFORNIA SUR: Isla San Marcos, *Johnston* 3614 (CAS, GH, UC, US); Isla San Marcos, *Moran* 3965 (DS); Santa Rosalia, *Palmer* 185a, 185 (CAS, GH, US); 8 mi W of Santa Rosalia, *Powell and Turner* 1826, 1829 (SRSC, TEX); 3 mi N of Santa Rosalia, *Powell and Turner* 22219 (SRSC, TEX); 10 mi N of Santa Rosalia, *Reed* 6225 (DS, POM); ca 12 mi N of Santa Rosalia, *Sikes and Babcock* 281 (SRSC, TEX).

Two growth forms of *Perityle aurea* are evident in the field, and both have been preserved in existing collections of the species. One form is of small plants, superficially resembling the Baja California populations of *P. californica*, and the other form is of taller, more robust and succulent plants resembling *P. crassifolia*. The small form is known to occur in roadside soils where dry conditions prevail, and the large form occurs in places that receive and retain more water. The growth forms likely are ecologically controlled. I have seen both forms growing only a few paces apart, and when seeds of both plant sizes were grown under identical greenhouse conditions, only the larger, more succulent forms developed. The island specimens of *P. aurea* differ slightly from the mainland forms, most notably in achene morphology and in being awnless, although awned forms also occur on San Esteban Island.

Perityle aurea seemingly is related to *P. crassifolia*, from which it is readily delimited by yellow ligules, chromosome number ($n = 17$), and distribution. An affinity of *P. aurea* with the *P. crassifolia* alliance is not indicated by its yellow ligules and chromosome number. All other members of the *P. crassifolia* group have white ligules and have $x = 19$. My first impression from superficial morphological examinations was that the species was related to *P. californica* ($n = 13$, 12, 11) and *P. cuneata* ($n = 16$, 12), both annual yellow-rayed taxa with habits similar to the small growth form of *P. aurea*. But *P. aurea* exhibits a combination of vegetative and floral features which characterize only the *P. crassifolia* alliance: robust and rather succulent habit, achenes with callous margins absent or thin, other unique achene morphology, and pappus bristles retrorsely barbed at the tips. Also, chromatographic studies have shown that *P. aurea*, like members of the *P. crassifolia* group, produces the abundant yellow flavonoid compounds that have been detected elsewhere in sect. PERITYLE only in the *P. parryi* group of Texas. I conclude that *P. aurea* evolved, probably from *P. crassifolia* var. *robusta*, through speciation that involved adaptation of the annual habit and aneuploid reduction in chromosome number. Artificial hybridizations have strongly suggested that the above taxa are reproductively isolated (Powell, 1972c).

5. **Perityle incana** Gray, Proc. Amer. Acad. 11: 78. 1876. TYPE: **Mexico:** BAJA CALIFORNIA: Guadalupe Island, Feb.-May, 1875, *E. Palmer* 43 (Holotype, GH!; isotypes, NY!, US!).

Nesothamnus incanus (Gray) Rydb. N. Amer. Fl. 34: 12. 1914.

Plants shrubby, 10-40 (80) cm high, many branched and densely leafy, stems tomentulose-canescent; leaves alternate, thickish, tomentulose-canescent, 6-14 cm long, 4-7 cm wide, deeply 3-divided or palmate, the divisions again deeply lobed or cleft; petioles 1.5-7.0 cm long; capitulescence of many tightly clustered heads (naked corymbs) borne on short peduncles; heads discoid, 5-7 mm high, 4-8 mm wide, involucres campanulate; bracts broadly oblong-lanceolate to broadly linear; disc corollas yellow, 2-3 mm long, throats narrowly campanulate or broadly tubular;

achenes 2.0-3.8 mm long, narrowly obdeltoid to narrowly oblanceolate, with prominent callous margins, the margins coarse-ciliate, the faces coarse-pubescent; pappus crown of 2 broad, laciniate squamellae, 0.5-0.9 mm long, and rarely a narrow, fimbriate scale, 1.0-1.2 mm long; chromosome number, $n =$ ca. 50-57.

Endemic to Guadalupe Island and islets, growing on cliffs near the sea. Flowering winter, spring, and early summer.

REPRESENTATIVE SPECIMENS:

MEXICO: **Baja California:** ISLA GUADALUPE: *Anthony* 249 (DS); *Carlquist* 440 (RSA, UC); Barracks Cove, *Copp* 157 (DS); *Franceschi* 7 (A, DS, POM, UC); *Howell* 8172 (CAS); Outer Islet, *Lindsay* 2621 (SD); Islote Negro, *Mason* 1519 (ARIZ, CAS, DS, US); *Moran* 2904 (DS, RSA); Outer Islet, *Moran* 5682 (CAS, DS, NY, SD, UC); North Twin Canyon, *Moran* 6133 (SD); N end of island, *Moran* 6435 (DS, SD); cliffs of the Lower Circus, *Moran* 12023 (SD); N side of Mt. Augusta, *Moran* 12042 (DS, SD, UC); SW Oak Canyon, *Moran* 13792 (SD).

This cliff-dwelling Guadalupe Island endemic is perhaps the most distinct species of sect. PERITYLE. Its identifying features include: shrubby habit; tomentulose-canescent pubescence; clustered, naked capitulescence; coarse pubescenct achenes; pappus of broad, laciniate squamellae and rarely a narrow, fimbriate scale. Considering its relatively large, shrubby habit, unique character, and isolated distribution, *Perityle incana* would seem to be a primitive member of the genus, although this possibility is not strengthened by its hexaploid chromosome number. According to Reid Moran (personal communication), the taxon is not in danger of extinction, largely because its habitat is out of reach of the goats which have overrun the island for more than a century.

It is clear that *Perityle incana* does not belong with any of the related-species groups, and thus stands as an anomalous species. In fact, the species could be recognized as a montotypic genus with little change in the taxonomic naturalness of the subtribe. I suspect, however, that the taxon is distantly related to the *P. crassifolia* group and is best treated as a member of sect. PERITYLE. *Perityle incana* is similar to *Pericome* in habit and capitulescence characters, and perhaps shares ancestral affinity with that genus.

6. **Perityle turneri** Powell, Madroño 21: 456-457. 1972. TYPE: **Mexico:** DURANGO: 3.4 mi E of Ey Palmito, 2 Apr. 1970, *A. M. Powell* 1858 (Holotype, TEX!; isotype, SRSC!).

Plants herbaceous to suffrutescent perennials, decumbent, prostrate, or semierect, stems spreading 20-45 cm long, often purplish, lower stems often rooting at the nodes, upper stems puberulent to densely so, short-pilose, or subtomentose; leaves mostly opposite, puberulent to densely so, short-pilose to densely so, or subtomentose, often purplish, 3.0-4.5 (8.5) cm long, 1.5-3.0 (4.0) cm wide, ovate, deltoid, or subcordate, the apexes acute or attenuate, the margins serrate, serrate-crenate, serrate-lobed to doubly so, the serrations or lobes acute or acuminate; petioles 1.0-1.5 (3.0) cm long; capitulescence of 1-3 (4) heads on peduncles (1.0) 2-6 cm long; heads radiate, subglobose, 5-7 mm high, 0.7-1.4 cm wide, involucres hemispherical to broadly campanulate; receptacles conical; ray flowers ca. 12-18, ligules white, (3) 6-9 mm long, oblong; disc corollas yellow, (1.8) 2.0-2.8 (3.0) mm long, throats short-campanulate, short-funnelform, rarely narrowly tubular-funnelform; achenes 1.5-2.0 mm long, obovate to oblong-ovate, with thin or prominent callous margins, the margins ciliate, the faces puberulent in the center; pappus of a prominent crown of squamellae and 2 (rarely 1) unequal bristles, the longest 0.6-1.5 mm long; chromosome numbers $n = 17$, $n = 17 \text{ II} + \text{I}$.

Moist seeps and canyons, higher elevations to ca. 9500 feet, southern Chihuahua and Durango in the Sierra Madre Occidental. Flowering spring and fall. (Fig. 3).

REPRESENTATIVE SPECIMENS:

Mexico: CHIHUAHUA. 4 mi SW of Villa Matamoros, *Correll and Gentry* 22819 (LL); near La Rocha, NE slope of Sierra Mohinora, *Correll and Gentry* 23109 (LL); Burro Canyon near Parral, *Pringle* 13650 (ARIZ, CAS, GH, SMU, TEX, UC, US). Durango. Quebrada San Juan, ca. 50 mi W of Durango and 23 mi NW of Los Coyotes RR,

Fig. 3. Distribution of *P. turneri* (closed squares); *P. lineariloba* (closed star); *P. microcephala* (closed triangles); *P. microglossa* var. *microglossa* (closed circles); *P. microglossa* var. *saxosa* (open triangles); *P. ciliata* (open squares); *P. coronopifolia* (open circles); *P. hofmeisteria* (open star); not plotted is *P. canescens*.

Cronquist 9568 (NY, SMU, TEX, US); 2 km S of El Espinozo del Diablo, and 65 km SW of El Salto, *Cronquist and Fay* 10786 (NY); 6 mi W of La Ciudad, *Flyr* 273 (TEX); ca. 35 mi W of El Salto, *Gentry and Arguelles* 18210 (US); San Ramon, *Palmer* 60 (GH, NY, UC, US); 2.2 mi E of El Palmito, *Powell and Turner* 1857 (SRSC, TEX); 12 mi W of La Ciudad, *Sikes and Babcock* 380 (SRSC, TEX). SINALOA. 0.9 mi W of El Palmita, ca. 47 mi E of Concordia, *Breedlove* 1721 (DS).

Plants of this remarkable species were rarely collected until part of its high-altitude distributional range was made accessible by the road cut across the Sierra Madre Occidental from Durango to Mazatlan. At the type locality near Mex. 40, *Perityle turneri* is abundant in wet mats formed by dense growths of *Selaginella* and small ferns. In overall aspect, at least at the type locality, the taxon shows striking resemblance to members of the tribe Astereae.

Perityle turneri is related to *P. lineariloba,* from which it is easily delimited by leaf shape, and to *P. microcephala,* from which it can be distinguished by its capitulescence and head size. Further discussion concerning the taxonomy of this species is available elsewhere (Powell, 1972e).

7. **Perityle lineariloba** Rydb. N. Amer. Fl. 34: 18. 1914. TYPE: **Mexico:** DURANGO: San Ramon, 21 Apr.-18 May 1906, *E. Palmer* 89 (Holotype, NY!; isotypes, GH!, UC!, US!).

Plants seemingly perennial, with semi-annual roots, stems lignescent near the base, decumbent, ca. 30 cm long, grayish-puberulent above; leaves mostly opposite, finely puberulent, 2.5-6.0 cm long, 1.5-3.5 cm wide, pinnately 3-5 divided, the divisions linear or nearly so and entire or cleft into linear segments; petioles 0.7-2.0 cm long; capitulescence of solitary heads on long peduncles, 4-10 cm long; heads radiate, 5-6 mm high, 5-7 mm wide, involucres broadly campanulate; ray flowers ca. 10-15, ligules white, 4-7 mm long, oblong; disc corollas yellow (?), 1.8-2.0 mm long, throats narrowly campanulate-funnelform; achenes 1.3-1.5 mm long, narrowly obovate to oblong-obovate, with thin or prominent callous margins, the margins and faces short-pubescent; pappus of a conspicuous crown of squamellae and 1 (rarely none) delicate bristle, ca. 0.5 mm long; chromosome number, unknown.

Known only from the type collection. (Fig. 3).

The distinguishing characteristics of *Peritylе lineariloba* include its pinnately divided leaves, long peduncles, and relatively large heads with long ligules. Most of its floral features are like those of *P. turneri,* to which the species is related.

8. *Peritylе microcephala* A. Gray, Proc. Amer. Acad. **21**: 391. 1886. TYPE: **Mexico:** CHIHUAHUA: rocky hills near Chihuahua, 8 Oct. 1885, *C. G. Pringle* 571 (Lectotype, GH!; isolectotype, US!). LECTOPARATYPE: **Chihuahua:** mountains above Batopilas, Oct, 1885, *E. Palmer* 268 (GH); isolectoparatypes, NY! US!).

Plants suffrutescent perennials, 20-40 cm high, many-stemmed and densely leafy, erect or decumbent, densely grayish-puberulent to pilosulous; leaves mostly opposite, densely grayish-puberulent, 1.5-3.5 (5.0) cm long, 0.8-2.0 (3.0) cm wide, deltoid-ovate, ovate, to subcordate, the margins serrate-crenate to doubly so, or shallow-lobed; petioles 0.3-1.0 (1.8) cm long; capitulescence of several heads tightly clustered on short peduncles; heads radiate, 3-4 mm high, 4-5 mm wide, involucres short-campanulate; ray flowers ca. 8-12, ligules white, 2-5 mm long, oblong; disc corollas yellow, often purple-tinged, 1.5-2.0 mm long, throats narrowly campanulate-funnelform; achenes 1.5-1.8 mm long, narrowly obovate to oblong-ovate, with callous margins, the margins and faces short-pubescent; pappus of a prominent crown of squamellae and 2 (rarely 1) unequal, delicate bristles, the longest 0.5-1.0 mm long; chromosome number, unknown.

Sierra Madre Occidental of Chihuahua and Sonora. Flowering Aug-Nov, and probably in the spring also. (Fig. 3).

REPRESENTATIVE SPECIMENS:

Mexico: CHIHUAHUA. *Damon* s.n. (UC); Guicorichi, Rio Mayo, *Gentry* 1973 (ARIZ, UC, US); near Batopilas, *Goldman* 215 (GH, NY, US); Madrono Mine, ca. 5 km NW of Pinos Altos, *Hewitt* 171 (GH); Guayanopa Canyon, Sierra Madre, *Jones* s.n. (POM, US); Santa Clara Mts., *LeSueur* 340 (ARIZ, CAS, GH, LL, TEX, UC); Mapula Mts., *Pringle* 764 (LL, NY, RSA, UC, US). SONORA. La Mesa Colorado, *Gentry* 541, 541m (ARIZ, DS); Sierra de Papas, *Gentry* 630 (DS).

Everly (1947) treated *Perityle microcephala* as a synonym of *P. spilanthoides.* I have found, however, that *P. microcephala* represents a valid species, while *P. spilanthoides* is synonymous with the weedy variety of *P. microglossa.*

Perityle microcephala belongs with the group of white-rayed species which includes *P. turneri, P. peariloba,* and *P. microglossa.* All of these taxa are quite similar in achene, pappus, and most other floral characters, but *P. microcephala* is clearly delimited from *P. turneri* and *P. leariloba* by its capitulescence of small, tightly clustered heads, grayish pubescence, and is easily separated from *P. microglossa* by its pubescence and perennial habit. Overall morphological similarity and distributional considerations (Fig. 3) suggest that *P. microcephala* is most closely related to *P. microglossa. Pringle* 764 and *Gentry* 630, here ascribed to *P. microcephala,* approach *P. microglossa* in vegetative characteristics.

9. **Perityle microglossa** Benth. Bot. Sulph. 119. 1844. TYPE: **Nicaragua** (?): Realejo, Nicaragua (?), 1837, *R. B. Hinds* (K!).

9a. **Perityle microglossa** var. **microglossa**

Perityle acmella Harv. & Gray, Mem. Amer. Acad. II. 4: 77. 1849. TYPE: **Mexico:** "California", *Coulter* 278 (Holotype, GH!; isotypes, NY!).

Galinsogeopsis spilanthoides Schultz-Bip. in Seem. Bot. Herald 307. 1856. TYPE: **Mexico:** SINALOA: Sierra Madre, 1849, *B. Seeman* 1982 (Lectotype, K!). LECTOPARATYPE: same data, *B. Seeman* 1981 (K).

Pericome spilanthoides Benth. & Hook. ex. Hemsl. Biol. Centr. Amer. Bot. 2: 215. 1881.

Perityle microglossa var. *effusa* A. Gray, Syn. Fl. N.

Amer. **1**: 332. 1884. TYPE: **Arizona:** Santa Catalina Mts., 5 June 1882, *C. G. Pringle* (Holotype, GH!; fragment, US!; isotype NY!).

Perityle effusa Rose, Contr. U.S. Nat. Herb. **1**: 104. 1891. TYPE: **Mexico:** SONORA: Alamos, 26 Mar.-8 Apr. 1890, *E. Palmer* 350 (Lectotype, US!; isolectotypes GH!, NY!). LECTOPARATYPE: same data, *E. Palmer* 377 (US!); isolectoparatypes, (GH, NY!).

Perityle spilanthoides (Schultz-Bip.) Rydb. N. Amer. Fl. **34**: 17. 1914.

Plants weedy, herbaceous annuals, 20-60 cm high, erect or decumbent, mostly branching above the base, stems few or many, upper portions, especially peduncles, copiously glandular-puberulent, rarely merely puberulent with few glandular hairs; leaves opposite or alternate, mostly opposite, puberulent, glandular-puberulent or glabrous, often turning purplish, (2.0) 3.0-7.0 (10.0) cm long, (1.5) 2.0-5.0 (9.0) cm wide, extremely variable in size and shape, cordate, ovate, broadly ovate-cordate to subreniform, or subdeltoid, the margins merely singly or doubly crenate-even or irregular, to strongly 3-lobed or cleft, pedately divided, or subhastate; petioles 0.5-3.0 (4.0) cm long; capitulescence of 1-3 or many heads clustered on relatively short peduncles 0.6-3.5 (6.0) cm long; heads radiate, 3.5-4.5 (6.0) mm high, 4.0-6.5 (7.0) mm wide, involucres campanulate; ray flowers 6-12, ligules white, 1.5-3.5 mm long, oblong; disc corollas yellow, 1.2-2.2 mm long, throats tubular-funnelform; achenes 1.5-2.0 mm long, linear-oblong to linear-elliptic, rarely very narrow and short obovate, with thin to prominent callous margins, the margins ciliate, the faces glabrous or puberulent; pappus of a crown of squamellae and 2 unequal bristles, the longest 0.8-1.2 mm long; chromosome numbers, $n = 34, 51$.

Rather widespread weed of northwestern Mexico, most common in Sonora, Sinaloa, and Baja California Sur, ranging south to Colima, seemingly introduced in northeastern Mexico and extreme south Texas. Flowering probably year around. (Fig. 3).

REPRESENTATIVE SPECIMENS:

MEXICO: **Baja California Sur.** San Jose del Cabo, *Anthony* 326 (CAS, DS, GH, POM, UC, US); ca. 6 km NW of Mira Flores, *Carter* 2663 (DS, UC, US); Arroyo de los Pozos, *Moran* 6886 (SD); La Paz, *Palmer* 92 (CAS, GH, NY, US); Boca de la Sierra, *Powell and Sikes* 1672 (SRSC, TEX); 1 mi N of Pescadero, *Powell and Sikes* 1676 (SRSC, TEX); vicinity of San Jose del Cabo, *Wiggins* 5689 (DS, NY, UC, US). **Chihuahua.** Tres Hermanos, SW of Batopilas, *Hewitt* 36 (GH). **Colima.** Colima, *Orcutt* 4551 (DS). **Nayarit.** Acaponeta, *Jones* s.n. (POM, UC); San Blas, *Maltby* 22 (US); Maria Magdalena Islands, *Maltby* 175 (NY, US); Tepic, *Palmer* s.n. (US). **San Luis Potosi.** near waterfall at El Salto, *King* 3877 (NY, TEX, UC, US); from San Luis Potosi to Tampico, *Palmer* 1093 (GH, NY, US). Sinaloa. Culiacan, Brandegee s.n. (UC); ca. 64 mi S of Culiacan, *Breedlove* 1545 (DS); Imala, *Gentry* 5455 (ARIZ, DS, NY, UC); San Blas, *Jones*, s.n. (CAS, NY, POM, UC); Lodiego, *Palmer* 1614 (GH, NY); 56 mi NW of Mazatlan, *Powell and Sikes* 1682 (SRSC, TEX); Rio del Fuerte, near El Fuerte, *Rose, Standley and Russell* 13587 (NY, US); vicinity of Villa Union, *Rose, Standley and Russell* 13932 (NY, US); ca. 5 mi E of Costa Rica, *Sikes and Babcock* 192 (SRSC, TEX); 70 mi S of Mazatlan, *Sikes and Babcock* 206 (SRSC, TEX). **Sonora.** 15 mi NE of Alamitos, Rio San Miguel, *Abrams* 13357 (DS); Hermosillo, *Brandegee* s.n. (DS, GH); 12 mi W of Navojoa, *Gentry* 7950 (UC, US); Alamos, *Palmer* 673 (US); Rio Mayo, Navojoa, *Sikes and Babcock* 177 (SRSC, TEX); 2.4 mi N of Soyopa, *Sikes and Babcock* 157 (SRSC, TEX); 23 mi E of Navojoa, *Sikes and Babcock* 185 (SRSC, TEX). **Zacatecas.** near San Juan Capistrano, *Rose* 2427 (NY, US). U.S.A.: **TEXAS:** Cameron Co. Rio Hondo, *Chandler* 7007 (US); E of Rio Hondo, *Clover* 1742 (ARIZ, TEX); Laguna Atacosa Refuge, *Fleetwood* 6069 (TEX). Willacy Co. Sauz Ranch, *Johnston* 53, 280 (TEX).

The type locality originally given for *Perityle microglossa*, Realejo, Nicaragua, is probably in error. The southern-most collection I have seen was from Colima, Mexico (Fig. 3), and it seems likely that the species would have been collected again in Nicaragua or in intermediate localities if it were there. The type locality probably was San Blas, Nayarit, which also was visited during the Voyage of the Sulphur and where *P. microglossa* is known to occur. According to Rogers McVaugh (personal communication), the localities of many other Sulphur collections were mixed up in similar fashion.

The variable nature of *Perityle microglossa* is evident from the synonymy and from Everly's (1947) confused treatment of the taxon. The current studies have led to the recognition of two biological entities within *P. microglossa.* One is var. *microglossa* (Fig. 3), a widespread, weedy polyploid ($n = 34, 51$), and the other is var. *saxosa* (Fig. 3), a more restricted "native" diploid ($n = 17$). Greenhouse tests utilizing numerous collections of var. *microglossa* have shown that it is self-compatible and that it reproduces prolifically by seed. Only a few such tests have been conducted with var. *saxosa,* but all have indicated self-incompatibility for the diploid taxon. The morphological characters which distinguish the two varieties are not entirely consistent, and several morphological intermediates, for which chromosome numbers are not known, are found among existing collections. Variety *microglossa* typically exhibits shorter ligules, glandular-pubescent and shorter peduncles, tighter capitulescences, and a weedy habit, as compared to var. *saxosa* that usually displays longer ligules, rather smooth and longer peduncles, more lax capitulescences, and a "native" habit.

Morphologically, *Perityle microglossa* (particularly var. *saxosa*) is close to *P. microcephala.* Considering the evidence presented for these two species, it can be postulated that *P. microglossa* evolved from the montain-dwelling *P. microcephala* through derivation of annual habit and adaptation to soil habitats. Variety *microglossa* must have evolved in response to polyploidization and development of reproductive self-compatibility which allowed for its "weedy" proliferation.

Additional studies of *Perityle microglossa* var. *saxosa,* as well as *P. microcephala,* are most desirable. If var. *saxosa* proves to be a "native," diploid, and self-incompatible progenitor of var. *microglossa,* then perhaps specific status should be accorded the latter taxon.

9b. **Perityle microglossa** var. **saxosa** (Brandeg.) Powell, comb. nov.

Perityle saxosa Brandeg. Zoe **5:** 225. 1905. TYPE: **Mexico:** SINALOA: vicinity of Culiacan, Cerro Colorado, 5 Nov. 1904, *Brandegee* (Holotype, UC!; isotypes, GH!, POM!, US).

Perityle urticifolia Rydb. N. Amer. Fl. **34:** 15. 1914. TYPE: **Mexico:** SINALOA: Tepic, 5 Jan.-6 Feb. 1892, *E. Palmer* 1960 (Holotype, NY!; isotypes, GH!, UC!, US!).

Plants herbaceous annuals, possibly rarely weak perennials, 15-50 cm high, erect, upper stems and peduncles sparsely to densely puberulent, rarely moderately glandular-puberulent; leaves opposite or alternate, mostly opposite, glabrous to puberulent, rarely glandular-puberulent, 2-6 (8) cm long, (1.0) 1.5-3.5 (5.0) cm wide; capitulescence usually open, of 1-3 heads on relatively long peduncles, 2-7 cm long; ligules 3.5-4.5 mm long; disc corollas 1.7-2.0 mm long; achenes 1.0-1.6 mm long; pappus bristles 2, unequal, the longest 1.0-2.0 mm long; chromosome numbers $n = 17$, 18.

Mostly in foothills and lower elevations, both sides of the Sierra Madre Occidental, perhaps most common in Chihuahua, Sonora, and Sinaloa. Flowering probably year around. (Fig. 3).

REPRESENTATIVE SPECIMENS:

MEXICO: **Chihuahua.** Temores, *Flyr* 60 (TEX); near Descanso, *Flyr* 77 (TEX); *Palmer* 238 (GH, NY, US). **Durango.** Tamazula, *Gentry* 5234 (ARIZ, DS, GH, NY, UC). **Nayarit.** 4 mi E of Jalcocotan on road to Tepic, *McVaugh* 12147 (US). **Sinaloa.** 68 mi N of Mazatlan, *Flyr* 128 (TEX); 4 mi S of La Cruz junction, on MEX 15, *Flyr* 122 (TEX); Cerro Colorado, *Gentry* 5468 (ARIZ, DS, NY, UC, US); Canyon de Tarahumare, Sierra Surotato, *Gentry* 7315 (GH, NY, US); road from Las Flechas to La Rastra, *Goldman* 323 (GH, NY, US); 30.4 mi E of Villa Union, *Powell and Turner* 1853 (SRSC, TEX). **Sonora.** just S of Jecori, *Drouet, Richards, and Lockhart* 3692 (DS, GH, NY); 18 mi NW of Campas, *Drouet, Richards, and Lockhart* 3704 (DS, GH); San Bernardo, Rio Mayo, *Gentry* 1255 (ARIZ, GH, UC); near Alamos, *Gentry* 4825 (ARIZ, DS, GH, NY); 12 mi SE of Colonia Oaxaca, *Hastings and Turner* 65-43 (ARIZ, DS, SD); Petaquilla Canyon, White 3320 (ARIZ, GH); La Vega Azul, SW of Cononia Morelos, *White* 4852 (ARIZ, GH, NY, US); 35 mi NE of Cajeme, on road to Tesopaco, *Wiggins* 6408 (DS, US).

The Hastings and Turner and the White collections from NE Sonora are tentatively assigned to var. *saxosa*, but their somewhat doubtful affinity with this taxon should be noted. The specimens have elongated achenes, approaching the fruit characteristics of *Perityle ciliata* and *P. coronopofolia*, and they are perennial. In vegatative features they are more like *P. microglossa*. Perhaps the unusual collections are from a relict population which is transitional between the shorter-achened (e.g., *P. microglossa*) and the longer-achened (e.g., *P. ciliata*) members of the white-rayed alliance. Again, however, as is the case with most of the poorly collected Sierra Madre taxa, further study is required.

10. **Perityle canescens** Everly, Contrib. Dudley Herb. 3: 393. 1949. TYPE: **Mexico:** SINALOA: Capadero, Sierra Tacuichamona, 12 Feb. 1940, *H. S. Gentry* 5588 (Holotype, DS!; isotypes ARIZ!, GH!, NY!, UC!, US!).

Plants low, suffruticose perennials, 6-15 cm high, densely leafed upper stems pilose; leaves opposite or alternate, pilose-hirsute to villous, 1.2-1.7 cm long, 0.5-0.9 cm wide, 3-pinnatifid with linear segments, ovate-cordate in outline, crisped; petioles 5-9 mm long; capitulescence essentially of solitary heads on short peduncles; heads radiate, 5-7 mm high, 6-8 mm wide, involucres broad campanulate; ray flowers ca. 10, ligules white, 2.5-3.5 mm long, oblong to broadly so; disc corollas yellow, becoming purple-tinged 2.5-3.0 mm long, throats broad tubular; achenes 2.0-3.5 mm long, oblong-oblanceolate and nearly truncate on both ends, with thick callous margins, the margins merely puberulent, faces evenly puberulent; pappus of a prominent crown of united, erose squamellae, and 2 very unequal, rather stout, bristles, the longest 1.5-2.3 mm long; chromosome number, unknown.

Known only from the type collection.

Perityle canescens is related to *P. coronopifolia* from which it is distinguished by habit; dense indument; tendency for solitary heads; leaf morphology; thickly calloused achenes with short-pubescent margins; strong, more or less united crown of pappus squamellae; stout pappus bristles; and distribution.

Two other species, *Perityle ciliata* and *P. hofmeisteria* are grouped with the above taxa in the white-rayed alliance, largely on the basis of their similar floral characteristics (particularly achene and pappus). In habit and achene shape, *P. canescens* resembles *P. lemmoni* (sect. *Laphamia;* Powell, 1973), but the former taxon obviously belongs with sect. *Perityle* on the basis of its pappus crown.

11. **Perityle ciliata** (L. H. Dewey) Rydb. N. Amer. Fl. 34: 17. 1914.

Laphamia ciliata L. H. Dewey, Bot. Gaz. **20:** 425. 1895. TYPE: **Arizona:** rocks along Pine Creek near Pine, Ariz., 26 Aug. 1891, *D. T. MacDougal* 676 (Holotype, US!; isotype, US!).

Plants suffruticose perennials, 15-30 cm high, many-stemmed, erect to pendulous, densely short-pubescent above; leaves opposite or alternate, densely gray-pubescent underneath, pubescent to puberulent on upper surfaces, 0.8-2.0 (3.0) cm long, 0.6-1.3 (2.4) cm wide, deltoid-ovate to ovate-rhombic, the marigns serrate, shallow-lobed, or serrate-crenate; capitulescence of several heads clustered on short peduncles; heads radiate, 5-7 mm high, 5.5-7.0 mm wide, involucres campanulate; ray flowers ca. 6-10, ligules white, 3-6 mm long, broadly oblong to oblong-elliptic; disc corollas yellow, often purple tinged, 2.0-2.5 (3.0) mm long, throats tubular to tubular-funnelform; achenes 2.0-2.8 mm long, linear-oblong, with prominent callous margins, the margins long-ciliate, the faces slightly angled and pubescent; pappus of a crown of squamellae and 2 (rarely 3) slender bristles, 1.5-2.0 (2.5) mm long; chromosome number, $n = 17$.

Restricted in distribution to the mountains of central Arizona; rock-dwelling. Flowering spring, summer, and fall. (Fig. 3).

REPRESENTATIVE SPECIMENS:

Arizona: APACHE CO.: Springerville, *McGinnies* (ARIZ). COCONINO CO.: Long Valley, Coconino Natl. Forest, Coconino Rec. Crew 492

(US); Oak Creek, W of Troutdale, *Goodding* 198-47 (ARIZ, SMU); 4 mi W of Strawberry, *Sikes* 99 (SRSC, TEX). GILA CO.: Barnhart Pass, Matzatzal Mts., *Collom* 102 (GH, NY, US); Fossil Creek Hill, *Collom* 594 (US); Parker Creek Canyon, Sierra Ancha Mts., *Gould* 3632 (ARIZ, CAS, UC); Workman Creek Falls, Sierra Ancha, *Johnson* (ARIZ); Peterson Ranch, Sierra Ancha, *Pase* 1306 (ARIZ); 5.8 mi W of Strawberry, *Sikes and Patterson* 427 (SRSC, TEX). MOHAVE CO.: Hualapai Mts., *Braem* (DS); trail to Potato Patch, Hualapai Mts., *Braem* 875 (DS). YAVAPAI CO.: near Senator Mine, along road from Prescott, *Eastwood* 16721 (CAS); between Prescott and Ash Fork, Eastwood 16770 (CAS); Groom Creek, mts. near Prescott, *Kearney and Peebles* 9750 (ARIZ, UC); near Granite Dells, vicinity of Prescott, *Kearney and Peebles* 12780 (ARIZ, GH, NY, US); Prescott, *Peebles, Harrison, and Kearney* 2645 (ARIZ, US).

This species is clearly related to *P. coronopifolia* from which it is conveniently delimited by leaf shape.

12. **Perityle coronopifolia** A. Gray, Pl. Wright. 2: 82. 1853. TYPE: **New Mexico**: GRANT CO.: copper mines of Santa Rita del Cobre, Sept., 1851, *C. Wright* 1196 (Holotype, GH!; isotypes, NY!, US!).

Laphamia coronopifolia (A. Gray) Hemsl. Biol. Centr. Amer. Bot. 2: 210. 1881.

Laphamia scopulorum M. E. Jones, Contr. West. Bot. 12: 48. 1908. TYPE: **Mexico**: CHIHUAHUA: Colonia Juarez, 6000 ft., 12 Sept. 1903, *M. E. Jones* (Holotype, POM!; fragment, US!).

Plants low, suffruticose perennials, 6-36 cm high, erect or pendulous, many-stemmed, very leafy, grayish-pubescent; leaves opposite or alternate, puberulent to densely so, or nearly glabrous, 0.7-2.5 (3.5) cm long, 0.5-1.2 (2.0) cm wide, 3-palmate and lobed with slender-spathulate segments; pedately divided, or delicately 2,3-pinnatifid with linear-filiform segments; petioles 2-8 (12) mm long; capitulescence of several heads clustered on short peduncles; heads radiate, 5.0-6.5 mm high, 5-6 mm wide, involucres campanulate; ray flowers ca. 8-12, ligules white, 3-7 mm long, broadly oblong, oblong-elliptic, to subspathulate; disc corollas yellow, often purple tinged, 2.0-2.8 mm long, throats tubular, tubular-funnelform, or tubular-campanulate; achenes 1.8-2.5 mm long, linear-oblong to narrowly oblanceolate, with thin or prominent callous margins, the margins typically long-white ciliate, rarely short ciliate, the faces slightly angled and glabrous or pubescent; pappus of a crown of squamellae and 2 (rarely 3) slender bristles, 1.5-2.5 mm long; chromosome number, $n = 17$.

Rather widsepread and common in southern New Mexico-Arizona, and rare in northern Chihuahua, Mexico; rock dwelling. Flowering spring, summer, and fall. (Fig. 3).

REPRESENTATIVE SPECIMENS:

MEXICO: **Chihuahua.** near Colonia Juarez, 6000 ft, Sierra Madres, *Jones* (POM, US).

U.S.A.: **Arizona:** COCHISE CO.: Miller Canyon, Hauchuca Mts., *Barneby* 5172 (CAS, NY); Ramsey Canyon, Huachuca Mts., *Goodding* 758 (GH, NY, RSA). GRAHAM CO.: Fry Canyon, Pinaleno Mts., *Shreve* 4365 (ARIZ); Graham Mt., *Thronber and Shreve* 7783 (ARIZ). GREENLEE CO.: Mts. back of Clifton, *Greene* (NY); San Francisco Mts., *Greene* (POM); 0.5 mi N of Metcalf, *Maguire, Richards and Moeller* 11822 (ARIZ, GH, NY, US). PIMA CO.: Spud Ranch, Rincon Mts., *Blumer* 3331 (ARIZ, DS, GH, UC); north slope Baboquivari Peak, *Clark* 12565 (GH); San Pedro Vista, Santa Catalina Mts., *Parker* 8096 (ARIZ, NY, RSA, US); below Goose-Head Rock, Mt. Lemmon, *Sikes* 95 (SRSC). SANTA CRUZ CO.: Flux Canyon, Patagonia Mts., *Kearney and Peebles* 10193 (ARIZ, US); Nogales to Ruby, *Kearney and Peebles* 14961 (ARIZ, GH, NY). **New Mexico:** DOÑA ANA CO.: W side, Organ Mts., *Dunn* 7274 (NMC, RSA); E peaks, Organ Mts., *Powell* 1393 (SRSC); Dripping Springs Canyon, Organ Mts., *Sikes* 108 (SRSC). OTERO CO.: Dry Canyon, *Rehn and Viereck* (US). SOCORRO CO.: Mogollon Creek, Mogollon Mts., *Metcalf* 323 (NMC, NY, UC, US); Gila Hot Springs, Mogollon Mts., *Metcalf* 828 (POM, UC, US).

Perityle coronopifolia is closely related to *P. ciliata*, from which it is best distinguished by leaf shape. The species also has affinity with *P. canescens*. Both *P. coronopifolia* and *P. canescens* have lobed leaves which are technically distinguishable, and they are further delimited by the long white-ciliate achene margins, clustered heads, pubescence, and distribution.

The principal distribution of *Perityle coronopifolia* is in southern Arizona and New Mexico. The one known Mexican collection, originally described as *Laphamia scopulorum*, is considered to be a morphological variant. The *Jones* specimens from near Colonia Juarez are both of poor quality but show delicate pinnatifid leaves, short-pubescent achene margins, and inconspicuous pappus squamellae. These two fruit characteristics indeed approach those of Laphamian taxa (Powell, 1973), but the strong indication of its relationship with the Peritylean *P. coronopifolia* suggests its correct placement with the latter species.

13. **Perityle hofmeisteria** Rydb. N. Amer. Fl. 34: 18. 1914. TYPE: **Mexico:** DURANGO: vicinity of Durango, Apr.-Nov., 1896, *E. Palmer* 28 (Holotype, NY!; isotypes, GH!, US!).

Plants suffrutescent to herbaceous perennials (possibly also annuals), 12-25 cm high, puberulent; leaves opposite or alternate, puberulent, 1.0-5.5 cm long, 0.2-2.0 cm wide, ovate to subspathulate and entire to shallow-lobed, or ovate-cordate and serrate to serrate-lobed; petioles 0.5-2.0 (3.0) cm long; capitulescence of 1-3 heads borne on relatively short peduncles, 1.5-2.8 cm long; heads radiate, 6-7 mm high, 4-6 mm wide, involucres turbinate-campanulate; ray flowers ca. 10-12, ligules white, 4-5 mm long, oblong; disc corollas yellow, 2.5-3.0 mm long, throats tubular-funnelform; achenes 2.5-3.0 mm long, linear-oblong to narrowly obovate, with thin or thick callous margins, the margins prominently ciliate, the faces puberulent especially in the centers; pappus of a crown of squamellae and 2 subequal bristles, 2-3 mm long; chromosome number, $n = 16 \pm 1$.

Seemingly endemic in Durango, Mexico; probably rock-dwelling. Flowering spring-fall. (Fig. 3).

SPECIMEN EXAMINED:

Mexico: DURANGO: 3 mi N of Rodeo, *Flyr* 332 (TEX).

The *Flyr* 332 specimen, said by the collector to be "seemingly an annual," conforms to the types of *Perityle hofmeisteria* in floral but not in vegetative features. The main differences are in habit appearance and leaf shape. The species is poorly understood at present, but its affinity is with

P. ciliata and *P. coronopifolia* from which it is readily distinguished by leaf morphology and distribution (Fig. 3).

14. **Perityle jaliscana** A. Gray in S. Wats. Proc. Amer. Acad. 22: 431. 1887. TYPE: **Mexico:** JALISCO: Rio Blanco, ca. 10 mi NW of Guadalajara, 17-23 Sept. 1886, *E. Palmer* 554 (Holotype, GH!; isotypes, NY!, US(2)!).

Plants low, suffruticose perennials, 5-17 cm high, stems spreading, densely puberulent; leaves opposite or alternate, densely puberulent to nearly glabrous, 2.0-3.5 cm long, 0.8-1.8 (2.0) cm wide, deltoid, deltoid-rhombic, deltoid-ovate, or subhastate to subhalberd, usually 2-4 lobed proximally, rarely serrate-lobed; petioles 0.7-1.3 (1.7) cm long; capitulescence of 1-several heads clustered on short, slender peduncles; heads discoid, 5.0-6.5 mm high, 4-5 mm wide, involucres funnelform-campanulate; disc corollas cream-white and purple-tinged, 2.0-2.5 (3.0) mm long, throats tubular-campanulate; achenes 1.8-2.2 (2.8) mm long, oblong or nearly so, slightly tapering to the base, truncate, with prominent callous margins, rarely with 3-callous margins, angled on both faces, the margins and faces short-pubescent; pappus of a vestigial crown of squamellae, and 2 (3) slender bristles, 0.5-1.0 mm long, the bristles rarely flattened; chromosome number, $n = 17$.

Rock-dwelling endemic in Jalisco, Mexico. Flowering spring-fall. (Fig. 4).

SPECIMENS EXAMINED:

Mexico: JALISCO: ca. 40 km N of Guadalajara, road to San Cristobal de la Barranca, *McVaugh* 22114 (NY, SD); Sierra San Esteban, near Guadalajara, *Pringle* 2352 (GH, UC, US); Sierra de San Esteban, *Pringle* 15634 (ARIZ, CAS, LL, SMU, US); *Rose and Painter* 7476 (NY, US); 5 mi SW, by road, from San Cristobal de la Barranca, *Sikes and Babcock* 383 (SRSC, TEX).

Although relatively few collections of *Perityle jaliscana* are known, it is the best-collected of four closely related endemic species of Jalisco, Mexico. The others, *P. rosei*, *P. trichodonta,* and the recently described *P. feddemae*, are known only from type collections.

Fig. 4. Distribution of *P. jaliscana* (open circles); *P. rosei* (closed square); *P. trichodonta* (open square); *P. feddemae* (closed circle).

Perityle jaliscana and *P. feddemae* are the most distinct of the four species. I have followed Everly (1947) in recognizing *P. rosei* and *P. trichodonta,* even though future collections might indicate that they should be merged as a single species. Furthermore, both *P. rosei* and *P. trichodonta* might simply be ecological variants of *P. jaliscana.* I recognize the four species at this time mainly to preserve taxonomic consistency. In all three sections of the genus *Perityle* there are groups of closely related species that are no more distinctive than are the Jalisco endemics. In Jalisco, *P. feddemae,* with its dissected leaves, seems to be quite distinct, and it was recently discovered in a locality not far from the other species (Fig. 4). Strict endemism is common among the rock-dwelling taxa of *Perityle,* and lacking evidence to the contrary, I think it possible that the taxa in question are endemic species.

Perityle jaliscana is most closely related to *P. rosei.* Most of its distinctive features, such as discoid heads, smaller, oblong achenes, shorter pappus bristles and squamellae, subhastate leaves, and short, dense pubescence, appear as if they could have been derived from *P. rosei.*

15. **Perityle rosei** Greenm. Proc. Amer. Acad. **40:** 45. 1905. TYPE: **Mexico:** JALISCO: in the Sierra Madre W of Bolanos, 15-17 Sept. 1897, *J. N. Rose* 2947 (Holotype, US!; isotypes, GH!, NY!).

Plants suffruticose perennials, 10-20 cm high, stems erect or spreading, densely short-pilose; leaves opposite or alternate, short-pilose to puberulent, 1.8-3.0 cm long, 1.0-1.5 (2.0) cm wide, deltoid to deltoid-ovate or deltoid-rhombic, rarely subhastate, the margins entire or nearly so; petioles 5-9 mm long; capitulescence of 1-several heads on short peduncles; heads radiate, ca. 5 mm high, 4-5 mm wide, involucres campanulate; ray flowers ca. 13, ligules white, 2.0-2.5 mm long; disc corollas cream-white and purple-tinged, 2.0-2.3 mm long, throats tubular-campanulate; achenes 2.0-2.5 mm long, narrowly obdeltoid, with prominent callous margins, slightly angled on both faces, the margins and faces puberulent to subglabrous; pappus of a short crown of squamellae, more or less united, and 2 (3-4) slender bristles, 1.5-2.0 mm long, the 3-4 bristles, if present, reduced in length; chromosome number, unknown.

Known only from the type collection. (Fig. 4).

Perityle rosei is best delimited from *P. jaliscana* by its radiate heads, nearly obconical achenes, longer crown of pappus squamellae and longer bristles, nearly deltoid, subentire leaves, and longer, less dense pubescence.

16. **Perityle trichodonta** Blake, Proc. Biol. Soc. Wash. 37: 60. 1924. TYPE: **Mexico:** JALISCO: Sierra Madre W of Bolanos, 15-17 Sept. 1897, *J. N. Rose* 2978 (Holotype, US!; isotype, GH!).

Plants low, suffruticose perennials, ca. 10 cm high, many-stemmed and spreading, densely gray-pubescent above; leaves mostly opposite, densely hirtellous-pilose and grayish, 7-9 mm long, 2.5-5.0 mm wide, ovate to ovate-rhombic and subhastate; petioles 2-4 mm long; capitulescence of 1-several heads clustered on short peduncles; heads radiate, ca. 4.5 mm high, ca. 4 mm wide, involucres funnelform-campanulate; ray flowers ca. 8, ligules white, 1.0-1.5 mm long; disc corollas cream-white and purple-tinged, 2.0-2.5 mm long, throats tubular-campanulate; achenes 1.5-2.2 mm long, narrowly obdeltoid, with prominent callous margins, slightly angled on both faces, the margins and faces puberulent to subglabrous; pappus of a short crown of squamellae, more or less united, and 2 slender bristles, 1.5-2.2 mm long, chromosome number, unknown.

Known only from the type collection. (Fig. 4).

Perityle trichodonta looks as though it could be a small-leafed, more densely pubescent, shorter liguled form of *P. rosei*, but it does differ in the characters listed. Future collections might reveal that *P. trichodonta* should be merged with *P. rosei*.

17. **Perityle feddemae** McVaugh, Contr. Univ. Mich. Herb.

9: 431-433. 1972. TYPE: **Mexico:** JALISCO: Rancho Viejo, ca. 10 km ENE of Huejuquilla el Alto, rock-crevices, open oak-woodland, elev. 1900 m, 31 Oct. 1963, *Feddema* 2278 (Holotype, MICH; isotype, SRSC!).

Plants suffruticose perennials, 10-25 cm high, stems spreading, puberulent; leaves mostly opposite, puberulent, glandular-dotted, 1.7-3.5 cm long including petioles, dissected-pinnatifid with linear-spatulate segments; capitulescence of 1-3 heads on short, slender peduncles; heads discoid, 5-6 mm high, 3-5 mm wide, involucres funnelform-campanulate; disc corollas pale yellow, 2.3-2.8 mm long, throats tubular-campanulate; achenes 2-3 mm long, oblong-oblanceolate, with prominent callous margins, angled on both surfaces, the margins and faces short-pubescent; pappus of a short crown of squamellae and 2 slender, unequal bristles, ca. 1.0 mm long; chromosome number, unknown.

Known only from the type collection. (Fig. 4).

This taxon possibly is most closely related to *Perityle jaliscana* that also has discoid heads, but its dissected leaves mark it as the most distinctive of the Jalisco endemics.

18. **Perityle parryi** Gray, Pl. Wright. 2: 106. 1853. TYPE: **Texas:** Canyon of the Rio Grande, Aug. 1852, *C. C. Parry* 521 (Isotype, NY!).

Laphamia parryi (Gray) Benth. & Hook. ex Hemsl. Biol. Centr. Amer. Bot. 2: 210. 1881.

Leptopharynx trisecta Rydb. N. Amer. Fl. 34: 23. 1914. TYPE: **Mexico:** CHIHUAHUA: dry cliffs, rocky hills near Chihuahua, 20 Mar. 1885, *C. G. Pringle* 183 (Holotype, NY!; isotypes, DS!, GH!, UC!, US!).

Plants low, woody-based perennials in crevices of rocks or tall, spreading, herbaceous to suffruticose perennials in soil, 10-75 cm high; leaves opposite or alternate, glandular-pubescent, 2-6 (9) cm long, 0.8-4.0 (6.0) cm wide, cordate to subreniform in outline, margins irregularly lobed, dentate, or laciniate, but typically shallow to deeply 3-lobed, and in some specimens even subcruciform; petioles 1.2-

Fig. 5. Distribution of *P. parryi* (open triangles); *P. vaseyi* (closed triangles); *P. aglossa* (open squares); *P. cordifolia* (closed circles); *P. leptoglossa* (closed squares); *P. lloydii* (open star); *P. lobata* (closed stars); *P. palmeri* (open circles).

4.0 cm long; capitulescence of 1-3 heads borne on peduncles 1-7 cm long; heads radiate (rarely discoid), 0.8-1.0 cm high, 0.7-1.4 cm wide, involucres hemispherical to campanulate; bracts numerous, lanceolate to linear, rarely oblanceolate, acute to attenuate at the apex; ray flowers ca. 12-16 (rarely 1-6), ligules yellow, oblong, showy; disc flowers numerous, corollas yellow, (3.2) 4-6 mm long, throats tubular; achenes (2) 3-4 mm long, linear-elliptic to obconical-elliptic, with thin to prominent callous margins, the margins short-pubescent to dense-pilose, faces pubescent; pappus of a crown of squamellae, and 1 (rarely 0 or 2) barbellate bristle, (1.0-2.5) 3-6 mm long, typically tapering to a point, the barbs typically antrorse throughout, rarely becoming lateral or retrorse toward the tip; chromosome number, $n = 17$.

Western Big Bend area of Texas and adjacent Mexico; occurring in rocks and soils. Flowering essentially year around. (Fig. 5).

REPRESENTATIVE SPECIMENS:

MEXICO: **Chihuahua.** 11 mi NE of Camargo, *Johnston* 7920 (GH); road to San Carlos Mines, *Johnston and Muller* 39 (GH); 12 mi S of Ojinaga, *Johnston and Muller* 1443 (GH); near new lake on Rio Conchos, *Powell, Turner, and Magill* 2030 (SRSC, TEX); rocky hills near Chihuahua, *Pringle* 183 (DS, GH, NY, UC, US); 1 mi E of km 100, Ojinaga-Camargo road, *Sikes and Patterson* 397 (SRSC, TEX); 20 km N of Chihuahua, *Stewart and Johnston* 2119 (GH). U.S.A.: **Texas:** Brewster Co. Lost Mine Peak, Chisos Mts., *Correll and Johnston* 24540 (LL); Green Valley Ranch, *Correll and Wasshausen* 27825 (LL); Agua Fria Spring, *Cory* 18638 (GH); Santa Helena Canyon, *Cory* 26475 (US); N side Whirlwind Spring area, 02 Ranch, *Fletcher* 1143 (SRSC); Packsaddle Mt., *McAfee* 261 (SRSC); Chisos Mts., *Muller* 8247 (GH, NY, US, TEX); lower Window Trail, Big Bend Park, *Powell and Sikes* 1528 (SRSC, TEX); Basin, Chisos Mts., *Sikes* 32 (SRSC, TEX); Boot Springs Trail, *Sikes* 116 (SRSC, TEX); Nine-Point Mesa, *Warnock and Johnston* 17670 (SRSC); Rosillos Mts., *Warnock* 20603 (SRSC). Presidio Co. S edge of Presidio, *Correll and Johnston* 21867 (LL); 10 mi SE of Redford, *Correll and Johnston* 21898 (LL); Casa Piedra road, 20 mi S of Marfa, *Cox* s.n. (SRSC); Capote Creek, *Havard* s.n. (US); near Cottonwood Springs, Sierra Tierra Vieja, *Hinckley* 1850 (GH, NY, US); ca. 9 mi N of Lajitas, *Powell* 1243 (SRSC); 5 mi S of Redford, *Powell, Sikes, and Watson*

1396 (SRSC); 12 mi S of Redford, *Powell, Sikes, and Watson* 1398 (SRSC); 3 mi E of Ruidosa, *Powell and Brey* 1513 (SRSC); Capote Creek, ca. 1 mi below Capote Falls, *Powell* 1518 (SRSC).

The three yellow-flowered species of west Texas and adjacent Mexico (Fig. 5), *Perityle parryi, P. vaseyi,* and *P. aglossa,* are morphologically similar. *Perityle parryi* and *P. vaseyi* are particularly close and somewhat confusing taxonomically, primarily because of intermediate leaf forms and uncertain distributional integrity.

Perityle parryi occurs as a rock-dwelling subshrub and as a soil-dwelling perennial, typically with leaves that are merely 3-lobed. *Perityle vaseyi* is a soil-dwelling, taprooted perennial, with deeply trisected leaves. However, some Mexican populations of *P. parryi* (= *L. trisecta*) have deeply trisected leaves, as do some soil-dwelling Texas forms, and it is not always possible to distinguish the taxa by leaf morphology. *Perityle parryi* is further delimited by long-tapering pappus bristles (one per achene) which are antrorsely barbellate, bracts usually lanceolate or linear and somewhat attenuate, and disc corollas with usually narrowly tubular throats, as opposed to *P. vaseyi* with shorter pappus bristles that are retrorsely barbellate at the tips, bracts usually oblanceolate and acute, and more broadly tubular disc corollas.

It is suspected that the soil-dwelling forms of *Perityle parryi* and *P. vaseyi* may occasionally hybridize. Any hybridization, however, would be difficult to detect morphologically. It is not known whether the leaf variability of *P. parryi* is intrinsic or whether it might be the result of hybridization with *P. vaseyi.* In spite of marginal sympatry (Fig. 5), mixed populations of the two species have not been found, and no clear-cut hybrids have been detected. The subject is under experimental study.

The populations of *Perityle parryi* near Ruidosa, Texas, in the Sierra Vieja and one collection 12 mi S of Ojinaga (*Johnston and Muller* 1443) are notably anomalous. Their pappus bristles are short and have retrorsely barbed tips, resembling those of *P. vaseyi.* In addition, the Sierra Vieja populations may be nearly rayless or entirely discoid. In other morphological characters the anomalous populations conform with *P. parryi*. The discoid forms should not be confused with *P. aglossa*, which is always rayless.

19. **Perityle vaseyi** Coult. Contr. U. S. Nat. Herb. **1**: 42. 1890. TYPE: **Texas:** BREWSTER CO. Chisos Mts., 1889, *G. C. Nealley* (245?), (Holotype, US!).

Plants perennial with fleshy taproots, (10) 15-75 cm high, herbaceous to suffruticose, stems erect or spreading; leaves opposite or alternate, glandular-pubescent, 2.5-6.5 cm long, 2-5 cm wide, typically palmately divided into 3 lobes or subcruciform, with the lobes also dissected, cleft, or parted, rarely the leaves are strongly 3-lobed, cleft, or parted; petioles 1.4-3.5 cm long; capitulescence of 1-3 heads borne on peduncles 1-8 cm long; heads radiate, 0.8-1.0 cm high, 1.0-1.3 cm wide, involucres hemispherical to campanulate; bracts numerous, oblanceolate to linear-lanceolate, typically acute, less often alternate at the apex; ray flowers ca. 14-16, ligules yellow, oblong, showy; disc flowers numerous, corollas yellow, 3.2-5 (6) mm long, throats tubular to broadly so; achenes (2.0) 3.0-4.0 mm long, linear-elliptic to obconical-elliptic, with thin to prominent callous margins, the margins short-pubescent to dense pilose, faces pubescent; pappus of a crown of squamellae, and 1 (rarely 0 or 2) barbellate bristle, 1.5-4.0 mm long, typically truncate, the barbs retrorse or lateral toward the tip; chromosome number, $n = 17$.

Desert soils, especially gypsiferous clay, southwestern Big Bend area of Texas and adjacent Mexico. Flowering essentially year around. (Fig. 5).

REPRESENTATIVE SPECIMENS:

MEXICO: **Chihuahua.** 6.5 mi S of Ojinaga, *Powell, Turner, and Magill* 2002 (SRSC, TEX); 5 mi S of Ojinaga, *Powell, Turner, and Magill* 2079 (SRSC, TEX). Coahuila. Picachos Colorados, *Johnston and Muller* 141 (GH). U.S.A.: **Texas:** BREWSTER CO. petrified forest, *Cory* 2706 (GH); Hot Springs, *Cory* 6477 (POM); Glenn Springs, *Cory* 44014 (TEX); Terlingua Creek on 02 Ranch, *Fletcher* 917

(SRSC); 2-3 mi E of Terlingua, *Flyr* 16 (SMU, SRSC, TEX); 8 mi E of Lajitas, *Flyr* 19 (SMU, TEX); 1 mi SE of Terlingua, *Flyr* 180 (SMU, TEX); 2 mi SE of Hen Egg Mt., *Johnston and Warnock* 3656 (SRSC); top third of Packsaddle Mt., *McAfee* 184 (SRSC); 70 mi S of Alpine, *Powell and Sikes* 1530 (SRSC, TEX); 18 mi SE of Castolon, *Powell, Averett, and Watson* 1539 (SRSC, TEX); 0.4 mi N of Castolon, *Powell, Averett, and Watson* 1544 (SRSC, TEX); near Big Bend Tunnel, *Sikes* 39 (SRSC, TEX); near hwy. 118 entrance to Big Bend Park, *Sikes* 40 (SRSC, TEX); 7 mi E of Castolon, *Sikes and Averett* 330 (SRSC, TEX); road to Fisk Canyon, *Warnock* 1148 (SRSC); Avary Canyon, Big Bend Park, *Warnock* 9139 (SRSC); Big Bend Park, *Warnock and Wallmo* 12211 (SRSC); San Vicente, near the Rio Grande, *Young* s.n. (TEX).

As discused previously under Phylogenetic Considerations, an ancestral connection is hypothesized for *Perityle vaseyi* and its allies with the *P. crassifolia* group of Baja California. The primary evidence for this possible relationship are the similar habits and pappus bristles (with retrorsely barbed tips) of *P. vaseyi* and *P. crassifolia* and the chromatographic profiles with yellow compounds, common to both groups.

Morphologically, *Perityle vaseyi* and its relatives are closer to the *P. cordifolia* group of western Mexico. The distribution of the Texas species (Fig. 5) could have been achieved by migration from a Sierra Madre Occidental origin. The headwaters of the Rio Conchos are in the Sierra Madre near Creel, just across the divide from *P. cordifolia* country. The distribution of *P. parryi* near the Rio Conchos in eastern Chihuahua and the location of *P. vaseyi* and *P. aglossa* near the Rio Grande, suggest the possibility of eastern migration along the river systems.

20. **Perityle aglossa** Gray, Pl. Wright 2: 107. 1853. TYPE: **Texas:** Rio Grande below Presidio del Norte, Aug. 1852, *C. C. Parry* (Lectotype, GH!).

Laphamia aglossa (Gray) Benth. & Hook. ex Hemsl. Biol. Centr. Amer. Bot. 2: 210. 1881.

Leptopharynx aglossa (Gray) Rydb. N. Amer. Fl. 34: 24. 1914.

Plants woody-stemmed perennials in rock crevices, 15-45 cm high; leaves opposite or alternate, glandular-pubescent, 2-4 cm long, 0.6-2.3 cm wide, ovate, subcordate or subdeltoid, irregularly lobed, laciniate, or serrate-dentate, often shallow-3-lobed; petioles 0.8-2.3 cm long; capitulescence of 1-3 heads borne on peduncles 1.0-2.5 cm long; heads discoid, 8-11 mm high, 4-8 mm wide, involucres campanulate; bracts linear to linear-lanceolate, attenuated at the apex; disc flowers numerous, corollas yellow, typically pink- or purple-tinged, 4.2-6.0 mm long, throats tubular; achenes (2.0) 2.5-3.2 mm long, oblong-obconical, with prominent callous margins, the margins short-pubescent to dense-pilose, faces pubescent; pappus of a crown of squamellae and 1 (rarely 2) barbellate bristle, 3.7-5.5 mm long, tapering to a point, the barbs antrorse throughout; chromosome number, $n = 17$.

Restricted in southern Brewster Co. and Terrell Co., Texas, along and near the Rio Grande; crevices of limestone. Spring-fall. (Fig. 5).

REPRESENTATIVE SPECIMENS:

Texas: BREWSTER CO.: mouth of Regan Canyon on Rio Grande, *Hinckley and Warnock* 3737 (US, SRSC); near Boquillas, *Marsh* 306 (GH); near Big Bend Tunnel, *Sikes* 38 (SRSC); 4 mi W of Hot Springs, Big Bend Park, *Warnock and Turner* 8291 (SRSC); San Vicente Canyon, Big Bend Park, *Warnock and Parks* 8764 (LL, SMU, SRSC); limestone hills, Terlingua area, *Warnock* 13980 (SRSC); Heath Canyon, Black Gap Refuge, *Warnock* 20615 (SRSC); mouth of Regan Canyon, *Warnock and Hinckley* 461050 (SMU, SRSC, TEX). TERRELL CO.: mouth of San Francisco Canyon, *Surratt* 133 (SRSC); mouth of San Francisco Canyon, *Warnock and Surratt* 9817 (LL, SMU, SRSC); 9 mi E of Sanderson, *Warnock* 13155 (SRSC); along Rio Grande, between Regan Canyon and Sanderson Canyon, *Warnock* 15854 (SRSC).

Although only one type specimen is cited for *Perityle aglossa* (*Parry*, Aug. 1852), I have seen another specimen which probably came from Parry's original collection. At NY a sheet labeled "*P. aglossa*, Arroyo San Carlos, April 1852," displays specimens of both *P. aglossa* and *P. parryi*. Judging from present-day distributions of the species, I believe that the specimens were probably mixed after

Parry's collections were made. Furthermore, the *P. aglossa* specimen on the NY sheet probably was from the original collection and perhaps should be recognized as an isolectotype. The *P. parryi* specimen is discoid and probably came from the vicinity of Ruidosa above Presidio.

Perityle aglossa is a limestone-dwelling subshrub with good distributional integrity. In addition to habit and discoid heads, the species is distinguished from *P. parryi*, its closest relative, by subtle characters of the leaves, involucral bracts, and disc corollas.

21. **Perityle cordifolia** (Rydb.) Blake, Contr. U. S. Nat. Herb. 23: 1602. 1962.

Leptopharynx cordifolia Rydb. N. Amer. Fl. 34: 22. 1914. TYPE: **Mexico:** SINALOA: vicinity of Topolobampo, 23 Mar. 1910, *J. N. Rose, P. C. Standley*, and *P. G. Russell* 13294 (Holotype, NY!?; fragment of type, UC!; isotype, GH!).

Plants suffrutescent perennials, rather low and spreading or semi-pendulent, 10-20 cm high, stems strong but herbaceous except at the bases, pilose; leaves mostly alternate, bright green, pilose, 3.5-11.0 cm long, 1.5-9.0 cm wide, cordate to broadly so, veins prominent, the margins doubly serrate-dentate, rarely crenate; petioles 1.5-4.5 mm long; capitulescence of solitary heads borne on rather stout peduncles, 2.5-6.0 cm long; heads radiate, rarely cernuous, 10-12 mm high, 9-15 mm wide, involucres hemispherical to campanulate, typically truncate at the base; bracts 10-13 mm long, linear and attenuate; ray flowers numerous, ligules yellow, 9-15 mm long, oblong-elliptic; disc flowers numerous, corollas yellow, 5-7 mm long, throats tubular; achenes 2.5-3.0 mm long, narrowly oblong, with thin or prominent callous margins, the margins typically densely ciliate, rarely puberulent, faces glabrous or puberulent in the center; pappus of a crown of squamellae, ca. 0.5 mm or less, and a single bristle, 4-7 mm long, the bristle tapering from base, a fine tip and densely barbellate; chromosome number, $n = 17$.

A petrophilic, cliff-dwelling species, possibly also rooted in soils of shaded bluffs, Sonora and Sinaloa, Mexico. Flowering probably year around. (Fig. 5).

REPRESENTATIVE SPECIMENS:

Mexico: SINALOA: hill near Topolobampo, *Flyr* 63 (TEX); N of Topolobampo, *Flyr* 76 (TEX); road to Los Animas beach from Los Mochis, *Flyr* 105 (TEX); 23 mi N of Culiacan, *Flyr* 111B (TEX); Cerro Tecomate, W of Pericos, *Gentry* 5743 (ARIZ, DS, GH, NY, UC); ca. 1 mi E of Topolobampo, *Sikes and Babcock* 188 (SRSC, TEX); bluffs W of Topolobampo, *Sikes and Babcock* 190 (SRSC, TEX). SONORA: 32 mi N of Navojoa, *Flyr* 103 (TEX); Canyon Sapopa, Rio Mayo, *Gentry* 1282 (ARIZ, GH, NY, UC); Aquibiquichi, near Batacosa, *Gentry* 3003 (ARIZ, CAS, GH, UC, US); Cerro de Bayajori, 12 mi W of Navojoa, *Gentry* 7949 (UC, US); 23 km E of Navojoa, *Moran* 4032 (DS, SD, UC); 1-2 mi N of San Carlos Resort, *Powell and Sikes* 1689 (SRSC, TEX); 10 mi N of Guaymas, *Randle and Werner* 1 (ARIZ).

Perityle cordifolia belongs with a group of four other morphologically similar species; *P. palmeri, P. leptoglossa,* and *P. lloydii* also of northwestern (mainland) Mexico, and *P. lobata* of Baja California. In spite of their similarities, the taxa are rather clearly delimited by vegetative features, excepting *P. lloydii,* which has characters of the other three mainland species. I have grown all of the taxa except *P. lloydii* under identical conditions, and each did maintain its characteristic morphology.

Everly (1947) treated *Perityle cordifolia* as synonymous with *P. palmeri.* I recognize these taxa as related but certainly distinct species. In fact, the soil-dwelling *P. palmeri* could have evolved from the rock-dwelling *P. cordifolia,* but on morphological grounds, *P. palmeri* shares even closer relationship with *P. lobata. Perityle cordifolia* is readily delimited from *P. palmeri* by its woody habit; bright green, pilose, cordate leaves with prominent veins and doubly serrate margins; long ligules; long attenuate involucral bracts; long pappus bristles; and long style branches.

22. **Perityle leptoglossa** Harv. & Gray in A. Gray, Mem. Amer. Acad. II. 4: 77. 1849. TYPE: **Mexico:** SONORA: "vicinity of Hermosillo," 1829-1830, *Coulter* 277 (Holotype, GH!; fragment, US!).

Leptopharynx leptoglossa (Harv. & Gray) Rydb. N. Amer. Fl. 34: 22. 1914.

Plants shrubby, spreading or erect, 10-60 cm high, stems densely grayish-puberulent; leaves mostly alternate, densely puberulent, gray-green, 3.0-5.5 cm long, 1.3-3.5 cm wide, cordate to cordate-ovate, the margins shallow-lobed and crenate to serrate, or merely crenate-serrate; petioles 1.3-2.5 cm long; capitulescence of solitary heads borne on relatively stout peduncles, 2-5 cm long; heads radiate, rarely cernuous, 8-10 mm high, 7-12 mm wide, involucres campanulate-cylindroidal and truncate at the base; bracts 5-8 mm long, linear to linear-lanceolate and attenuate to subattenuate; ray flowers numerous, ligules yellow, 6-10 mm long, oblong to oblong-elliptic; disc flowers numerous, corollas yellow, 4-5 mm long, throats tubular; achenes (2.2) 2.5-3.0 mm long, narrowly oblong, with thin or prominent callous margins, the margins long- or short-ciliate, the faces glabrous or minutely pubescent at the center; pappus of a crown of squamellae less than 0.5 mm long, and a single bristle, 2.5-4.5 mm long, the bristle tapering from base to apex and densely barbellate; chromosome number, $n = 17$.

Strictly rock-dwelling, in the vicinity of Hermosillo, Sonora, Mexico. Flowering probably year around. (Fig. 5).

REPRESENTATIVE SPECIMENS:

Mexico: SONORA: 3 mi S of Magdalena, *Aleramo* 13216 (DS); rocky sides of El Cerro de la Campana, *Drouet, Richards and Alvarado* 3387 (DS, GH, NY); 6 km N of Hermosillo, *Drouet and Richards* 3757 (DS); San Miguel de Horcasitas, *Eisen* (UC); 41 mi N of Hermosillo, *Flyr* 96 (TEX); 26 mi S of Hermosillo, *Gentry* 4572 (UC); ca. 28 mi N of Hermosillo, *Powell and Averett* 1520 (SRSC, TEX); ca. 28 mi N of Hermosillo, *Powell and Sikes* 1683 (SRSC, TEX); near Hermosillo, *Ripley* 14309 (CAS); vicinity of Hermosillo, *Rose, Standley, and Russell* 12346 (NY, US); near Magdalena, *Shreve* (NY); near Estacion Torres, *Shreve* 6070 (ARIZ); 8 mi W of Hermosillo, *Wiggins and Rollins* 96 (DS, GH, NY); ca. 1 mi N of Torres, *Wiggins* 6266 (DS, GH, POM, US); 12 mi from Ures on road to Babiacari, *Wiggins* 7359 (DS, TEX, US).

The most distinctive features of *Perityle leptoglossa* are:

shrubby habit; leaf margins shallow-lobed or merely crenate-serrate; densely puberulent upper stems and leaves; small heads and short ligules; short bracts; achene margins typically short-ciliate; pappus bristles typically slender at bases. At one locality ca. 28 mi N of Hermosillo, I observed a few plants that were 2½ ft. high, the largest woody plants in the genus. The species is related to *P. palmeri* and *P. lloydii*.

23. **Perityle lloydii** Rob. & Fern. Proc. Amer. Acad. 30: 118. 1894. TYPE: **Mexico:** SONORA. Badehuachi, 2 Dec. 1890, *C. E. Lloyd* 400 (Holotype, GH!; isotypes, NY!, UC!, US(3)!).

Leptopharynx lloydii (Rob. & Fern.) Rydb. N. Amer. Fl. 34: 22. 1914.

Plants semishrubby, erect, 10-40 cm high, stems woody to herbaceous, pilose; leaves mostly opposite, pilose, 2.5-4.5 cm long, 1.5-2.5 cm wide, cordate to cordate-ovate, the margins doubly serrate; petioles 1.5-3.0 cm long; capitulescence of solitary heads borne on peduncles 2.0-3.5 cm long; heads radiate, rarely cernuous, 8-9 mm high, 6-7 mm wide, involucres campanulate-cylindroidal and truncate at the base; bracts 5-7 mm long, linear and attenuate; ray flowers numerous, ligules yellow, 5-8 mm long, oblong to oblong-elliptic; disc flowers numerous, corollas yellow, ca. 4 mm long, throats tubular; achenes ca. 3 mm long, narrowly oblong, the callous margins short-pubescent; pappus of a minute crown of squamellae (ca. 0.2 mm long), and a single bristle ca. 3 mm long, the bristle slightly tapering from base to apex and densely barbellate; chromosome number unknown.

Known only from the type collection. (Fig. 5).

Perityle lloydii is poorly delimited from the other mainland taxa of the *P. cordifolia* species-group. In leaf shape, pubescence, and achene morphology (short-pubescent margins and reduced pappus squamellae) *P. lloydii* resembles *P. cordifolia*. In shrubby habit, small heads, short ligules, and other floral characters, the taxon approaches *P. lepto-*

glossa. Its pubescence is like that of *P. palmeri*. Overall, *P. lloydii* possibly is closer to *P. leptoglossa*, and further collections might well provide evidence for merging the taxa.

24. **Perityle lobata** (Rydb.) I. M. Johnston, Proc. Calif. Acad. IV. **12**: 1205. 1924.

Leptopharynx lobata Rydb. N. Amer. Fl. 34: 23. 1914. TYPE: **Mexico:** BAJA CALIFORNIA: Commondu, 19 Feb. 1889, *T. S. Brandegee* (Holotype, GH!; isotype, UC!).

Plants fleshy-rooted perennials, possibly also annuals, low and spreading, semierect, or semipendulent, 10-40 cm high, stems weak, herbaceous, and rather brittle, usually purplish, glabrous to sparse-pilose; leaves mostly alternate, bright green, turning purplish, glabrous to sparse-pilose, 3-8 (12) cm long, 1.8-6.0 (8) cm wide, cordate, cordate-orbiculate, or subreniform, strongly 3-lobed, cleft, or parted, rarely divided, the segments further shallow-lobed or the blades even 5-cleft, the margins dentate-lobed and acuminate, overall the blades appear regularly laciniate; capitulescence of solitary heads borne on weak peduncles 3-8 (15) cm long; heads radiate, cernuous, 10-12 mm high, (5) 7-9 mm wide, involucres cylindroidal to campanulate, truncate at the base; bracts 5.0-9.5 mm long, linear-lanceolate to lanceolate-ovate, subattenuate, often purplish; ray flowers 8-12, ligules yellow, often turning purplish when dry, 2.5-9.0 mm long, oblong-elliptic; disc flowers numerous, corollas yellow, often purple-tinged, 3.8-5.0 mm long, throats tubular-funnelform; achenes (3) 3.5-5.0 mm long, narrowly oblong to oblong-elliptic, with prominent callous margins, the margins densely ciliate, faces glabrous to puberulent at the center; pappus of a crown of squamellae, 0.7-1.0 mm long, and a single bristle 3.5-6.0 mm long, the bristle very stout at the base, tapering to a point, densely barbellate; chromosome number, $n = 17$.

Restricted to Baja California Sur in the area of Sierra de la Giganta. Flowering year around. (Fig. 5).

REPRESENTATIVE SPECIMENS:

MEXICO: BAJA CALIFORNIA SUR. Arroyo Carrizal, E of Rancho El Horno, NE of San Javier, *Carter and Ferris* 3811 (UC, US); Arroyo Santo Domingo, Rancho El Horno, *Carter and Ferris* 3867 (DS, SD, UC); vicinity of Portezuelo E of La Victoria, *Carter and Ferris* 3911 (DS, UC); NW of Rancho El Horno, on steep escarpment of Mesa de San Alejo, W of San Javier, *Carter and Sharsmith* 4199 (UC); Purisima, *Gentry* 4213 (ARIZ, DS, GH, UC); Puerto Escondido, *Johnston* 4115 (CAS, GH, NY, UC, US); ca. 10 mi W of Loreto, *Powell and Sikes* 1663 (SRSC, TEX); ca. 10 mi S of Mission Dolores, *Wiggins, Carter, Ernst* 287 (DS, US); arroyo Quisapol, E of La Presa, trail to Laguna Caquihui, Sierra de la Giganta, *Wiggins* 15544 (DS).

Perityle lobata has perhaps been separated from mainland Mexico and its relatives there for about four million years. At least according to Moore and Buffington (1968), this is how long the Baja California peninsula has been drifting westward from the mainland. *Perityle lobata* is clearly related to *P. palmeri.* Distributional considerations suggest that the two present-day taxa once had a common range (Fig. 5), or else proximal distributions before the Sea of Cortez became a barrier of its present width.

It is possible that *Perityle lobata* has been introduced to the mainland and has hybridized there, accounting for some of the variability in mainland taxa such as *P. palmeri.* In fact, it might be postulated that *P. palmeri* has evolved from *P. lobata* instead of the other way around as previously assumed. However, if the latter conjecture were accurate, one might expect that *P. palmeri* would be more like *P. lobata* of Baja California. I have not found any evidence that *P. lobata* has been introduced recently to the mainland.

As opposed to *Perityle palmeri*, *P. lobata* can be recognized by its leaf architecture, its purplish stems, pubescence, ligule length and number, bract width, achene length, and its stout bristles.

25. **Perityle palmeri** S. Wats. Proc. Amer. Acad. **24:** 57. 1889. TYPE: **Mexico:** SONORA: Guaymas, Oct., 1887, *E. Palmer* 308 (Holotype, GH!; isotypes, NY!, UC!, US (3)!).

Leptopharynx palmeri (S. Wats.) Rydb. N. Amer. Fl. 34: 23. 1914.

Plants fleshy-rooted perennials, low and spreading, semierect, or semipendulent, 10-25 cm high, stems herbaceous and rather brittle, often purplish, short or long pilose; leaves mostly alternate, short or long pilose, grayish-green, 6-10 cm long, 3.0-5.5 cm wide, cordate, cordate-ovate, to cordate-orbiculate, the margins acutely shallow-lobed and serrate-dentate, the lobes several, or the blades strongly 3-lobed, overall the blades may appear irregularly laciniate; capitulescence of solitary heads borne on peduncles 2-6 (8) cm long; heads radiate, often cernuous at maturity, 8-11 mm high, 6-13 mm wide, involucres hemispherical to campanulate and truncate at the base; bracts 7-10 mm long, linear to linear-lanceolate and attenuate; ray flowers numerous, ligules yellow, 7-8 (10) mm long, oblong-elliptic; disc flowers numerous, corollas yellow, 4-6 mm long, throats tubular; achenes 2.5-3.5 mm long, narrowly oblong, with prominent callous margins, the margins densely long-ciliate, faces glabrous or puberulent; pappus of a crown of squamellae, 0.5-0.9 mm long, and a single bristle, 3-5 mm long, the bristle stout, tapering from base to apex, and densely barbellate; chromosome number, $n = 17$.

Primarily, if not entirely, soil-dwelling, most common in the vicinity of Guaymas, Sonora, but also in northern Sinaloa, Mexico. Flowering probably year around. (Fig. 5).

REPRESENTATIVE SPECIMENS:

Mexico: SINALOA: Topolobampo, *Blakey* (ARIZ.) SONORA: Guaymas, *Brandegee* (POM, UC); Plam Canyon, W side of Sierra Libre, 35 mi S of Hermosillo, *Carter* (ARIZ); San Pedro Bay, *Craig* 691 (POM); Guaymas, *Dawson* 1003 (DS, US); cliffs, E side of Guaymas, *Drouet and Richards* 3846 (DS); 2.8 mi N of Guaymas, *Lewis* 5334 (SMU); 36 mi S of Hermosillo, *Lindsay* 1125 (DS); near Guaymas, Palmer 1218 (US); Sahuaral Bay, *Powell and Averett* 1523 (SRSC, TEX); 1 mi E of San Carlos Resort, *Powell and Sikes* 1687 (SRSC, TEX); 6 km N of Empalme, *Ripley* 14307 (CAS); 1 mi E of San Carlos Resort, *Sikes and Babcock* 169 (SRSC, TEX); 1 mi N of Naval Base, Guaymas Bay, *Sikes and Babcock* 176 (SRSC, TEX).

Perityle palmeri is best distinguished from *P. lobata*, perhaps its closest relative, and from *P. cordifolia* by the following characters: fleshy roots, weak perennial habit in soils, lobing of the leaves, ligule length, bract length, and pilose pubescence.

26. **Perityle californica** Benth. Bot. Sulph. 23. 1844. TYPE: **Mexico:** BAJA CALIFORNIA: Magdalena Bay, 1837?, *R. B. Hinds* (K!).

Perityle plumigera Harv. & Gray, Mem. Amer. Acad. II. 4: 77. 1849. TYPE: **Mexico:** SONORA: "California" (vicinity of Hermosillo), *Coulter* 279 (Holotype, GH!; fragment, UC!, US!).

Perityle deltoidea S. Wats. Proc. Amer. Acad. 24: 57. 1889. TYPE: **Mexico:** BAJA CALIFORNIA: Los Angeles Bay, 1887, *E. Palmer* 568 (Holotype, GH!; isotypes, NY!, UC!, US!).

Plants delicate or robust annuals, 6-35 cm high, erect or decumbent, sparsely or densely leaved; leaves opposite or alternate, glandular-puberulent to short pilose, 1-6 (10) cm long, 0.5-2.5 (6.0) cm wide, often purplish when mature, deltoid, ovate, or cordate, 3-lobed to subcruciform with the segments serrate-crenate or shallow-lobed, or the margins merely shallow-lobed to serrate; petioles 0.3-1.5 (4.0) cm long; capitulescence of 1-5 heads borne on delicate peduncles; heads radiate, 3.5-7.5 mm high, 3.0-5.0 (7.5) mm wide, involucres narrowly to broadly campanulate; bracts linear, oblanceolate, or obovate; ray flowers 10-15, ligules yellow, oblong-elliptic; disc corollas yellow, 2.0-3.0 (3.5) mm long, throats tubular to subfunnelform; achenes 1.5-2.5 (3.0) mm long, narrowly obovate, oblanceolate, to oblong-oblanceolate, with thin or prominent callous margins, the margins short or long ciliate, faces puberulent to densely so; pappus of a crown of squamellae and a single bristle, 1.5-3.0 (3.5) mm long, the bristle barbellate to subplumose; chromosome numbers, $n = 13, 12, 11$.

Common in desert soils, Sonora and Sinaloa of mainland

Mexico, and along most of the Baja California peninsula to just S of La Paz. Flowering Dec.-June. (Fig. 6).

REPRESENTATIVE SPECIMENS:

MEXICO: BAJA CALIFORNIA. San Juan Mine, *Moran* 8117 (DS, SD, UC); Los Angeles Bay, *Palmer* 568 (GH, NY, UC, US); 4 mi S of Rancho Rosarito, *Powell and Turner* 1808 (SRSC, TEX); El Arco, N end of town, *Sikes and Babcock* 297 (SRSC, TEX); mesa S of Rancho Mesquital, *Wiggins* 11326 (DS, GH, UC). BAJA CALIFORNIA SUR. Isla Magdalena, *Brandegee* s.n. (GH, UC, US); 20 km E of San Ignacio, *Carter, Alexander, and Kellogg* 1972 (DS, UC, US); 26 km NW of San Ignacio, *Carter, Alexander, and Kellogg* 2521 (DS, GH, UC, US); Arroyo del Cajon de Tecomaja, SW of Puerto Escondido, *Carter and Kellogg* 2906 (UC); Rancho El Horno, NE of San Javier, *Carter and Ferris* 3789 (UC); SE of La Soledad, *Carter* 5418 (UC); Arroyo, 4 mi above La Purisima, *Constance* 3146 (DS, GH, LL, US); Isla San Jose, *Moran* 3785 (DS, SD, UC); Isla Santa Catalina, *Moran* 3867 (DS, SD); Isla San Marcos, *Moran* 8983 (SD, US); Isla Carmen, *Moran* 9133 (SD); Isla Danzante, *Moran* 9253 (SD); Santa Rosalia, *Palmer* 185 (CAS,GH, US); ca. 19 mi N of La Paz, *Porter* 414 (CAS, DS, UC); 20 mi S of El Arco, *Powell and Sikes* 1650 (SRSC, TEX); 0.5 mi S of San Ignacio, *Powell and Sikes* 1653 (SRSC, TEX); ca. 8 mi S of Santa Rosalia, *Powell and Sikes* 1657 (SRSC, TEX); 33 mi S of Santa Rosalia, *Powell and Sikes* 1659 (SRSC, TEX); Bahia de la Concepcion, *Powell and Sikes* 1661 (SRSC, TEX); 10 mi W of Loreto, *Powell and Sikes* 1664 (SRSC, TEX); 13.6 mi S of Mulege, *Powell and Turner* 1835 (SRSC, TEX); 11.5 mi W of Loreto, *Powell and Turner* 1837 (SRSC, TEX); 15 mi W of San Javier, *Powell and Turner* 1845 (SRSC, TEX); 3 mi E of La Paz, *Sikes and Babcock* 216 (SRSC, TEX); near km 40 on hwy between La Paz and Santo Domingo, *Thomas* 8455 (CAS); Isla Partida, *Wiggins, Carter, and Ernst* 412 (DS); Commondu, *Wiggins* 5502 (CAS, DS, GH, NY, UC, US); 22 mi N of San Ignacio, *Wiggins* 7888 (DS, GH, TEX, UC, US); 20 mi S of Mulege, *Wiggins* 11408 (CAS, DS, GH, UC, US); 6 mi W of Canipole, *Wiggins* 11439 (CAS, DS, GH, UC, US); Llano Caquihui, W of Los Dolores, *Wiggins* 15516 (DS, US); 16 mi E of La Paz, *Wiggins* 15625 (DS, US); Isla Carmen, *Wiggins* 17497 (DS). SINALOA. N of Topolobampo, *Flyr* 72 (TEX); vicinity of San Blas, *Rose, Standley, and Russell* 13244 (NY, US); vicinity of Fuerte, *Rose, Standley and Russell* 13472 (NY, US); W side of Topolobampo Harbor, *Sikes and Babcock* 189 (SRSC, TEX). SONORA. 8 mi N of Hermosillo, *Breedlove* 1758 (DS); San Pedro Bay, *Craig* 662 (POM); E side of Guaymas, *Drouet and Richards* 3844 (CAS, DS, GH, US); 73 mi S of Hermosillo, *Flyr* 98A (TEX); 47 mi N of Hermosillo, *Frye and Frye* 2305 (GH, US); 1 mi E of San Carlos Resort, *Powell and Sikes* 1686 (SRSC, TEX); 1-2 mi

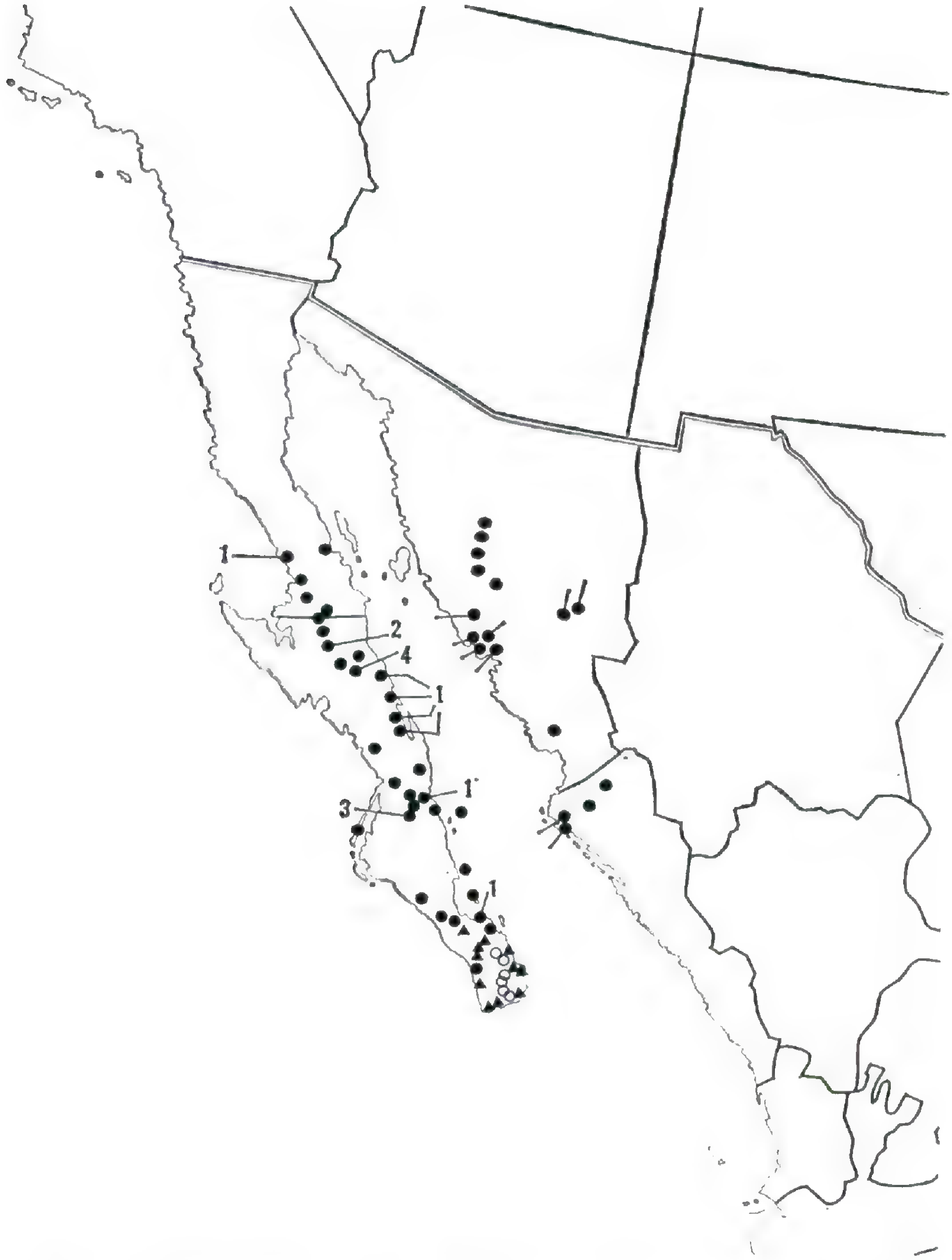

Fig. 6. Distribution of *P. californica* (closed circles); the bars indicate populations from which chromosome numbers were taken, with (1) $n = 11$ II, (2) $n = 12$ II, (3) $n = 13$ II, and (4) n =10 II + 1 III; all mainland counts have been $n = 13$. *P. cuneata* var. *cuneata* (open circles); *P. cuneata* var. *marginata* (closed triangles).

N of San Carlos Resort, *Powell and Sikes* 1691 (SRSC, TEX); vicinity of Navojoa, *Rose, Standley, and Russell* 13140 (NY, US); 110 mi E of Hermosillo, *Sikes and Babcock* 151 (SRSC, TEX); 32 mi N of Hermosillo, *Shreve* 10053 (LL); 10 mi N of Hermosillo, *Wiggins* 6250 (DS, POM, US); 5 mi SE of Torres, *Wiggins* 6273 (DS, GH, POM, US).

In her discussion of *P. californica,* Everly (1947) emphasized the variable habit of this taxon. The species occurs in Baja California and in Sinaloa-Sonora of mainland Mexico. Most of its morphological variability is expressed in plant size, number of leaves, and leaf shape. Floral characteristics are essentially the same throughout the distributional range.

Chromosomal variability also exists in *Perityle californica* where numbers of $n = 13$, 12, 11, and 10 II + 1 III have been reported (Powell, 1968; 1972b). Some distributional and morphological correlation with chromosome number has been observed, although no taxonomic status is warranted for the cytotypes. Plants of the mainland populations are $n = 13$, as so far determined, and tend to be rather tall and robust with deeply lobed (often trilobed) leaves. In wet years *P. californica* is a common weed in some parts of Sonora and Sinaloa. Chromosome numbers of $n = 13$, 12, 11, and 10 II + 1 III have been found in Baja California populations (Fig. 6), and the plants are usually small with leaves not deeply lobed (mostly serrately-lobed). I have found the Baja California populations to be invariably small and scattered, but I have not seen the peninsula in a wet year. Populations with $n = 11$ are most common in Baja California and probably extend throughout the range of the species (Fig. 6). One population with $n = 12$ has been found, and those with $n = 10$ II + III presumably arose through hybridization of cytotypes with $n = 12$ and $n = 11$ (Fig. 6). The one peninsula collection with $n = 13$ (Fig. 6) could have been introduced from the mainland, or seemingly less likely at present, could represent the presence of native $n = 13$'s on the peninsula. It seem reasonable to conclude that *P. californica* in Baja California evolved by aneuploid reduction in chromosome number from mainland cytotypes.

Perityle californica does not share close or obvious relationship with any species, and its origin as a low-numbered aneuploid is not clear. The species is superficially similar to *P. cuneata* ($n = 16, 12$), but these taxa differ considerably in floral characters, particularly of the achenes and pappus. Indeed, the floral differences between these two aneuploid species are significant enough to cast considerable doubt upon their common origin. *Perityle californica* has narrow oblanceolate achenes with a single, long, subplumose pappus bristle, while *P. cuneata* has broad, obcordate or obovate achenes with two delicate pappus bristles. The morphology of *P. californica* (including flower color and achene and pappus features) resembles that of the *P. cordifolia* group ($x = 17$), and possibly originated therefrom by aneuploid reduction.

Certain aspects of the *Perityle californica* synonymy are somewhat confusing, but a good explanation of the historical situations was given by Everly (1947).

27. **Perityle cuneata** Brandeg. Zoe **1**: 54. 1890. TYPE: **Mexico:** BAJA CALIFORNIA: Sierra de Laguna, near Todos Santos, 21 Jan. 1890, *T. S. Brandegee* (Holotype, UC!; isotype, US!).

27a. **Perityle cuneata** var. **cuneata.**

Plants robust annuals, 25-50 (80) cm high, erect or decumbent, sparsely to densely leaved; leaves opposite or alternate, glandular-puberulent to nearly glabrous, 3-8 (15) cm long, 1.5-4.5 (11.0) cm wide, often purplish when mature, cordate to broadly so, ovate, or subhastate, the margins serrate-lobed to serrate-crenate; petioles 0.6-2.0 (5.0) cm long; capitulescence of 1-3 heads borne on rather stout peduncles; heads radiate, 5-8 (10) mm high, 6-10 (12) mm wide, involucres campanulate to hemispherical; bracts oblanceolate to obovate and attenuate; ray flowers 10-15, ligules yellow, oblong-elliptic; disc corollas yellow, 3.0-3.5 mm long, throats tubular; achenes (2.5) 3.0-3.8 mm long, obcordate-cuneate to oblanceolate, with broad callous margins, often purplish, the margins puberulent, faces glabrous to puberulent; pappus of a crown of squamellae and 2 (rarely 0-2) delicate bristles, 0.5-1.2 (2.0) mm long; chromosome number, $n = 12$.

Infrequent in soils, Cape Region of Baja California Sur to just S of La Paz, most common on eastern side. Fowering Jan.-Sept. (Fig. 6).

REPRESENTATIVE SPECIMENS:

Mexico: BAJA CALIFORNIA SUR: San Jose del Cabo, *Brandegee* (DS, GH, US); Sierra San Francisquito and La Chuparosa, E side of Sierra de la Victoria, *Carter and Ferris* 3386 (DS, SD, UC); ca. 3 km above Boca de la Sierra, *Moran* 7091 (CAS, DS, GH, SD, TEX); Potrero de Almenta, S fork of Canyon San Pedro, *Moran* 7387 (CAS, DS, SD); ca. 5 mi S of San Antonio, *Powell and Sikes* 1667 (SRSC, TEX); Boca de la Sierra, *Powell and Sikes* 1671 (SRSC, TEX); 2 mi S of San Antonio, *Sikes and Babcock* 233 (SRSC, TEX); ca. 2 mi N of San Antonio, *Sikes and Babcock* 265 (SRSC, TEX); ca. 6 mi SW from Santiago, *Thomas* 7715 (CAS, DS, SD, US); ca. 5 mi SW of La Palma and ca. 8 mi NW from Santa Anita, *Thomas* 7738 (DS, SD, UC).

The two varieties of *Perityle cuneata* are morphologically similar, although extreme forms of these taxa do exhibit considerable differences. Everly (1947) recognized *P. cuneata* and *P. cuneata* var. *marginata* as conspecific. In addition to the morphological differences, I have recognized var. *cuneata* ($n = 12$) and var. *marginata* ($n = 16$) because of their chromosome numbers. Indeed, the chromosomal differences suggest that further study might demand the elevation of var. *marginata* to specific rank.

Besides its chromosome number, *Perityle cuneata* var. *cuneata* is characterized by robust habit, large cordate leaves, large heads, tubular disc corollas, obcordate-cuneate achenes, and attenuate involucral bracts. The plants of var. *marginata* are usually smaller with smaller leaves, smaller heads and other floral characters, campanulate-funnelform disc corollas, obovate achenes, and acute involucral bracts. In addition, var. *cuneata* usually occurs in higher hills and canyons of the Cape Region while var. *marginata* occurs mostly in sandy places not far above sea level.

Perityle cuneata does not exhibit a close morphological relationship with any other species. Superficially, *P. cuneata* most resembles *P. californica,* but it possibly evolved independently of the latter taxon by aneuploid reduction from the *P. cordifolia* line.

27b. **Perityle cuneata** var. **marginata** (Rydb.) I. M. Johnston, Proc. Calif. Acad. IV. **12:** 1204. 1924.

Perityle marginata Rydb. N. Amer. Fl. **34:** 14. 1914. TYPE: **Mexico:** BAJA CALIFORNIA: San Jose del Cabo, 25 Mar. 1911, *J. N. Rose* 16459 (Holotype, NY!; fragment, UC!; isotypes, GH!, US!).

Plants delicate or robust annuals, 6-40 cm high, erect or decumbent; leaves 1.5-5.0 (10) cm long, 0.9-3.0 (5.0) cm wide, cordate, ovate, or deltoid, the margins doubly serrate-crenate to shallow-lobed; petioles 0.2-1.8 (4.0) cm long; heads radiate, 4-7 mm high, 4-7 mm wide; bracts subovate, oblanceolate, or linear-lanceolate and acute; ligules yellow; disc corollas yellow, 2 (2.5) mm long, throats narrowly campanulate, campanulate-funnelform, rarely subtubular; achenes 1.5-2.0 (2.5) mm long, obovate, subcuneate, rarely almost oblong, with prominent callous margins, the margins short or long-ciliate; pappus of a crown of squamellae and 2 (rarely none) delicate bristles, 0.5-1.0 (1.5) mm long; chromosome number, $n = 16$.

Infrequent in desert soils, Cape Region of Baja California Sur and N to near La Paz, most common on southern and western sides. Flowering probably year around. (Fig. 6).

REPRESENTATIVE SPECIMENS:

Mexico: BAJA CALIFORNIA SUR. San Jose del Cabo, *Jones* s.n. (NY, POM, SD, UC); Arroyo de los Pozos, *Moran* 6886 (CAS, DS, GH, TEX); 2.5 km NE of Cabo San Lucus, *Moran* 7049 (CAS, DS, GH, SD); 6.4 mi N of Todos Santos, *Porter* 79 (CAS, DS, UC); 1.4 mi W of El Coyote, *Porter* 118 (CAS, DS, UC); ca. 17 mi S of San Antonio, *Powell and Sikes* 1668 (SRSC, TEX); ca. 9 mi S of San Bartolo, *Powell and Sikes* 1670 (SRSC, TEX); 26 mi NE of Todos Santos, *Powell and Sikes* 1680 (SRSC, TEX); 2 mi NE of Eureka, *Powell and Turner* 1848 (SRSC, TEX); ca. 1 mi N of Pescadero, *Sikes and Babcock* 255 (SRSC, TEX); near km 40 between La Paz and Santo Domingo, *Thomas* 8455 (DS, GH); 5 mi W of San Jose del Cabo, *Wiggins* 14370 (CAS, DS, TEX, UC); 8 mi E of Cabo San Lucas, *Wiggins* 14645 (CAS, DS, GH, TEX, UC).

The NY (holotype) and UC specimens of the type collection (*Rose* 16459) are typical of var. *marginata*, while the US and GH specimens (isotypes) approach var. *cuneata*. It is possible that the type collection may be mixed, containing plants of both varieties.

Some of the small forms of var. *marginata* are so like *P. californica* superficially that the two taxa can not be told apart except by microscopic examination of the achenes and pappus. The *Thomas* 8455 collection includes plants of both var. *marginata* and *P. californica*, but I have not otherwise noted sympatric occurrence of the taxa. No interspecific hybridization has been detected.

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CAREX EXILIS, GEOCAULON LIVIDUM AND OTHER PLANTS OF INTEREST IN PITTSBURG, NEW HAMPSHIRE. South Bay Bog at the southern end of First Connecticut Lake in Pittsburg, Coös County, New Hampshire apparently was not visited by A. S. Pease, S. K. Harris and other botanists who collected extensively in Coös County. The bog is very extensive, much of it open but with scattered clumps of stunted Black Spruce and Tamarack. Lying between 1600 and 1700 feet elevation, it appears in every way to be boreal in character with the following species of shrubs in abundance, *Ledum groenlandicum, Rhododendron canadense, Andromeda glaucophylla, Kalmia polifolia, K. angustifolia, Cassandra calyculata, Pyrus melanocarpa, Viburnum cassinoides* and *Vaccinium angustifolium.*

Bog Branch of Cedar Stream flows through or along the northern edge of South Bay Bog and near it, in sites where some drainage appears to run off the adjacent upland, there are scattered trees of *Thuja occidentalis* L., some up to 30 inches d.b.h. These represent remnants of the primeval forest since, along with dying trees of large size, there are fallen ones in all stages of decay. Several species of orchids grew in the immediate vicinity of trees of Arbor Vitae, the rarest of which was *Listera convallarioides* (Liv.) Nutt. A plant here of perhaps greater interest was *Epilobium palustre* L. var. *palustre* of which Seymour (1969) states "Often with *Thuja,*" but of which he cites only one locality in New Hampshire, "Mt. Washington." Pease (1964) states its habitat as "Boggy places, especially on the high mountains," but he gives two localities for it at lower elevations both probably with some "Cedar" associated, "Stewartstown, Cedar bog" and "Columbia, near Lime Pond."

In the more open part of South Bay Bog dominated by sphagnum moss and the previously mentioned shrubs and dwarf conifers there are plants of still greater interest to a taxonomist, one being *Carex exilis* Dewey and the other *Geocaulon lividum* (Richards.) Fern. *Carex exilis* is a sedge of local but wide distribution in New England, it being found occasionally in all States except Connecticut. Fernald (1950) omits mention of New Hampshire and Vermont in his statement of range for the species though he does mention Massachusetts, while Seymour (1969) gives but one township for it in New Hampshire, "Tamworth" where it was collected by F. L. Steele in a bog near Chocorua Lake and where he has shown it to me. Specimens of it are in the herbaria of the New England Botanical Club (NEBC) and the University of New Hampshire (NHA). However also at NHA are two other collections of fairly long standing, the earlier being from Windham in Rockingham County collected on June 14, 1897 by W. S. Harris. This record was included in the list published by Hodgdon and Friedlander (1949). The second collection of *Carex exilis* at *NHA* is from a bog in Pittsburg known as "Moose Pasture" lying along East Inlet about two miles northeast of Second Connecticut Lake. This was collected by me in company with Peter Allen on July 23, 1960 and bears my collection number 11636. Pease (1964) did not include *C. exilis* in his "Flora" and it is quite possible that this specimen of it was not available for inspection at the time that Pease was gleaning additional records for Coös County and Harris was carefully checking the manuscript before publication. The specimens of *C. exilis* observed at South Bay Bog on our visit of June 8, 1973 were completely dioecious, the clones or colonies of female individuals being widely separated from the males.

The other species of outstanding interest at South Bay Bog was *Geocaulon lividum.* I have been quite familiar with the Northern Comandra from the frequency of its occurrence in bogs on Campobello Island, New Brunswick and its presence on the Wolf Islands in the Bay of Fundy where R. B. Pike and I have observed it. It seems strange that a species inhabiting bogs at low elevations in coastal eastern Maine and the Maritime Provinces should be confined to montane areas inland though the same relationship seems to hold for *Rubus chamaemorus* L. and *Lycopodium annotinum* L. var. *pungens* (LaPyliae) Desv. Harris (1965) discussed the distribution of *Geocaulon lividum* in a critical way, pointing out that its habitat in stations that he visited was mostly damp but not boggy sites and that the lowest elevation for it was at 2500 ft. on the Basin Rim in Coös County. The station at South Bay Bog is in no way montane and the elevation is between 1600 and 1700 feet. It is entirely possible that botanists have concentrated their collecting more in the mountains than in the more prosaic terrain of bogs that often lie between the mountains, thus passing by an interesting intermediate type of habitat for certain species that are supposed to occur only in coastal areas or near the tops of mountains. In any event it is evident that *Geocaulon lividum* should be searched for widely as Stuart Harris pointed out, not only as he suggested, in montane situations but also in bogs at intermediate elevations in Northern New England.

Specimens of *Carex exilis* and *Geocaulon lividum* have been deposited in the herbaria of the New England Botanical Club (NEBC) and the University of New Hampshire (NHA).

These discoveries would not have been possible except for the expert guidance of Dr. Peter Allen. In addition I have borrowed freely in preparing this article from notes that he made or that we recorded jointly on the occasion of our visit to South Bay Bog on June 8, 1973.

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NEW STATION FOR NUPHAR MICROPHYLLUM IN DURHAM, NEW HAMPSHIRE. Pittsfield, N. H. (Merrimack County) is no longer the southernmost collection point in New Hampshire for *Nuphar microphyllum* (Pers.) Fern. as reported in my article "Some Morphological Aids in Distinguishing *Nuphar microphyllum* from Similar Aquatics" (Rhodora 75: 65-74, March 1973). On October 8, 1973 while A. R. Hodgdon and I were scouting the Lamprey River in Durham as a possible field trip site for his course in aquatic plants at the University of New Hampshire, I discovered a colony of *N. microphyllum* growing with *N. variegatum* and *Nymphoides cordata* in about two feet of water in a small cove near the upper end of Moat Island. Perhaps closer observation may reveal some plants of the hybrid, *Nuphar* × *rubrodiscum*. Undoubtedly other stations for *N. microphyllum* exist but its relative rarity in southern New Hampshire has made it unnoticeable to the casual observer. The two specimens collected late in the season are a bit ragged and will be kept as vouchers in the NHA Herbarium. An attempt will be made to secure more presentable material for the New England Botanical Club Herbarium.

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TYPIFICATION OF CHAMAESARACHA CORONOPUS

The type of *Chamaesaracha coronopus* was erroneously listed as *Berlandier* 1494 (= 234) (Rhodora 75: 339). The section referring to the type material should read:

Chamaesaracha coronopus (Dunal) Gray, Bot. Calif. 1: 540. 1876. Holotype (G!), [Texas, Bexar Co.], Rio Medina, between Laredo and Bejar [San Antonio]. 1828. *Berlandier* 1513 (= 253). Isotypes: GH! & K!.

The locality indicated on the holotype and original description is only between Laredo and San Antonio, then Bejar, Mexico. An isotype at Kew, however, has Rio Medina on the label. The Medina River flows southeast from Bandera County into Medina County, then east into Bexar County. The route taken by Berlandier likely crossed the Medina River in Bexar County, about 12 miles south of San Antonio.

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RANGE EXTENSION OF WOODWARDIA AREOLATA. While I was walking through a swampy area close to Spruce Hole Bog in Durham, N.H. on October 20, 1973, a fern frond came to my attention that from afar resembled an aberrant form of sensitive fern, *Onoclea sensibilis.* Upon further investigation, however, what was found turned out to be the fertile frond of *Woodwardia areolata* (L.) Moore, the netted-chain fern, so named for its long sori arranged in a row on each side of the secondary midrib.

The discovery of this fern is noteworthy when one realizes that only two stations for it have ever been recorded from New Hampshire, both in Rockingham County: Rye Beach by Walter Deane in 1886 (N.E.B.C.) and Seabrook by A. A. Eaton in 1896 (N.E.B.C.) In the seventy-seven years since those recorded findings, *Woodwardia areolata* has not been found in New Hampshire. In addition, this new station extends the range of this coastal plain species by approximately twenty miles.

Shaded by two bushes of *Vaccinium corymbosum,* a total of six plants have been located within an area of three feet. The plants are growing on rotting stump matter and are surrounded most of the year by a foot of water or more.

Such a find always leads one to speculate as to how this fern came to occur at this location, how long it has been there, and why it was not discovered long before this.

A voucher specimen of the *Woodwardia areolata* is deposited in the University of New Hampshire herbarium.

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EDITORIAL ANNOUNCEMENT

With this number the present editor-in-chief with twelve and a half years of service in that capacity, is completing his tenure. Also Dr. Radcliffe B. Pike, as a valued associate editor during this entire period, is completing his editorial connection.

We trust that the younger group of editors who are now in charge will find the journal to be prospering. Many changes in Rhodora have been made during the past twelve years; we express the hope that the journal can continue to be molded to fit changing needs.

The new editor-in-chief is Dr. Alfred Linn Bogle, Associate Professor of Botany at the University of New Hampshire. Please send all manuscripts and communications to Dr. A. Linn Bogle, Department of Botany and Plant Pathology, University of New Hampshire, Durham, New Hampshire 03824.

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INSTRUCTIONS FOR CONTRIBUTORS TO RHODORA

Manuscripts must be double-spaced or preferably triple-spaced (not on corrasable bond), and a list of legends for figures and maps provided on a separate page. Footnotes should be used sparingly, as they are usually not necessary. Do not indicate the style of type through the use of capitals or underscoring, particularly in the citations of specimens, except that the names of species and genera may be underlined to indicate italics in discussions. Specimen citations should be selected critically especially for common species of broad distribution. Systematic revisions and similar papers should be prepared in the format of "The Systematics and Ecology of Poison-Ivy and the Poison-Oaks," W. T. Gillis, Rhodora 73: 161-237, 370-443. 1971, particularly with reference to the indentation of keys and synonyms. Papers of a floristic nature should follow, as far as possible, the format of "Contribution to the Fungus Flora of Northeastern North America. V.," H. E. Bigelow & M. E. Barr, Rhodora 71: 177-203. 1969. For bibliographic citations, a recommended list of standard journal abbreviations is given by L. Schwarten & H. W. Rickett, Bull. Torrey Bot. Club 85: 277-300. 1958.

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A SYSTEMATIC STUDY OF THE GENUS KALMIA (ERICACEAE)

JOHN E. EBINGER

A study of the cytology and genetics of the genus *Kalmia* was started in 1961 by Dr. Richard A. Jaynes of the Connecticut Agricultural Experiment Station. At that time little was known about the genetics of this group although a few of the species are important ornamental shrubs. Dr. Jaynes has now accumulated many living representatives of most of the species due to the efforts of numerous botanists and friends. As a result of his studies (Jaynes 1968a, 1968b, 1969, 1971b) information is now available concerning cross compatibility, speciation, and possible evolutionary relationships within the genus.

As treated here, the genus is composed of seven species, six varieties and numerous forms, both natural and cultivated. The genus is restricted to North America and Cuba, being particularly abundant along the east and west coasts and at higher elevations and latitudes. No monographic study of the genus has been undertaken, but the species have been adequately described in many floristic works, and Small (1914) treated all of the species that are presently recognized. Since one of the species is commonly cultivated and all are probably poisonous, this taxon has also been reviewed in horticultural and agricultural literature. This present study is an attempt to bring together most of this information in the light of what is now know about the genetics and cytology of the genus.

ACKNOWLEDGEMENTS

The author is grateful to the many people who helped in the completion of this study. Dr. Richard A. Jaynes provided access to his herbarium specimens and living material as well as his notes and extensive knowledge concerning the cytology and genetics of the genus. The Connecticut Agricultural Experiment Station provided space and equipment for 4 months to examine and collect material. Also, many individuals at Eastern Illinois University provided helpful criticism and advice in the preparation of the manuscript. The author is also indebted to the many curators who sent specimens for examination. Over 8,000 specimens were examined from 75 herbaria from the United States, Canada, and Europe. In the lists of representative specimens these herbaria are indicated by their abbreviations following Lanjouw and Stafleu (1964).

HISTORY OF THE GENUS

References to mountain laurel, *Kalmia latifolia,* appear in the early literature of the American colonies. The Cape Cod "Rose-trees" of Henry Hudson's log (Purchas, 1625) may have been this species (Holmes, 1956), and Smith (1624) mentions that laurel occurs in Virginia. This species was first described and figured by Plukenet (1696) under the name *Cistus sempervirens,* described by Gronovius (1739) who called it "The Common Laurel/vulgarly called Ivy," while the first color print was figured by Catesby (1743) under the name *Chamaedaphne.*

Because of their potential as ornamentals, some of the species were introduced into Europe. According to Aiton (1789) *Kalmia latifolia* and *K. angustifolia* were introduced into England in 1734 and 1736 by Peter Collinson, an English merchant and fellow of the English and Swedish Royal Societies. A third species, *K. polifolia,* was introduced in 1767. Catesby (1743) reported that *K. latifolia* from Pennsylvania flowered in his garden at Fulham in 1740. Numerous horticultural forms have been developed as a result of breeding and selection in Europe for the past 200 years.

Probably the first detailed account of the toxic characteristics of the genus occur in Peter Kalm's journal (Benson, 1937) in which he described in detail the poisonous properties of the "Laurel Trees" (*Kalmia latifolia*). He also described both *K. angustifolia* and *K. latifolia* as to their characteristics, economic importance, habitat requirements and general distribution.

The generic name *Kalmia* was first proposed by Chenon (1751) in a doctoral thesis, and was based on specimens that Peter Kalm had collected during his trip to the New World. *Kalmia latifolia* and *K. angustifolia* are described in this thesis, and Linnaeus (1753) included both in his Species Plantarum. Later, Linnaeus (1754) described the genus and placed it in his first order (Monogynia) of his tenth class (Decandria).

The genus is now regarded as a relatively primitive member of the Ericaceae. Drude (1889) placed it in the Tribe Phyllodoceae Drude of the subfamily Rhododendroideae Drude, and its position has not been changed by most subsequent authors. The members of this tribe are generally evergreen plants, usually with buxoid or ericoid leaves, with regular flowers, and with seeds that usually lack appendages. Two microscopic characteristics of the anthers have also been used to characterize the tribe: the presence of resorption tissue involving the epidermis of the anther and the absence of filaments among the pollen tetrads. Copeland (1943) discussed in detail the morphology and anatomy of the tribe Phyllodoceae and considered the genera *Rhodothamnus* Reichenb., *Kalmia,* and *Phyllodoce* Salisb. to be relatively primitive, an opinion also expressed by Wood (1961). Studies of wood anatomy by Cox (1948) indicate that the genus *Kalmia* is closely related to

Rhodothamnus and that these two genera represent one of the three lines of evolution in the Phyllodoceae.

There have been few nomenclatorial complications in the genus, and only two other generic names have been proposed. Kuntze (1891) used Catesby's pre-Linnean name of *Chamaedaphne* and made wholesale transfers to it, while Small (1914) divided *Kalmia* into two genera. He proposed the genus *Kalmiella* for *Kalmia hirsuta* and its related species that differ by having a deciduous calyx and flowers borne singly in the axils of ordinary or somewhat reduced leaves. In all other morphological and anatomical characteristics these species do not differ from the other members of the genus, and there is no real justification for their removal. Except for Alain (1957), all subsequent authors have treated these species as members of the genus *Kalmia.*

ECONOMIC IMPORTANCE OF KALMIA

The genus *Kalmia* is economically important mainly because a few of the species are commonly grown as ornamentals. By far the most important species is the mountain laurel, *Kalmia latifolia,* which is commonly planted as an ornamental throughout its natural range as well as in other parts of North America and Europe where climate and soil are satisfactory. This species varies widely in flower color, foliage, and size, and many cultivars have been named and described (Holmes, 1956; Dudley, 1967). Cultivars of mountain laurel had been named by 1840, and at the present time at least 90 names have been applied to different forms of the species. This species has been suggested as a possible choice for the national flower of the United States (Van Rensselaer, 1889), and presently it is the state flower of Connecticut and Pennsylvania.

The sheep laurel, *Kalmia angustifolia,* is also becoming an important cultivated plant. Unlike the mountain laurel, this species can be propagated by cuttings. A number of cultivated forms are available, and selections should become available as soon as nurserymen become familiar with handling them. This species is not important for its wood as few specimens exceed 3 feet in height, but it is economically important as a weed. Smith, Hodgdon and Eggert (1947) considered it an important weed in low-bush blueberry fields and tried fire, continued cutting, and lime to control it. Later, Trevett (1956) reported on the effects of 2,4-D and 2,4,5-T in controlling sheep laurel in blueberry fields. Porcher (1869) found that the leaves and twigs of this species will dye cotton a fine drab color if a copper mordant is used.

The foliage of *Kalmia latifolia* is commonly gathered in eastern United States for floral displays as well as for Christmas decorations and other festivities, continuing a tradition started in colonial days. As early as 1913, Britton suggested that this species should probably be protected since it was becoming rare in some areas due to indiscriminate collecting. Buttrick (1924), in an extensive article concerning growth and cultivation of mountain laurel in Connecticut, estimated that the amount of foliage of this species used in New York City probably exceeded 1,000 tons per year and that the maximum amount used in the United States for decorative purposes probably exceeded 10,000 tons per year. It is still commonly found in decorations, but no figures are presently available concerning the amount used. The foliage of mountain laurel can also be used to dye cloth. Nicholson and Clovis (1967) found that the boiled leaves of this species produced a yellow tan color on wool if a chrome mordant was used.

In the past, the wood of the mountain laurel was occasionally used to make small items. Peter Kalm in his journal (Benson, 1937) mentions that the strong wood is carved into weaver's shuttles, pulleys, spoons and trowels. Browne (1857) considered the wood to be similar to that of the European Box and that it was sometimes used for the handles of light tools, for screws, boxes, and that it was supposed to make good clarinets. He also mentioned that the American Indians used the wood for making small dishes, spoons, and other domestic utensils, and according to Benson (1937), this was the source of the common name "spoonwood." Other uses include the making of rustic furniture and as a substitute for brier pipes (Britton, 1913). Due to the small size of most mountain laurel shrubs, the wood is rarely used at the present time except locally for tool handles and novelties.

Kalmia latifolia, as a common understory shrub, is important in preventing water runoff and soil erosion. Studies by Johnson and Kovner (1956) in the southern Appalachian Mountains show that the cutting of dense stands of laurel and rhododendron in hardwood stands decreased the evapotranspiration rate and correspondingly increased the annual streamflow on the average of 2 inches per year.

Extracts from the leaves of most species of *Kalmia* were at one time considered important as medicine. Barton (1802, 1804) mentions that a saturated tincture prepared from the leaves of *Kalmia latifolia* in a proof spirit could be used for certain fevers. According to Rafinesque (1830) preparations of this species were used as a narcotic, errhine, antisyphilitic and antiherpetic, while Griffith (1847) considered it useful for fever, itching and in cases of hemorrhaging and dysentery. Wood and Bache (1851) considered it useful mainly for cutaneous affections when applied as an ointment or decoction. During the latter part of the 19th century the leaves of *K. latifolia* were still commonly found in drug stores. According to Paschkis (1881), they were dried, rolled into a pipe-form and used principally as a remedy for diarrhea. The leaves of *K. hirsuta* were used in the south as a cure for itching and for mange in dogs (Porcher, 1869), while Holmes (1884) reports that *K. angustifolia* was commonly used by the Cree Indians of the Hudson Bay region for bowel complaints and as a tonic.

PROPAGATION OF KALMIA

Numerous cultivars of *Kalmia latifolia* have been named; no large scale nursery production of any of these forms exists, however, because they have been considered difficult to root, hard to graft, and are untrue from seed. As a result, one common source of this species for ornamental purposes has been native woodland stands. Recent studies, however, indicate that it is possible to root cuttings of this species and that selected types do breed true.

According to Jaynes (1971d) most *Kalmia* species can be started from cuttings. He found that greenwood cuttings of *Kalmia angustifolia, K. hirsuta, K. polifolia,* and *K. microphylla* root readily under mist or a plastic tent. By contrast, *K. cuneata* cuttings were difficult to root, while *K. latifolia* was highly variable in its rooting ability. In this latter species the ability to root is related to the age of the stock plant, since 89% of the cuttings from 1-year-old plants rooted, while only 21% of those from 4 or more year-old plants rooted. Jaynes also reported that most of the sterile hybrids can be propagated readily from cuttings, even when *K. latifolia* is one of the parents. Jaynes (1972) found that clones of *K. latifolia* vary in their ability to root from cuttings and that cuttings of cuttings or young grafts root more readily than cuttings from the original stock plant.

Few attempts have been made to graft any of the species of *Kalmia.* Trumpy (1893) had some success using side grafts with current year's wood of *Kalmia latifolia,* while Jaynes (1971d, 1972) grafted current year's growth of *K. latifolia* onto stock of the previous year using cleft or side-veneer grafts. The grafts were made in mid-June, kept in plastic tents for 6 weeks, hardened for 2 weeks, and overwintered in a lath house. The first report on the success of layering *K. angustifolia* was probably by Curtis (1795).

The propagation of *Kalmia* from seeds has been extensively studied. Nichols (1934) found that *Kalmia polifolia* seeds germinated only after stratification, while *K. angustifolia* and *K. latifolia* seeds had a germination rate 5 times higher after stratification for 12 weeks. In contrast, Jaynes (1971c) reported that of these 3 species, only *K. latifolia* required stratification, the others germinating without any pregermination treatment. Jaynes also found that *K. cuneata,* as well as *K. latifolia,* required stratification, but that soaking the seeds in gibberellin for 24 hours created the same response as stratification. The most difficult species to propagate appears to be *K. hirsuta,* which germinated best after a heat-humidity treatment (heating the seeds in a moist chamber at 80°C for 30-60 minutes). Jaynes (1968c) suggested that this response to high temperature may have adaptive value and could have evolved as a result of recurring ground fires. He also suggests that *K. ericoides,* a closely related species that is native to sandy pine areas of Cuba, may require a similar pregermination treatment. *Kalmia microphylla* is similar to *K. polifolia* in that it needs no pregermination treatment. The studies of Flemer (1949) and Jaynes (1971c) indicate that all species of *Kalmia* germinate best at 22°C under light in a mixture of sand, ground sphagnum, and peat moss that has a pH of 4.2.

A mycorrhizal association, without which growth will not occur, has been demonstrated for *Kalmia latifolia,* and it is probably necessary for all species of the genus. Flemer (1949) found that mountain laurel seedlings grew very poorly in sterile culture without the associated endophyte, but when the seedlings were combined with the fungal associate they rapidly outgrew the controls. Microscopic examination revealed hyphae sheathing the younger portions of the roots and frequent hyphal connections with mycorrhizal coils in the cortical cells. No attempt was made to identify the fungus involved.

GENETICS OF THE GENUS KALMIA

Many species of *Kalmia* are sympatric, and most have similar habitat requirements. Even so, no natural hybrids have been reported, and recent studies suggest that such hybrids are unlikely to occur. Jaynes (1968a, 1971d) made all possible crosses, including reciprocals, between 6 species of the genus (omitting only *Kalmia ericoides*) and found that the barriers to gene flow are well developed. Most of the interspecific crosses were difficult to complete since no seed was set, the resulting seed failed to germinate, or the seed produced albino or yellow-green seedlings. Stylar inhibition of pollen tube growth appeared to be the most common reason for the lack of seed set. Only 9 combinations yielded viable seedlings and all were sterile. By contrast, intra-specific crosses between plants differing in flower color and growth habit within and between geographic sources showed no evidence of genetic barriers.

Little is known about the inheritance of traits in the genus; the only detailed study involves flower color in *Kalmia angustifolia.* In this species, Jaynes (1971b) found that the presence of anthocyanin pigment is determined by a single dominant gene, with the homozygous recessive lacking red pigment in the leaves and stem and having white flowers. This trait is carried in the population as a heterozygote, but is rarely expressed. These white forms are at a selective disadvantage in the wild as the seedlings are weak, especially when small.

Inbreeding depression and self incompatibility have been observed in some species of *Kalmia.* Jaynes (1968b) found that self pollinated *Kalmia latifolia* and *K. angustifolia* set 85-90% less seed than cross pollinated plants, while *K. polifolia,* in contrast, showed no self incompatibility. The seedlings of all three species, however, showed inbreeding depression. As measured by height growth, the vigor of the outcrossed seedlings was generally twice that of the selfs. Jaynes (1971a) also noticed inbreeding depression when sibling red-budded mountain laurel was crossed. It is possible that compact seedlings of *Kalmia* species of potential ornamental value can be obtained by selfing.

Few cytological studies of the genus have been undertaken. Hagerup (1928) in an extensive cytological study of the bicornes reported a chromosome number of $n = 12$ for *Kalmia latifolia* and $n = 24$ for *K. glauca* (*K. polifolia*). He found that the chromosomes of *K. polifolia* were about half as large as those of *K. latifolia,* so that the amount of chromatin in the two species seemed to be about the same. Later, Callan (1941) reported a chromosome number of $2n = 44$ for *K. polifolia,* which in light of recent studies is an error. Jaynes (1969) studied cytologically all of the taxa except for the Cuban species. He found that with the exception of *K. polifolia* ($n = 24$), all had a chromosome number of $n = 12$. No differences were found in the size of the chromosomes, and their smallness prevented a karyotype analysis.

POLLINATION IN KALMIA

The most distinctive feature of the genus is its pollen-discharge mechanism. Near the middle of the corolla are 10 sacs that form small lobes on each keel of the flower bud. Just before anthesis the anthers are pushed upward into these sacs by the elongating filaments. As the corolla opens the anthers are held in the sacs and are carried down and outward, the elastic filaments being bent backward under tension. When the flower is disturbed by a large insect, one or more of the anthers are released from their sacs. The filament, which is under tension, snaps the anther upward, showering the insect with pollen. This mechanism was first described by Sprengel (1793) and later by Hasskarl (1863) for *Kalmia latifolia,* while Rothrock (1867) observed the same mechanism in *K. angustifolia.* Studies by Penhallow (1882) showed that the pollen of *K. latifolia* could be thrown up to 14 cm. from the flower while in *K. angustifolia* it was thrown up to 8 cm. away. These authors suggested that this was a method of insuring self-pollination since the pollen was thrown toward the stigma of the flower. Beal (1867) was the first to describe the way in which the flowers were cross-pollinated by insects. He observed that while a bumble bee was searching around the base of the flower, the proboscis liberated the stamens which projected their pollen onto the underside of the insect's body. This pollen was then rubbed onto the stigma of other flowers visited. This process was also discussed by Gray (1876, 1879).

When an anther is released, the pollen tetrads are discharged as a fine powder in some species, and in others as a sticky net caused by the presence of viscid threads that hold the tetrads together. According to Matthews and Knox (1926) these extremely fine, non-cellular threads are probably derived from small quantities of microspore mother cell protoplasm which are excluded from the pollen tetrads. They also suggest that this feature is an adaptation that facilitates pollination in relatively large, upright flowers like those of the genus *Rhododendron.* These threads were found in *Kalmia latifolia* by Ikuse (1954) and have been observed by the present author in *K. hirsuta* and *K. ericoides.* Their presence or absence was used by Copeland (1943) as a major characteristic in separating the tribes of the subfamily Rhododendroideae, with the tribe Phyllodoceae being the only one that consistently lacked these threads. According to Wood (1961) it is now apparent that viscid threads do occur in some species of *Kalmia, Phyllodoce* and *Loiseleuria,* all members of the Phyllodoceae. Because of this, the usefulness of this characteristic to distinguish tribes is doubtful.

Only a few species of insects have been observed pollinating *Kalmia* species. Beal (1867) listed bumble bees and other Hymenoptera, but mentions no species. The only detailed account was by Lovell and Lovell (1934) who collected and identified the pollinators found on a population of *Kalmia angustifolia* near Waldoboro, Maine. Their observations show that *K. angustifolia* is effectively cross-pollinated by bees and that a total of 14 species of insects is capable of springing the stamens. Of these, *Bombus ternarius* and *Andrena vicina* were the most common visitors to the flowers. During the present study, populations of *K. angustifolia* and *K. latifolia* were examined in southern Connecticut, and all insects found to release the stamens were collected and identified. These studies were made for 2 hour periods, at various times each day, from June 15 to June 25, 1970. In most instances the insect did not release the stamen by just landing on the flower. Usually the stamens were sprung by the proboscis while searching for nectar, but sometimes the legs set the stamens free. No honey bees were found on the flowers, and none were reported by Lovell and Lovell (1934).

Recently bees have been used by Jaynes (1971a) to pollinate caged plants of *Kalmia latifolia* and *K. angustifolia* for the large scale production of seed. In these experiments selected plants were caged before the flower buds opened. Honey bees (*Apis* spp.) or bumble bees (*Bumbus* spp.) were introduced into the cages when the flowers started to open. The plants that were in cages with bumble bees set large quantities of seeds (58 to 95% of the flowers forming capsules), while plants in cages with honey bees set fewer seeds (2 to 31% of the flowers forming capsules). Plants that were in cages with no bees rarely set seed (less than 1% of the flowers forming capsules).

CHEMISTRY OF KALMIA

Catesby (1743) was one of the first to report on the poisonous properties of members of this taxon. He found that when cattle and sheep were deprived of better food during severe winters, many died from eating the leaves of *Kalmia latifolia* (as *Chamaedaphne*). An extensive report by Kalm (Benson, 1937) mentions that young sheep die immediately or become very sick after eating leaves of *Kalmia latifolia,* but calves "were cured by giving them gunpowder and other medicines." According to Kalm, larger domestic animals are also affected by the leaves.

Most of the literature on livestock poisoning by *Kalmia latifolia* and *K. angustifolia* has been reviewed by Crawford (1908), Muenscher (1957) and Kingsbury (1964). Some experimental work has been done to determine the symptoms, dosage, and treatment of the poisoning by these species. One of the first studies was made by Wood (1883), who fed a decoction of *K. angustifolia* leaves to a sheep. The symptoms were similar to those observed by Pritchard (1956) who studied *K. angustifolia* poisoning in a flock of

Minnesota sheep. Experiments with *K. latifolia* by Cary and Matthews (1903), Crawford (1908) and Marsh and Clawson (1930) showed that all livestock tested were poisoned by this species. The western species, *K. microphylla*, is also poisonous but, because of its habitat, is seldom encountered by livestock. Fleming (1920) fed this species to some calves and sheep, most of which became sick, while Clawson (1933) found that the symptoms exhibited by sheep and goats were similar to those observed in animals fed *K. latifolia* and *K. angustifolia*. No information is available concerning the poisonous properties of the other members of the genus.

Catesby (1743), Kalm (Benson, 1937), Bigelow (1818), and other early authors mentioned that deer can eat the leaves of mountain laurel without suffering ill effects. Forbes and Bechdel (1930, 1931) indicate that laurel is eaten in considerable quantity by deer, especially in time of food shortage. When restricted to a laurel diet, however, deer become thin and weak and usually develop a mild condition of rickets. Death results when the animals are fed in excess of 1.29% of their live weight of laurel leaves.

All species of *Kalmia* are probably poisonous to humans (Hardin and Arena, 1969), although no deaths have been attributed directly to this genus. Bigelow (1818) and Griffith (1847) have reported instances of poisoning in humans. In these cases, a decoction made from the leaves of *Kalmia latifolia* produced toxic symptoms. The tough leaves and their bitter taste make it unlikely that anyone would eat them. Also, the quantity required to produce illness is greater than what a person would probably consume. According to Barton (1802) the Delaware Indians used the leaves of *K. latifolia* for suicide.

It has been suggested by various authors that the honey produced from *Kalmia* flowers is poisonous, but no definite proof is available. Barton (1802) reported that the honey from *Kalmia angustifolia, K. latifolia,* and *K. hirsuta* is poisonous to humans and listed a few instances of suspected poisoning by honey of these species. Miller (1895) and

Pellett (1920), in contrast, doubted that mountain laurel was responsible for poisonous honey. They felt that due to the abundance of this species it would seem that the cases of poisoning would be reported much more frequently if there was good reason to suspect the honey from this source. Some doubt is also expressed by Lovell (1926, 1951) since bees are rarely found on mountain laurel. Howes (1949), as well as Hardin and Arena (1969), indicate that *Kalmia latifolia* honey is an extremely distressing narcotic, varying in its effect in proportion to the quantity eaten. In none of the reports is the source of the poisonous honey known for certain, the genus *Kalmia* being suspected because other parts of these plants are known to be poisonous.

Andromedotoxin, the poisonous compound found in the genus *Kalmia*, is known to occur also in other genera of the Ericaceae. Numerous attempts have been made to isolate and determine the chemical structure of this compound. Lasché (1889) reported the occurrence of andromedotoxin in the leaves and twigs of *Kalmia angustifolia* and also in the fruits of *K. latifolia*, while Matusow (1897) found what he considered andromedotoxin in the roots of *K. latifolia*. More recently Jacobs and Lloyd (1939) and Waud (1940) isolated andromedotoxin from *K. angustifolia*. The chemical structure of andromedotoxin has been studied by Wood, Stromberg, Keresztesy and Horning (1954) and more recently by Tallent, Riethof and Horning (1957). The latter authors renamed the substance acetylandromedol and developed a procedure for detecting its presence in plant extracts through the use of paper electrophoresis. Though the chemical structure of andromedotoxin is still in doubt, its empirical formula is probably $C_{22}H_{36}O_7$.

FOSSILS OF KALMIA

Only a few fossil species of *Kalmia* have been named. Most are described from leaf impressions, and except for size, shape, and probable coriaceous texture, there is little reason to consider them members of the genus *Kalmia*, or members of the family Ericaceae. One living species is also known from fossil remains.

Kalmia brittoniana Hollick (1892).

This fossil was first described from clay beds of the Raritan formation, near Kerischerville, Staten Island, New York and is Upper Cretaceous in age (Museum, Staten Island Association of Arts and Science). The material illustrated consists of parts of three oblong, entire, probably coriaceous leaves, 0.7 × 2.7 cm., with prominent midribs and no secondary veins. Hollick (1906) mentions that the absence of secondary nervation, indicating a leaf of thick, coriaceous texture, was what largely influenced his referring the leaf to the genus *Kalmia.* This species has also been reported from the Upper Cretaceous deposits of North Carolina (Berry, 1907, 1920) and Alabama (Berry, 1913, 1919). When he described *Kalmia brittoniana* from the Tuscaloosa formation of Alabama, Berry (1919) suggested that there is no reason for its placement in the genus *Kalmia,* or even in the Ericaceae. He further sugested that the fossil probably represents some Upper Cretaceous species of the Proteaceae or the Myrtaceae.

Kalmia ? elongata Ashlee (1932).

This species was found in the Latah formation, Elk River, Idaho, and is Upper Miocene in age (University of Idaho collection No. 303). The specimen consists of two narrowly elliptical, subcoriaceous leaves, 0.9 × 1.7 cm., with entire margins and a petiole 2-4 mm. long. The leaves are superficially similar to *Kalmia microphylla,* but since the midrib is grooved and the secondary and tertiary veins are present, this fossil must be considered a doubtful member of the genus.

Kalmia elliptica Brown (1962).

This species was found in the Fort Union formation (Ilo Post Office, Wyoming) and the Denver formation (Golden, Colorado) and is Paleocene in age. The specimen illustrated by Brown (1962) consists of a single elliptic leaf with entire margins and secondary and tertiary veins that irregularly fork and loop near the margins. The specimen is similar in outline to a typical leaf of *Kalmia latifolia* but is about twice as large (7 × 17 cm.). The presence of the well developed and large number of secondary and tertiary veins, as well as their angle to the midrib, is not typical of any present day species of *Kalmia*. It must therefore be considered a doubtful member of the genus.

Kalmia saxonica Litke (1968).

This species was found at Brandis, northwest Saxony, Germany, and is Lower Miocene in age. It consists of pieces of cuticle with the upper epidermis occasionally attached. These fragments indicate that the leaf was entire margined, 1-1.3 cm. wide, and had an obvious midvein. The cells are polygonal with wavy margins, the stomata are round, 18μ wide, surrounded by a double cuticular ring and occasionally by radiating cuticular striations. The basal portion of glandular hairs are also present. The structure and arrangement of the cells is similar to that found in *Kalmia latifolia,* and it is possible that this fossil represents a member of this genus or a closely related genus of the Ericaceae. Similar cuticle remains were placed in the form genus *Kalmiophyllum* by Kräusel and Weyland (1959) when they described the species *Kalmiophyllum marcodurense.*

Kalmia polifolia, the Bog Laurel, has also been found in fossil form. It was first reported by Berry and Johnston (1922, as *K. glauca* Ait.) from interglacial deposits at Point Grey near Vancouver, British Columbia. The fossil specimen illustrated is of the same shape and size as those of living specimens of *K. polifolia.* Since the other fossil plants found clearly indicate a bog habitat, it is very possible that this fossil is a species of *Kalmia. Kalmia polifolia* has also been reported from Pleistocene lake deposits of the upper Connecticut River Valley in northern New Hampshire (Hollick, 1931). These fossils are post-glacial in age and according to Hollick are representative of the flora that migrated northward in the wake of the retreating Wisconsin ice sheet. The other fossil species found in the same deposits indicate a habitat and climate similar to that presently prevailing in the area. The plates in this article show excellent examples of leaves very similar in shape and size to those of living *K. polifolia.* As mentioned by Hollick, however, positive identification would "merely represent a matter of personal opinion" since the leaves of *K. polifolia, Andromeda polifolia,* and *Ledum groenlandicum* appear almost identical in outline.

TAXONOMIC TREATMENT

KALMIA Linnaeus, Sp. Pl. 1: 391. 1753.

Kalmiella Small, Fl. Southeast. U. S. 886. 1903.

Chamaedaphne Catesby ex Kuntze, Rev. Gen. Pl. 2: 388. 1891, non Moench.

Evergreen or rarely deciduous shrubs or small trees with pubescent to occasionally glabrous, terete or 2-edged twigs. Lateral buds very small, flattened, with 2 exposed valvate to overlapping scales. Leaves alternate, opposite, or in whorls of 3, exstipulate, usually coriaceous, petioled to subsessile, margins entire. Flowers solitary in the axils of leaves, or in terminal or axillary corymbiform racemes, or in terminal compound corymbs. Pedicels slender, terete, usually pubescent and with stalked glandular hairs, subtended by a pair of bractlets in the axil of a small leaf-like bract. Flowers 5-merous, actinomorphic, with hypogynous insertion. Calyx synsepalous, usually green and persistent in fruit; lobes 5, longer than the tube. Corolla sympetalous, white to pink, red or purple, with a short cylindrical tube extending into a rotate limb that is shallowly 5-lobed and commonly 10-keeled, the limb with 10 saccate depressions in which the anthers are held under tension. Stamens 10, shorter than the corolla; filaments usually filiform, glabrous or pubescent, dorsifixed; anthers 2-celled, unappendaged, short, ovoid, opening by large terminal slits; pollen discharged in tetrads, with or without viscid strands. Ovary superior, 5-celled, placentation axile, placentae massive with numerous ovules; style slender, terete, nearly straight; stigma unexpanded, slightly grooved. Fruit a subglobose to globose, 5-valved, septicidal capsule usually subtended by the persistent calyx. Seeds numerous, small and lightweight, testa tight or loose and extending well past the ends of the remainder of the seed. A North American genus extending from Alaska south in the mountains to California and Utah, eastward through Canada to the Atlantic Ocean and southward through eastern United States to Florida and Cuba.

Lectotype Species: *Kalmia latifolia* L. (cf. Britton 1908).

KEY TO THE SPECIES OF KALMIA

A. Leaves opposite; inflorescence a terminal corymbiform raceme.
  B. Midrib of leaves lacking stalked glands; seeds less than 1.5 mm long . . . . 1. *K. microphylla.*
  B. Midrib of leaves with stalked glands on both surfaces; seeds more than 1.5 mm long. . 2. *K. polifolia.*
A. Leaves alternate or in whorls; inflorescence various.
  C. Inflorescence a terminal compound corymb; leaves usually more than 2 cm broad. . . . . . 3. *K. latifolia.*
  C. Inflorescence a simple corymbiform raceme or the flowers solitary in the axils of the leaves; leaves usually less than 2 cm broad.
    D. Leaves more than 1.5 cm long; inflorescence a corymbiform raceme from the axils of the leaves.
      E. Leaves in whorls of 3, evergreen. . . . . 4. *K. angustifolia.*
      E. Leaves alternate, deciduous. . . 5. *K. cuneata.*
    D. Leaves less than 1.5 cm long; flowers mostly solitary in the axils of the leaves.
      F. Leaves broad, flat, the margins only slightly revolute; flowers scattered along the stem in the leaf axils. . . . . 6. *K. hirsuta.*
      F. Leaves narrow, strongly revolute; flowers clustered toward the ends of the twig giving the appearance of a terminal corymbiform raceme. . . . . 7. *K. ericoides.*

1. **Kalmia microphylla** (Hooker) Heller, Bull. Torrey Bot. Club **25**: 581. 1898.

Low growing alpine plant to sparingly branched shrub to 6 dm tall; branchlets terete to slightly 2-edged below the leaves, glabrous to lightly pubescent; leaves opposite, subsessile, the broad petiole to 2 mm long, the blades coriaceous, ovate to oval to narrowly lanceolate, to 4 cm long, 0.4-1.1 cm broad, whitened beneath with small hairs, a band of white hairs usually present on the upper surface on either side of the midrib, midrib lacking stipitate glands, margins flat to slightly revolute; inflorescence a few-flowered, terminal, racemose cluster, each flower on a glabrous pedicel 1-3 cm long, each pedicel subtended by a pair of bractlets in the axis of a leaf-like bract; calyx pink to light green, 5-10 mm broad, the lobes obtuse, margins ciliate; corolla rose-purple (rarely white), 0.8-2.0 cm broad; anthers purple, 0.6-1.6 mm long; fruit subglobose, 4-7 mm broad, 3.5-6 mm long; seeds 0.8-1.4 mm long, the testa extending past the ends of the seed. Chromosome number $n = 12$.

Kalmia microphylla has rarely been considered specifically distinct from *K. polifolia.* Hall (1912), when he transferred the taxon to a variety of *K. polifolia* mentioned that "No characters upon which the variety might be raised to specific rank have as yet been pointed out, except the variable one of size in plant and leaf." Most present floristic works maintain this taxon as a variety or subspecies of *K. polifolia,* though it has been considered a separate species by Small (1914), Rydberg (1954), Hultén (1948) and Abrams (1951). Hultén (1948) mentioned that it was with some hesitation that he accepted *K. microphylla* as being specifically different from *K. polifolia,* but that in Alaska, there does not seem to be any intermediate types. However, in 1968 he considered *K. microphylla* a subspecies of *K. polifolia.*

When these taxa are considered distinct the characters of plant and leaf size are the most commonly used for separation. *Kalmia polifolia* is a large shrub, 3 or more dm tall, the leaves are 2-4 cm long, 2½ to 3 times longer than broad, and the margins are usually strongly revolute. *Kalmia microphylla,* in contrast, is a much smaller plant, usually less than 1.5 dm tall, the leaves are usually less than 1.5 cm long, less than 2½ times as long as broad, and the margins are little if at all revolute. In most instances, these characters are sufficient to separate the two taxa; however, variation and overlapping of characters do occur. Other characters that have previously been overlooked are much more reliable in separating the two species. In *K. polifolia* clavate glands are present on the upper and lower surface of the leaf midrib, and the seeds are 1.5 to 2.2 mm long, while in *K. microphylla* these glands are absent, and the seeds are usually less than 1.3 mm long.

Kalmia microphylla is the only species of the genus found west of the Rocky Mountains. It extends from central California north to Alaska, and east through the Yukon and Northwest Territories to the extreme northwest corner of Manitoba. It is primarily a low-growing alpine shrub rarely exceeding 1 dm in height, but in bogs at lower elevations it may reach a height of 6 dm. The species consists of two varieties, one restricted to alpine and tundra areas, and one found in coastal lowland regions.

KEY TO VARIETIES

1. Leaves oval to broadly elliptic, usually less than 2 cm long and less than 2½ times as long as broad; calyx less than 7 mm broad. . . . . 1a. var. *microphylla.*
1. Leaves lanceolate, usually 2.5 cm long or longer, 2½ to 4 times as long as broad; calyx over 7 mm broad. . . . . 1b. var. *occidentalis.*

1a. **Kalmia microphylla** (Hooker) Heller var. **microphylla.**

Kalmia glauca Ait. γ *microphylla* Hook. Fl. Bor.-Amer. 2: 41. 1834. TYPE: swamps in the Rocky Mountains, *Drummond* (K). *Kalmia polifolia* var. *microphylla* Rehder in Bailey, Cycl. Am. Hort. 2: 854. 1900. (without basionym). *Kalmia polifolia* var. *microphylla* (Hooker) Hall, Univ.

California Publ. Bot. 4: 201. 1912. *Kalmia polifolia* ssp. *microphylla* (Hooker) Calder & Taylor, Canad. Jour. Bot. **43**: 1398. 1965.

Sparingly branched alpine shrub usually less than 1 dm tall (to 3 dm tall at lower elevations); nodes usually less than 1 cm apart; leaves ovate to oval to broadly elliptic, to 1.5 (rarely 2.5) cm long, less than 2½ times as long as broad; calyx pink to light green, 5-7 mm broad; corolla rose-purple 0.8-1.2 (rarely 1.5) cm broad; fruit 4-5 mm broad, 3.5-4.5 mm long; seeds 0.8-1.3 mm long.

Distribution: Mountainous regions of western North America from California, Nevada, Utah and Colorado north through the Rocky Mountains to the Yukon and Northwest Territories.

Common name: Alpine Laurel, Small-leaved Kalmia.

REPRESENTATIVE SPECIMENS

UNITED STATES: **Alaska:** Skagway, *Anderson* 1608 (ISC), *Eastwood* (GH). **California:** EL DORADO CO.: Echo Lake, *Beatle & Beatle* 3959 (ARIZ, DUKE, NY). FRESNO CO.: Marie Lake, *Kruckeberg* 3487 (RM, WS). HUMBOLDT CO.: Trinity Summit, *Davy & Blasdale* 5823 (US). INYO CO.: Pine Creek, *Duran* 3338 (GH, MICH, US). MADERA CO.: Shadow Creek, *Raven* (NY). MARIPOSA CO.: Crescent Lake, *Congdon* (MIN, WS). MODOC CO.: Dismal Swamp, *Weatherby* 1598 (NY, RM). MONO CO.: Treble Lake, *Munz* 19998 (NY). NEVADA CO.: Frog Lake, *Sonne* 438 (MU, PH, US). PLACER CO.: Squaw Valley, *Eggleston* 21607 (GH, NY, US, WS). PLUMAS CO.: Long Lake, *Hall* 9325 (GH, RM, US). SHASTA CO.: Lassen Nat'l Park, *Ferris & Lorraine* 10459 (GH, RM, US). SISKIYOU CO.: Mt. Shasta, *Cooke* 11296 (GH, OSC), 17654 (WS, WIU). TULARE CO.: Sky Blue Lake, *Howell* 25555 (US). TUOLUMNE CO.: Unicorn Creek, *Mason* 698 (GH). **Colorado:** BOULDER CO.: Brainard Lake, *Green* 279 (PENN). CLEAR CREEK CO.: Loveland Pass, *Robbins* 732 (ARIZ). GILPIN CO.: Forest Lake, *Roberts* (CM). JACKSON CO.: Cameron Pass, *Beaman & Erbisch* 1362 (MSC, RM). JEFFERSON CO.: Geneva Creek, *Livingston* 298 (DUKE). LARIMER CO.: Estes Park, *Cooper* 116 (RM), 157 (ARIZ, MIN, NMC, RM). ROUTT CO.: Routt Nat'l. Forest, *Weber* 6991 (WS). **Idaho:** BLAINE CO.: Sawtooth Peaks, *Macbride & Payson* 3707 (GH, RM, US). BOISE CO.: Middle Spangle Lake, *Hitchcock & Muhlick* 10130 (GH, NY, RM). BONNER CO.: Priest Lake, *MacDougal* 292 (NY). BOUNDARY CO.: Mt. Roothaan, *Daubenmire* 44289 (WTU). CLEARWATER CO.: Lolo Trail Rd., *Joslyn* 953 (ID), 954 (ID). FREMONT CO.: Henry Lake, *Payson & Payson* 2047 (GH, NY, RM). IDAHO CO.: Big Fog Mt., *Baker* 14762 (ID). SHOSHONE CO.: Little Lost Lake, *Wilson* 313 (GH, IDS, WS). VALLEY CO.: Boulder Lake, *Boone* 177 (ID). **Montana:** BEAVERHEAD CO.: Odell Lake, *Hitchcock & Muhlick* 14915 (NY, WS, WTU). CARBON CO.: Beartooth Mts., *Cronquist* 8068 (GH, NY, WS, WTU). DEER LODGE CO.: *Wate* (MONT). FLATHEAD CO.: Johns Lake, *Standley* 18513 (US). GALLATIN CO.: Spanish Peaks, *Vogel* (GH, MONT, US). GLACIER CO.: Hidden Lake, *Hitchcock* 1905 (MONT, RM). GRANITE CO.: Helena, *Kelsey* (MU, NY). LAKE CO.: McDonald Lake, *Hitchcock* 18343 (RM, WS, WTU). MADISON CO.: Old Hollowtop, *Rydberg & Bessy* 4654 (MONT). MISSOULA CO.: Lace Lake, *Rossbach & Rossbach* 184 (WTU). PARK CO.: Lady of the Lake, *Witt* 1233 (MINN, NY, WS, WTU). POWELL CO.: Upper Tincup Creek, *Trask* 117 (MONT). RAVALLI CO.: St. Mary's Peak, *Hitchcock & Muhlick* 15332 (NY, WS, WTU). STILLWATER CO.: Stillwater, *Hawkins* 35502 (MONT). SWEET GRASS CO.: Rainbow Lake, *Hitchcock* 16501 (CAN, IDS, NY, WS, WTU). TETON CO.: Henry Mts., *Williams* (GH). **Nevada:** ELKO CO.: Lamoille Lake, *Holmgren* 1404 (BRY, NY). WASHOE CO.: Mt. Rose, *Archer* 6425 (ARIZ, GH, NY, RENO). **Oregon:** BENTON CO.: Three Sisters, *Vechten* 212 (OSC). CLACKAMAS CO.: Clackamas Lake, *Bartlett & Grayson* 791 (NY). CROOK CO.: Des Chutes Nat'l. Forest, *Ferris & Duthie* 488 (RM). DESCHUTES CO.: Sparks Lake, *Bellinger* (WILLU). DOUGLAS CO.: Umpqua, *Ingram* 1515 (ORE). JACKSON CO.: Mt. Pitt, *Peck* 5184 (WILLU). KLAMATH CO.: Crater Lake *Applegate* 319 (US, WILLU), 345 (US). LANE CO.: McKenzie Pass, *Henderson* 16315 (ORE). LINN CO.: Hensley Meadows, *Coville & Applegate* 1152 (US). MARION CO.: Russell Lake, *Lee* 44 (OSC). UNION CO.: *Head* 1298 (OSC). WALLOWA CO.: Mirror Lake, *Peck* 1777 (NY, WILLU). **Utah:** DUCHESNE CO.: Mt. Agassiz, *Cottam & Biddulph* 3703 (BRY). SUMIT CO.: Motte Peak, *Payson & Payson* 5139 (CHRB, GH, PH, RM, US, WS). UINTAH CO.: Leidy Peak, *Maguire* 17679 (RM). UTAH CO.: Grandaddy Lakes Basin, *Stutz* 224 (BRY). **Washington:** CHELAN CO.: Ice Lake, *Morrill* 332 (MONT, ND, WTU). KITTITAS CO.: Mt. Stuart, *Elmer* 1103 (GH, K, MIN, US, WS). KLICKITAT CO.: Falcon Valley, *Suksdorf* (PH, WS, WTU). LEWIS CO.: Reflection Lake, *Townsend* (WS). OKANOGAN CO.: Slate Peak, *Ownbey & Meyer* 2302 (GH, IDS, ISC, MIN, NY, OSC, US). PEND OREILLE CO.: Sullivan Lake Dist., *Layser* 866 (WS). PIERCE CO.: Mt. Rainier, *Allen* 96 (CAN, GH, K, MIN, MSC, NY, US, WS). SKAMANIA CO.: Chiquash Mts., *Suksdorf* (WS). WHATCOM CO.: Mt. Baker, *Muenscher* 8077 (WS). YAKIMA CO.: Bird Creek Meadows, *Zuberbuhler* (WS). **Wyoming:** ALBANY CO.: Brooklyn Lake, *Nelson* 9226 (GH, MIN, RM). BIG HORN CO.: Upper Crater Lake, *Lofgren* 13 (MIN, NY, RM). CARBON CO.: Silver Lake, *Henry* (CM). FREMONT CO.: Gannett Creek, *Jozwik* 386 (GH, RM). JOHNSON CO.: Powder R. Pass, *Stephens* 40827 (VDB). LARIMER

CO.: North Park Range, *Goodding* 1839 (PENN). PARK CO.: Island Lake, *Truman* 54298 (WTU). SHERIDAN CO.: Dome Lake, *Pammel & Stanton* 62 (MIN). TETON CO.: Taggart Lake, *Williams* 1119 (ID, MIN, OSC, RM). YELLOWSTONE NAT'L. PARK: Artists Paint Pots, *Nelson & Nelson* 6170 (CM, ISC, MIN, GH, NY, RM, US).

CANADA: **Alberta:** Banff Nat'l. Park: Bow Pass, *Saunders* 11 (TRT); Lake Louise, *Brown* 578 (GH, PH, US), *McCalla* 2162 (ALTA, NY, US); Waterfowl Lake, *Walker* 2443 (PENN). Jasper Nat'l. Park: Athabasca Falls, *Moss* 2752C (ALTA, GH); Maligne Lake, *Scamman* 2664 (GH); Amethyst Lake, *MacFadden* 3246 (NO). Waterton Lakes Nat'l. Park: Summit Lake, *Moss* 975 (GH, NY, US); Upper Twin Lake, *Blais & Nagy* 1793 (CAN). Fairfax Lake, *Damais & Anderson* 2335 (ALTA); Mercoal, *Woollven* 6 (ALTA); Viewpoint, *Damais & Kempinsky* 5683 (ALTA); Virginia Hills, *Moss* 12469 (ALTA), 12503 (ALTA, CAN). **British Columbia:** Ernest C. Manning Prov. Park: Timberline Valley, *Hardy* 18501 (UBC, V); Three Brother Mts., *Underhill* 782 (V). Garibaldi Prov. Park: Castle Towers, *Davidson* (UBC). Glacier Nat'l. Park: Bald Mt., *Fogg, Jr.* 1273 (PENN, UBC); Eagle Mt., *Rosendahl* 944 (MIN). Kokanee Glacier Prov. Park: *Thompson* 14447 (CAN, GH, MICH, NY, PH, US, WTU). Kootenay Nat'l. Park: Ross Lake, *McCalla* 9603 (UBC, V); Emerald Lake, *Brown* (TRT). Mt. Assiniboine Prov. Park: Magog Lake, *Green* 551 (PENN). Mt. Revelstroke Nat'l. Park: *Calder & Savile* 10861 (NY, US), 8884 (NY, US). Tweedsmuir Prov. Park: *Trew* 17177 (V). Wells Gray Prov. Park: Battle Mt., *Ahti & Ahti* 6975 (V, WTU). Yoho Nat'l. Park: Emerald Lake, *Beer* (CM); Selkirk, *Shaw* 41 (GH, MIN, NY, PENN, US); Yoho Lake, *Pease* 22371 (MASS). Vancouver Island: Mt. Arrowsmith, *Taylor* 164 (TRT); Mt. Albert Edward, *Hett* 352 (V); Moat Lake, *Underhill* 299 (WTU). Atlin, *Szczawinski* (UBC, V). Caribou Pass, *Henry* 608 (GH, ISC); Ft. Steele, *Johnstone* (UBC, V); Lillooet, *Beamish & Vrugtman* 610710 (UBC); Mt. Hazel, *Slocomb* (V); Penticton, *Calder & Savile* 10751 (NY, RM, UBC, V, WS); Prince George, *Holland* (V); Sikanni Chief R., *Henry* 743 (PH); Summit Lake Landing, *Weber* 2589 (GH, WS); Skagit Valley, *Macoun* 72406 (ND, NY); Tenquille Lake, *Beamish & Vrugtman* 61010 (ID, UBC, WTU). **Manitoba:** Churchill, *Beckett* M-45-5 (MIN), *Ellis* 1287 (US), *Gillett* 1832 (ISC, US), *Gillis* 3244 (MSC), *Voss* 8999 (MICH), *Walker* 5090 (WIN); Tidal, *Brown* 178 (CAN, SASK). **Northwest Territories:** Aberdeen Lake, *Macpherson* 327 (CAN); Beverly Lake cabin, *Kuyt* 107 (CAN); Contwoyto Lake, *Thieret* 9415 (GH, US); Ennadai Lake, *Brown* 1320 (CAN); Gordon Lake, *Henderson* 19 (CAN); Great Bear Lake, *Porsild* 17117 (CAN), *Porsild & Porsild* 3429 (CAN), 3509 (CAN, US); Great Slave Lake, *Pike* (K); MacMillan Pass, *Porsild & Breitung* 11258 (CAN, GH, US); Maguse Lake, *Gussow* 33 (CAN); Nueltin Lake, *Harper & Porsild* 2211 (CAN, PH),

2246 (CAN), 2271 (MICH, MIN, PH), 2554 (MICH, MIN, NY); Small Tree Lake, *Maini & Swan* 506 (RM, SASK); Thelon Game Sanctuary, *Carroll* 65 (CAN); Yellowknife Highway, *Thieret & Reich* 7742 (CAN, MIN), 8121 (US). **Yukon:** Granite Mt., *Porsild & Breitung* 10576 (CAN, ISC, GH, US, WTU); Mayo Dist., *Bostock* 102 (CAN); McQueston Area, *Campbell* 493 (CAN); Mt. Sheldon, *Porsild & Breitung* 11094 (CAN, GH, US, WTU), 11485 (CAN, GH); pass between Teslin & Nisutlin R., *Porsild & Breitung* 11045 (CAN, NY), 11148 (CAN); St. Elias Mt., *Pearson & Porsild* 67-166A (CAN); Yukon-Mackenzie border, *Calder & Kukkonen* 27664 (ISC, NY); White Pass Summit, Bolton (US).

Plant and leaf size in *Kalmia microphylla* var. *microphylla* is controlled to some extent by the environment. In the typical alpine form the leaves are extremely small, usually less than 1.2 cm long. The type specimen, which represents this extreme, has leaves less than 1 cm long and is extremely short, less than 1 dm tall. At lower elevations the leaves are not uncommonly 2 cm long and the plant 2 dm tall. Rarely taller plants are found with leaves to 2.6 cm long. These larger leaved forms are superficially similar to *K. polifolia* and probably account for the variation in taxonomic treatment of *K. microphylla* in the past.

Kalmia microphylla and *K. polifolia* probably never come into contact with each other. In the Northwest Territories, however, the northern part of both their ranges, it is possible that the two taxa may occur together. The author has seen very few specimens of *K. polifolia* from the Northwest Territories, but this species is common in northern Alberta, Saskatchewan, and Manitoba. A few specimens of *K. microphylla* have been examined from the Northwest Territories, and this species extends all the way to the northwestern corner of Manitoba. No specimens, however, have been observed from Alberta or Saskatchewan. Sterile hybrids have been produced by crossing these two taxa (Jaynes, 1968a), but no specimens from northern Canada have been found that are morphologically similar to these hybrids.

The only other taxon with which *Kalmia microphylla* var. *microphylla* might be confused is *K. microphylla* var. *occidentalis.* Both taxa occur in western North America and their ranges overlap. The two are easily separated, however, since var. *occidentalis* has lanceolate leaves that are usually more than 2.5 cm long and 2½-4 times as long as broad, while var. *microphylla* has oval to eliptical leaves that are smaller and less than 2½ times as long as broad. Also, var. *occidentalis* has larger flowers, with the corolla more than 1.5 cm broad and the calyx 7-10 mm wide. Variety *microphylla,* by contrast, has smaller flowers, with the corolla less than 1.5 cm broad (usually less than 1.2 cm broad) and the calyx less than 7 mm wide.

Although both varieties are found in marshes, bogs, and other open wet areas, it appears that they rarely come into contact with one another. Of the var. *microphylla* specimens examined, most were collected at relatively high elevations according to the information available on the herbarium labels. The elevation at which this taxon was collected varied from an average altitude of 8,500 feet above sea level in California (5,200 to 11,500), to about 10,000 in Colorado, Nevada, Utah and Wyoming (7,000 to 12,500), to about 6,500 in Oregon (5,800 to 7,700), and to about 6,000 in Washington, Alberta and British Columbia (3,000 to 7,300). The altitudes in parentheses indicate the minimum and maximum elevations recorded from the labels. The information on the labels of specimens of var. *occidentalis* indicates that this species is found at lower elevations. Most of the specimens were from at or near sea level, but a few had been collected as high as 3,000 feet.

Kalmia microphylla var. *microphylla* and *K. microphylla* var. *occidentalis* apparently hybridize when they come into contact. A few specimens from Vancouver Island and the Cascade Mountains of Washington appear to be intermediate morphologically. These intermediate individuals are robust plants, 2-4 dm tall, similar in habit to the large-leaved var. *microphylla.* The leaves are 1.8-2.5 cm long, usually more ovate than lanceolate, and about twice as long as broad. The flowers are large, more typical of var. *occidentalis.* A few hybrids have been produced by crossing these varieties and they are highly fertile and set large quantities of seed (Jaynes, personal communication). Of the few suspected hybrids found, the pollen stainability varied from 10–90% normal pollen, indicating that some sterility occasionally results.

1b. **Kalmia microphylla** var. **occidentalis** (Small) Ebinger, comb. et stat. nov.

Kalmia occidentalis Small, N. Am. Fl. **29**: 53. 1914. TYPE: **Washington**: foothills of Mt. Rainier, 1883, *Mrs. Bailey Willis* (NY). *Kalmia polifolia* subsp. *occidentalis* (Small) Abrams, Ill. Fl. Pacific St. **3**: 302. 1951.

Sparingly branched shrub to 6 dm tall; leaves lanceolate, flat to slightly revolute margins, 2-4 cm long, some of the leaves always over 2 cm long and 2½-4 times as long as broad; calyx light pink, 7-10 mm broad; corolla usually rose-purple (rarely white), 1.5-2.0 cm broad; fruit 5-7 mm broad, 4.5-6 mm long; seeds 1-1.4 mm long.

Distribution: Along the western coast of North America from southern Alaska south to Oregon.

Common name: Western Swamp Kalmia; Western Bog Laurel.

REPRESENTATIVE SPECIMENS

UNITED STATES: **Alaska:** Admiralty Isl., *Hibber* 236 (UNM); Annette Isl., *Coville & Kearney* 381 (US); Douglas Isl., *Thorne* 10280 (UWM); Gravina Isl., *Anderson* 5352 (ISC), 2A599 (CAN, ISC); Kuiu Isl., *Rigg* 17 (WTU); Metlakatlan Isl., *Engstrom* (WTU); Mitkof Isl., *Brown* (ALA); Pleasant Isl., *Reiners* (HNH); Prince of Wales Isl., *Flett* 1976 (US); Revillagigedo Isl., *McCabe* 8590 (WTU); Woronkofski Isl., *Klein* 486 (ALA); Yakobi Isl., *Anderson* 1389 (US); Juneau, *Anderson* 6338 (ALA, BRY, CAN, GH, ISC, PH, RM, V); Mendenhall, *Anderson* 38 (CHRB); Petersburg, *Scamman* 515 (ALA, GH); Sitka, *Anderson* 160 (ISC, US); Wrangell, *Walker & Walker* 638 (CM, GH, NY, RM, US, WS); Yes Bay, *Gorman* 21 (K, NO, NY, US). **Oregon:** CLATSOP CO.: Gearhart, *Adair* (OSC); Knappa, *Bouch* (WTU); Delmoor, *Cooke* 10828 (OSC). **Washington:** GRAY HARBOUR CO.: Lake Quinault, *Thompson* 11429 (ALTA, GH, MONT, NY, PH, US, WS, WTU). ISLAND CO.: Whidbey Isl., *Smith* 480 (WS, WTU). KING CO.: Green Lake, *Benson* 1474 (WTU). MASON CO.: Lost Lake, *Jones* 6527 (PH, V, WTU). PACIFIC CO.: Ilwaco, *Foster* 865 (ORE, US). PIERCE CO.: Tacoma, *Sloan* (WTU). SAN JUAN CO.: Mt. Constitution, *Zeller & Zeller* 1193 (CM, GH, MIN, NY, US). SKAGIT CO.: Mt.

Higgins, *Thompson* 9639 (ND, US, WTU). SNOHOMISH CO.: Marysville, *Grant* (ARIZ, OAC, MU, RM, US). THURSTON CO.: Upper Valley of the Nisqually, *Allen* 4 (CAN, K, MIN, MSC, NY, US, WS). WHATCOM CO.: Custer, *Muencher & Muencher* 6007 (PH, US, WS).

CANADA: **British Columbia**: Aristazabal Isl., *McCabe* 3424 (WTU); Dewdney Isl., *Schofield* 70-27 (UBC); Goose Isl., *Martin & Guiquet* (V); Hope Isl., *Calder & Mackay* 31240 (CM, MIN); Lulu Isl., *Beamish & Vrugtman* 60519 (NY, OSC, UBC); Graham Isl., *Calder & Savile* 21349 (OSC, TRT, WS); Kunghit Isl., *Foster & Bigg* (UBC); Langara Isl., *Beebe* (V); Moresby Isl., *Calder & Taylor* 35771 (UBC); Prince Royal Isl., *McCabe* 3358 (WTU); Saltspring Isl., *Ashlee* (UBC, V); Vancouver Isl.: *Comox, Anderson* 483 (V); McCoy Lake, *Carter* 473 (US); Lost Lake, *Macoun* 618 (CAN, US); Port Hardy, *Racey* (UBC); Trout Lake, *Davidson* 6192 (UBC); Alice Arm, *Szczawinski* (V); Alouette R., *Garman* (V); Garibaldi Prov. Park, *Dow* D-2A-C (V); Haney, *Taylor* 1002 (UBC); Hope-Prince Hwy., *Brayshaw* 49470 (UBC); Kelsey Bay, *Calder & MacKay* 29204 (WTU); Kitsault, *Fisher* (UBC); New Westminster, *McCalla* 2944 (ALTA); Prince Rupert, *Mendel* 78 (V); Prudhomme Lake, *Taylor & Lewis* 618 (UBC); Terrace, *Szczawinski* (UBC, V).

Kalmia microphylla var. *occidentalis* has been considered specifically distinct only by Small (1914). In all floristic works of the west coast of North America this taxon has been considered a part of the eastern *K. polifolia,* although it has been rarely considered as a separate subspecies (Abrams, 1951). Hultén (1948) mentions that he was not able to separate the Alaskan specimens from those of Eastern America. He indicates, however, that a slight racial difference might exist, but that a large body of material would be necessary for a definite statement.

Kalmia microphylla var. *occidentalis* and *K. polifolia* are strikingly similar. Both have the same general habit and size, and except for a slight difference in flower size these structures are also the same. Under close morphological examination, however, these two species are easily separated. In *K. polifolia,* the leaf margins are usually revolute, and well developed stalked glands are present on both sides of the midrib. In *K. microphylla* var. *occidentalis,* by contrast, the leaves are not revolute, or only slightly so, and the stalked glands are absent. The two taxa also differ in seed size and calyx width. In *K. polifolia,* the seeds are long and narrow, 1.5-2.1 mm long, while the calyx varies in width from 5-7 mm. In *K. microphylla* var. *occidentalis*, the seeds are shorter and thicker, 1-1.4 mm long, and the calyx varies from 7-10 mm broad.

The geographic distribution of the two taxa also differs, and they never come into contact with one another. *Kalmia polifolia* is mainly an eastern species, occurring as far west as Saskatchewan and northeastern Alberta, while *K. microphylla* var. *occidentalis* occurs along the west coast from southern Alaska, south through British Columbia and from Washington to Oregon. Most of the specimens of var. *occidentalis* examined were from marshes, bogs and wet open areas at lower elevations from coastal areas and the islands off the coast of Alaska and British Columbia. Hultén (1968), who did not distinguish between these two species, shows this difference in distribution and also has an excellent drawing of *K. microphylla* var. ? *occidentalis* (as *K. polifolia* subsp. *polifolia*).

Cytologically, *Kalmia microphylla* var. *occidentalis* ($n = 12$) is more closely related to *K. microphylla* var. *microphylla* ($n = 12$) than it is to *K. polifolia* ($n = 24$). Crosses between var. *occidentalis* and *K. polifolia* result in triploid F_1 hybrids that produce less than 10% stainable pollen and no seeds (Jaynes, 1968a). In contrast, crosses between *K. microphylla* var. *microphylla* and var. *occidentalis* were highly fertile with the F_1's being intermediate between the two parents, producing viable seed and pollen that looked normal and fertile (Jaynes, personal communication).

Kalmia microphylla var. **occidentalis** f. **alba** Ebinger, forma nov.

Forma typicae habita statura etc. similis, floribus omnibus albis.

This white flowering form, which is similar to that found in some other species of *Kalmia*, has been collected at two different localities. **Alaska:** near Wrangell, *Mrs. J. C. Dart*, 1922. (US #1,118,961, Holotype). **British Columbia:** Lulu Island, peat bog between N. Westminster Highway and No. 4 road, *H. Rhodes, et al.*, 29 May 1954 (UBC).

2. **Kalmia polifolia** Wang., Schr. Berlin Ges. Naturf. Freunde 8: 130. 1788. TYPE: unknown.

Kalmia polifolia Ludwig, Neu. Wilde Baumz. 25. 1783. (nom. nud).

Kalmia glauca Loddiges ex Ludwig, Neu. Wilde Baumz. 25. 1783. (nom. nud.), Ait. Hort. Kew. 2: 64. 1789. TYPE: Plant growing in the Kew Gardens, (K).

Chamaedaphne glauca (Ait.) Kuntze, Rev. Gen. Pl. 2: 388. 1891.

Kalmia glauca var. *praecox* Lavallée Arbor. Segrez. 159. 1877. (nom. nud.).

Kalmia glauca var. *stricta* Jäger, Ziergeholze 279. 1865.

Kalmia glauca var. *superba* Makoy ex Bosse, Vollst. Handb. Blumengart. 2: 348. 1841. (nom. nud.), Jäger & Beissner, Ziergeholze 194. 1884. *Kalmia superba* K. Koch, Dendrologie 2(1) : 154. 1872. (nom. nud.).

Kalmia rosmarinifolia Dum.-Cours. Bot. Cult. 2: 250. 1802. TYPE: unknown. *Kalmia glauca β rosmarinifolia* (Dum.-Cours.) Pursh, Fl. Am. Sept. 296. 1814. *Kalmia polifolia* var. *rosmarinifolia* (Dum.-Cours.). Rehd. in Bailey, Cycl. Amer. Hort. 2: 854. 1900.

Kalmia oleaefolia Dum.-Cours. Bot. Cult. ed. 2. 3: 322. 1811. (as synonym).

Sparingly branched shrub to 1 m tall; branchlets slightly flattened, 2-edged, glabrous or puberulent, commonly with decurrent ciliate lines from the petiole base; leaves opposite, subsessile with a broad petiole to 2 mm long, coriaceous, linear to oblong, the margins usually revolute, 1.5-4 cm long, 0.3-1.3 cm broad, 2½ to 4 times as long as broad, whitened beneath with small hairs, the midrib covered with purple clavate hairs on both surfaces; inflorescence a few-flowered, terminal corymbiform raceme, each flower on a glabrous pedicel 1.5-3 cm long, each pedicel subtended by a pair of bractlets in the axis of a leaf-like bract; calyx deeply 5-lobed, colorless to light pink, 5-7 mm broad, the lobes obtuse, margins ciliate; corolla rose-purple, 1.2-1.8 cm broad; anthers purple, 1-1.5 mm long; fruit subglobose, 4-7 mm broad, 4-6 mm long; seeds 1.5-2.2 mm long, the testa extending past the ends of the seed. Chromosome number $n = 24$.

Distribution: Bogs, swamps, and other wet, open areas from northeastern Alberta east to the Atlantic Ocean and south to the Great Lakes, Pennsylvania, New York and New Jersey.

Common name: Bog Laurel, Swamp Laurel, Pale Laurel, Gold Withy.

REPRESENTATIVE SPECIMENS

UNITED STATES: **Connecticut:** HARTFORD CO.: Suffield, *Harger* 6524 (ARIZ), *Blewitt* 3490 (PH). LITCHFIELD CO.: Bingham Pond, *Weber* 1489 (ISC). NEW HAVEN CO.: Middlebury, *Shepard* (CONN). **Maine:** ANDROSCOGGIN CO.: Livermore, *Gordon* 657 (MAINE). AROOSTOOK CO.: Knoles Corner, *Neal* 1908 (MAINE), *True* 6068 (PENN). CUMBERLAND CO.: Standish, *Rossbach* 5599 (ACAD, MAINE). FRANKLIN CO.: Mt. Abraham, *Rossbach* 5389 (MAINE). HANCOCK CO.: Mt. Desert Isl., *Redfield* 4266 (US). KENNEBEC CO.: Monmouth, *Hyland* 90 (MAINE). KNOX CO.: Rockland, *Rossbach* 1429 (ACAD). OXFORD CO.: Old Spec, *Richards* 6032 (MAINE). PENOBSCOT CO.: Orono, *Fernald* 349 (GH, MASS, MIN, MSC, ND, NY, PH, US). PISCATAQUIS CO.: Greenville, *True* 4701 (PAC), 4814 (PENN). SOMERSET CO.: Jackman, *True* 4668 (PENN). WALDO CO.: Northport, *Rossbach* 2499 (ACAD), 5349 (MAINE). WASHINGTON CO.: Jonesport, *Steinmetz* 844 (MAINE). YORK CO.: Sunken Pond, *True* 214 (GH, PENN). **Massachusetts:** BERKSHIRE CO.: Wolf Swamp, *Walters* (NHA). ESSEX CO.: Andover, *Steele* (MU). FRANKLIN CO.: Hawley, *Forbes* 24 (MASS). HAMPDEN CO.: Ludlow, *Seymour* 557 (DUKE, GH, MASS, NY). HAMPSHIRE CO.: Belchertown, *Torrey* (MASS). MIDDLESEX CO.: Concord, *Eaton* (MAINE). WORCESTER CO.: Worcester, *Dowling* 818 (NY). **Michigan:** ALCONA CO.: *Hall & Hagenah* 447 (BLH). ALPENA CO.: *Hatt* (BLH). BARAGA CO.: Baraga, *Richards* 1783 (MICH, NY), 2956 (MAINE, MICH). CHARLEVOIX CO.: Beaver Isl., *Reis* 906 (BLH, MSC). CHEBOYGAN CO.: Mud Lake, *Gleason, Jr.* 665 (DUKE, GH). CHIPPEWA CO.: Sugar Isl., *McVaugh* 8745 (BLH, CAN, MICH). CLARE CO.: Lake Station, *Dreisbach* 5650 (MICH). CRAWFORD CO.: Hartwick, *Bingham* (BLH). DELTA CO.: Bull Run Creek, *Hagenah* 6723 (BLH). EMMET CO.: Carp Lake, *Gates & Gates* 10334 (RM). GOGEBIC CO.: Watersmeet, *Voss* 7846 (MICH), 12472 (MICH). GRAND TRAVERSE CO.: Traverse City, *Dieterle* 1299 (CM, MICH). GRATIOT CO.: Alma, *Davis* (MONT). HOUGHTON CO.: Laurium, *Herman* 7591 (NY, US). IRON CO.: Golden Lake, *Voss* 4122 (MICH). KALKASKA CO.: Carlisle, *Hagenah* 4602 (BLH). KEWEENAW CO.: Mott Isl., *Bailey & Bailey* 4131 (MICH).

LEELANAU CO.: Maple City, *Thompson* L-1693 (BLH). LENAWEE CO.: Clinton, *Wood & Wood* (US). LUCE CO.: Spring Lake, *Hagenah* 1913 (BLH). MACKINAC CO.: *Hagenah* 4876 (BLH). MANISTEE CO.: Manistee, *Daniels* 4267 (MONT). MARQUETTE CO.: Turin, *Barlow* (NY). MIDLAND CO.: Sanford Game Preserve, *Dreisbach* 7941 (MICH). MONTMORENCY CO.: Barding Swamp, *Case* (MICH). OAKLAND CO.: Lakeville, *Farwell* 4905 (BLH). OGEMAW CO.: Clear Lake, *Case, Jr.* (MICH). ONTONAGON CO.: Berglund, *Beaman* 1848 (MS). OSCEOLA CO.: Evart, *Monaghan* (MSC). OSCODA CO.: *Zimmerman* 416 (MICH). OTSEGO CO.: Otsego Lake Village, *Voss* 10847 (MICH). ROSCOMMON CO.: Higgins Lake, *Denton* 1038 (MSC). ST. CLAIR CO.: Capac, *Dodge* (MU, TENN). SANILAC CO.: Minden City, *Voss* 8341 (MICH). SCHOOLCRAFT CO.: Long Lake, *Voss* 2657 (MICH). WEXFORD CO.: Cadillac, *House* 4660 (US). **Minnesota:** BELTRAMI CO.: Star Isl., *Butters & Rosendahl* 6584 (MIN). CARLTON CO.: Atkinson, *Lakela* 3550 (DUL, MIN). CASS CO.: Lake Kilpatrick, *Ballard* (ORE, RM, US, WS). CLEARWATER CO.: Long Lake, *Morley* 1106 (MIN). COOK CO.: Sea Gull Lake, *Lakela* 3669 (DUL, MIN). CROW WING CO.: Bay Lake, *Sheldon* 2172 (MIN). ITASCA CO.: Sand Lake, *Johnson* 2042 (PH), 2207 (GH, US). KANABEC CO.: Mora, *Moore & Tryon, Jr.* 17504 (MIN). KOOCHICHING CO.: Rainy Lake, *Moore & Moore* 11793 (ISC, MIN). LAKE CO.: Basswood Lake, *Lakela* 8898 (DUL). PINE CO.: Bruno, *Jerabek* 66 (MIN). ST. LOUIS CO.: Palo, *Nickelson* 2432 (ISC, NY, WS). **New Hampshire:** BELKNAP CO.: Crystal Lake, *Hodgdon & Steele* 9125 (NHA). CARROLL CO.: Church Pond, *Gale* (NHA). CHESHIRE CO.: Keene, *Gilbert* (NY, PH). COOS CO.: Mt. Washington, *Hartmann* 207 (NY); *Moore* 260 (GY), 1081 (GY). GRAFTON CO.: Mt. Lafayette, *Fernald & Smiley* 11839 (GH). HILLSBORO CO.: Peterborough, *Batchelder* 1891 (KY). ROCKINGHAM CO.: Derry, *Batchelder* (NHA). STRAFFORD CO.: Barrington, *Hodgdon & White* 11935 (NHA). SULLIVAN CO.: Springfield, *Hodgdon & Steele* 9128 (NHA). **New Jersey:** MORRIS CO.: Mt. Hope, *Edwards & Rusling* (CHRB). SUSSEX CO.: Kittatinney Ridge, *Griscom* 9562 (GH). **New York:** CHAUTAUQUA CO.: Petit, *Thurber* (GH). COLUMBIA CO.: Knickerbocker Lake, *McVaugh* 1013 (PENN). ERIE CO.: Protection, *Miller* 3764 (MSC). ESSEX CO.: Whiteface Mt., *Rudd* 824 (US). FRANKLIN CO.: Upper Savanac Lake, *Guest* 132 (PAC, PENN). HAMILTON CO.: Bern Bog, *Henry* (CM). HERKIMER CO.: Twin Lake, *VanPelt & Long* (PH). MADISON CO.: Recksport, *House* 6930 (US). ONEIDA CO.: White Lake, *True* 38 (PENN). ONONDAGA CO.: Labrador Pond, *Clausen* 2129 (NY, PAC, PENN). OSWEGO CO.: Mud Pond, *Wiegand* 13764 (GH). ST. LAWRENCE CO.: Norfolk, *Phelps* 757 (GH, NY, US). SARATOGA CO.: Saratoga Lake, *House* 27663 (PENN). SCHENECTADY CO.: Princetown, *Svenson* (GH). SULLIVAN CO.: Neversink, *Jones, Phillips & Stebbins* 21 (GH). TIOGA CO.: Owego, *Mapes* 4767 (GH). ULSTER CO.: Rockland, *Camp* 3036 (NY). WASHINGTON CO.: Salem, *Stewart* 63 (NY). **Pennsylvania:**

CARBON CO.: Albrightsville, *Pretz* 13321 (PH). LACKAWANNA CO.: Elmhurst, *Glowenke* 4820 (PENN). MONROE CO.: Tannerville, *Leeds* 2237 (MIN, PH). PIKE CO.: Shohola Falls, *Byhouwer & Kobuski* 226 (GH). SUSQUEHANNA CO.: Ararat, *Glowenke* 134 (PENN). WAYNE CO.: Lehigh Pond, *Adams* 3699 (GH). **Rhode Island:** PROVIDENCE CO.: Glocester, *Collins* (CONN, GH, MASS, NHA, NY, PENN, PH). **Vermont:** ADDISON CO.: Ripton, *Eggleston* 280 (GH). CALEDONIA CO.: Peacham, *Blanchard* (PH, US). CHITTENDEN CO.: Colchester, *Pringle* (BRY). LAMOILLE CO.: Mt. Mansfield, *Moseley* (MASS). ORLEANS CO.: Lake Willoughby, *Stevens* (US). RUTLAND CO.: Mt. Tabor, *Seymour* 24407 (BRY). WINDHAM CO.: *Tyson, Moldenke & Moldenke* 10263 (NY). **Wisconsin:** BAYFIELD CO.: Sand Bay, *Cheney* 6371 (UWM). DOOR CO.: Bailey's Harbor Ridge, *Shinners* (UWM). FLORENCE CO.: Spruce Lake, *Mau* (UWM). FOREST CO.: Crandon, *Palmer* 27776 (GY). IRON CO.: Mercer, *Salamun* 228 (UWM). JACKSON CO.: *Ketchum, Hartley & Morrissey* 9158 (ISC). KEWAUNEE CO.: *Gregor* (OS). LINCOLN CO.: Tomahawk, *Engel* (UWM). MARINETTE CO.: Walsh, *Throne* (UWM). MONROE CO.: La Grange Twp., *Hartley* 7884 (MIN). ONEIDA CO.: Three Lakes, *Wadmond* 2758 (MIN). RUSK CO.: Ladysmith, *Goessl* 2162 (UWM). SHAWANO CO.: Camp Tivol, *Keefe* (UWM). TAYLOR CO.: Buch Lake Area, *Piehl* (UWM). VILAS CO.: Eagle River, *Hollister* 334 (US). WASHBURN CO.: Spooner, *Cheney* 6135 (UWM).

CANADA: **Alberta**: Lake Athabaska: Smith Landing, *Preble & Preble* 99a (US); Alta, *Raupp & Abbe* 4529 (ALTA, CAN, MIN, PH). Gregoire Lake, *Dumais & Anderson* 2693 (ALTA); Richardson Lake, *Whitehorn & Barber* 185 (SASK). **Labrador**: Anatolak, *Sewall* 469 (GH, US), 471 (GH, US); Ashuanipi Lake, *Harper* 3877 (CAN, MIN, US); Attikamagen Lake, *Harper* 3501 (CAN, ISC, MIN, PENN); Battle Harbour, *Koelz* 36 (MICH, US); Cape St. Charles, *Potter & Brierly* 3410 (GH, NMC); Cartwright, *Hitchcock* 23818 (US); Gannet Isl., *Potter & Brierly* 3411 (GH); Goose Bay, *Gillett & Findley* 4931 (ACAD, NY); Gready Isl., *Bishop* 474 (GH), 475 (GH); Hopedale, *Walker* 370 (PENN); Mealy Mts., *Gillett & Findley* 5273 (ACAD, NY, TRT, US); Mills Harbour, *Cook* 88 (GH, US); Petty Harbour, *Bishop* 476 (CAN, GH); Spotted Isl., *Wallace* 42 (CONN); Sandwich Bay, *Woodworth* 329 (GH), 330 (GH); Windy Tickle, *Potter & Brierly* 3407 (MASS). **Manitoba**: Baralzon Lake, *Scoggan & Baldwin* 8216 (GH, MIN, WIN); Cranberry Portage, *Freedmann* (WIN); Churchill Dist., *Schofield* 1001 (DUL, GH, MIN, WS); Duck Lake, *Scoggan & Baldwin* 8245 (ALTA, CAN, GH); Gillam, *Punter* 97 (WIN); Goldesand Lake, *Keleher* 107 (WIN); Heming Lake, *Keleher* 159 (WIN); Herchnier, *Core* 215 (WVA); Lake Winnipeg, *Lowe* (WIN); Lake Winnipegosis, *Scoggan & Baldwin* 8152 (CAN); Nelson River, *Scoggan* 3016 (ALTA, CAN, MIN, WIN); Nueltin Lake, *Baldwin* 2180 (CAN, TRT, WIN, WS); Oxford Lake, *Scoggan* 5390 (CAN); Reindeer Lake, *Bald-*

win 2028 (CAN, TRT, WIN); Seal River, *Ritchie* 1794 (CAN, MIN); Third Cranberry Lake, *Freedman* (WIN); Wabowden, *Gillett* 2790 (US); Whiteshell Forest Reserve, *Scoggan* 8781 (ALTA, WIN); York Factory, *Punter* 134 (WIN). **New Brunswick:** ALBERT CO.: Grindstone Isl., *Christie* 1576 (NBM). CHARLOTTE CO.: Campobello Isl., *Malte* 955/29 (CAN). GLOUCESTER CO.: Bathurst, *Malte* 13 (CAN). KENT CO.: Little Forks Brook, *Squires & Squires* (NBM). MADAWASKA CO.: St. Leonard, *Malte* 605 (CAN). QUEENS CO.: Castaway, *Gorham & Squires* (NBM). SAINT JOHN CO.: Portland, *Matthew* (NBM). WESTMORELAND CO.: Sackville, *Fowler* (QUK). YORK CO.: Fredericton, *Dore & Gorham* 4569 (ACAD). **Newfoundland:** BONAVISTA SOUTH DIST.: Lethbridge, *Rouleau* 8363 (NFLD). BURGEO-LA POILE DIST.: Grandy Brook, *Fernald, Long & Fogg* 359 (GH, PENN, PH). FERRYLAND DIST.: Witless Bay, *Rouleau* 5391 (CAN, NFLD, US). FOGO DIST.: Fogo Isl., *Sornborger* (GH). FORTUNE BAY-HERMITAGE DIST.: Hermitage Bay, *Palmer* 1353 (GH, US). GRAND FALLS DIST.: Bishop Falls, *Fernald & Wiegand* 6023 (CAN, GH, K, NY, PH). HUMBER DIST.: Eagle's Nest Brook, *Rouleau* 3069 (NFLD). ST. BARBE DIST.: Trout R., *Rouleau* 3515 (NFLD). ST. MARY'S DIST.: Colinet, *Rouleau* 4175 (NFLD). ST. JOHN'S DIST.: Doctor Hill, *Fernald, Long & Fogg* 1916 (GH, PENN, PH, US). TRINITY NORTH DIST.: George's Brook, *Rouleau* 6078 (NFLD). WHITE BAY DIST.: Twin Lakes, *Rouleau* 6525 (NFLD, US). **Northwest Territories:** Baralzo Lake, *Scoggan & Baldwin* 8335 (CAN), 8379 (CAN); Gagnon Lake, *Scotter* 3162 (CAN); Ingalls Lake, *S.C.Z.* (CAFB). **Nova Scotia:** ANNAPOLIS CO.: Karsdale, *Johnson* (ACAD). CAPE BRETON CO.: Scatari Isl., *Ershine* 51-1167 (QUK). COLCHESTER CO.: Folleigh Lake, *Perry* (ACAD). CUMBERLAND CO.: Sand R., *Schofield & Webster* 5592 (ACAD). DIGBY CO.: Central Grove, *Fernald & Long* 24285 (GH). GUYSBOROUGH CO.: Tor Bay, *Eshbaugh* 522 (IND). HALIFAX CO.: *Fernald, et al.* 24284 (GH, PH). HANTS CO.: Mt. Uniacke, *Jack* 3230 (GH), 3231 (GH). INVERNESS CO.: Mackenzie Mt., *Rossbach* 4235 (ACAD). KINGS CO.: Caribou Bog, *Erskine* (ACAD). LUNENBURG CO.: Deep Cove, *Smith, et al.* 19604 (ACAD, QUK). PICTOU CO.: New Glasgow, *Dore & Gorham* 45-389 (ACAD). QUEENS CO.: Eagle Head, *Donly* 1009 (ACAD). RICHMOND CO.: Grand R., *Smith, et. al.* 10110 (ACAD, TRT). SHELBURNE CO.: Barrington, *Fernald, Long & Linder* 22154 (CAN, GH). VICTORIA CO.: Cape Breton Nat'l. Park, *Armstrong* 452 (QUK). YARMOUTH CO.: Yarmouth, *Pease & Long* 22152 (GH, PENN). **Ontario:** ALGOMA DIST.: Michipicoten Harbour, *Hosie, Harrison & Hughes* 1223 (CAN, TRT). CARLETON CO.: Mer Blue, *Porsild* 7743 (CAN). COCHRANE DIST.: Fraserdale, *Kirk* 75 (TRT): Timmins, *Baldwin* 4761 (CAN, TRT). DURHAM CO.: Newtonville, *Krug & Purchase* 473 (TRT). FRONTENAC CO.: Kingston, *Beschel* 10128 (QUK). GREY CO.: Euphrasia Twp., *Jackson* (TRT). HALIBURTON CO.: Dorset, *Walshe* 12 (CAN, TRT). HURON CO.: Wingham, *Anderson* 724 (TRT). KENORA DIST.: Richmond Gulf, *Abbe & Abbe* 3383 (CAN, MIN); Las Seul, *Baldwin* 8739 (CAN, MIN, QUK, TRT); Big Trout Lake, *Moir* 13 (MINN), 21 (CAN, MIN), 1744 (MIN); Swan Lake, *Moir* 156 (MIN); Fort Severn, *Moir* 1337 (CAN, MIN); Black Duck R., *Moir* 1831 (MIN), 2037 (CAN, MIN, TRT); Windigo R., *Cringan* P-26 (ACAD, TRT). MANITOULIN DIST.: Great Duck Isl., *Grassel* 6028 (NY). MIDDLESEX CO.: London, *Baker* 1638 (OAC). MUSKOKA DIST.: Huntsville, *Soper & Shields* 4927 (TRT), 4967 (TRT); Margaret Lake, *Chow* 6415 (TRT). NIPISSING DIST.: Algonquin Park, *Watson* 3967 (TRT). PARRY SOUND DIST.: Axe Lake, *Shields & Shields* 1640 (TRT). PEEL CO.: Heart Lake, *Catling & Sparling* (TRT). RUSSELL CO.: Bourget, *Heimburger* 2612 (TRT). SUDBURY DIST.: Skead, *Winterhalder* 66114 (CAN). THUNDER BAY DIST.: Bear Trap Lake, *Voss* 10361 (MICH, TRT). TIMISKAMING DIST.: Hilliard Twp., *Baldwin & Breitung* 2564 (CAN, SASK, TRT). WATERLOO CO.: Baden, *Montgomery* 997 (GH, OAC). WELLAND CO.: Humberstone, *Soper & Dale* 3776 (GH, MIN, TRT, US). WELLINGTON CO.: Puslinch, *Stroud* (TRT). YORK CO.: Vandorf, *Robb* (TRT). **Prince Edward Island:** KING CO.: Bothwell, *Fernald & St. John* 11148 (CAN, GH, US, WS). PRINCE CO.: North Point, *Erskine & Dore* 1080 (ACAD, NY). QUEENS CO.: Brackley Point Rd., *Fernald, Long & St. John* 7901 (CAN, GH, PH, US, WS). **Quebec:** ABITIBI CO.: Watson Lake Area, *Bentley* 58145 (TRT), 5837 (CAN, TRT). BERTHIER CO.: Lanoraie, *Scoggan* 1538 (CAN). BONAVENTURE CO.: Nouvelle, *Collins & Fernald* (GY). CHAMBLY CO.: Saint-Bruno, *M.-Victoria & R.-Germain* 43884 (CM, GH, ND, PH). CHICOUTIMI CO.: Lac Merlac, *Brisson* 63124 (CAN). GASPE WEST CO.: Mt. Albert, *Scoggan* 1086 (CAN). GATINEAU CO.: Eardley, *Cody & van Rens* 11167 (DUKE, GH, MSC, NY, TENN). HULL CO.: King Mt., *Zavitz* 1107 (TRT). HUNTINGTON CO.: Covey Hill, *M.-Victoria & R.-Germain* 43300 (GH). LABELLE CO.: Nominingue, *Roy* 1167 (WVA), 3650 (ACAD, CONN, NY, RM, US). LAKE ST. JOHN WEST CO.: Peribonka, *M.-Victorin* 15849 (GH). LEVIS CO.: St. Nicolas, *Cayouette & Cayouette* 54-82 (TRT). MAGDALEN ISLANDS CO.: Grindstone Isl., *Fernald, et. al.* 7900 (CAN, PH, WS). MATANE CO.: Montagne Lake, *Boivin* 787 (PENN). MATAPEDIA CO.: Sayabee, *Scoggan* 13600 (CAN). MEGANTIC CO.: Black Lake, *Fernald & Jackson* 12137 (GH). MONTCALM CO.: Lac Tapani, *Pennell* 16686 (PH). MONTMAGNY CO.: Lake Monroe, *R.-Germain & Courtemanche* 454 (US). PAPINEAU CO.: Notre Dame du Laus, *C.-Joseph* 8508 (ACAD). PONTIAC CO.: Danford Lake, *Dore* 19994 (TRT). QUEBEC CO.: Montmorency Fall, *Macoun* 68560 (GH). RIMOUSKI CO.: Father Point, *Bartram & Long* 581 (PH). SAGUENAY CO.: Fort Chimo, *Porsild* 21873 (CAN); Knob Lake, *Harper* 3350 (HNH, QUK); Cairn Isl., *Abbe, et. al.* 3067 (RM); Seven Isl., *Robinson* 868 (CAN, GH, NY); Mutton Bay, *Lewis* 582 (CAN). ST. JEAN CO.: Villeneuve, *M.-Victorin, et. al.* 43047 (MU). SHERBROOKE CO.: Orford, *Forest* 16058 (CAN, CM, QUK, SASK). TERREBONNE CO.: St. Janvier, *Scoggan* 314 (CAN). TWO MOUNTAINS CO.: Oka, *M.-Victorin* 3223 (NY, US). WOLFE CO.: Lac Aylmer, *Hamel* 13217 (CAN). **Saskatchewan:** Athabaska Lake, *Lang* 188 (US); *Raupp* 6175 (CAN, GH, NY), 6657 (GH), 6731 (GH, NY); Bittern Cr., *Wheaton* (CAFB); Candle Lake, *Boivin & Breitung* 6157 (NY); Cree Lake, *Maini* 21 (RM, SASK), 235 (SASK), 236 (CAN, RM, SASK); Crooked R., *Breitung* 70 (SASK); Cumberland House, *Argus* 4083 (SASK); Hatchet Lake, *Maini* 91 (OAC, RM, SASK); Nipawin Prov. Park, *Argus* 4122 (SASK); Orley, *Breitung* 268 (ALTA, CAN, NY, US); Prince Albert Nat'l. Park, *Fraser* (PAC, SASK); Stoney Rapids, *Maini* 205 (RM, SASK), 275 (SASK), 462 (RM, SASK); White Fox, *Fraser* (SASK); Windrum Lake, *Bryenton* 166 (CAN).

The name *Kalmia polifolia* was first used by Ludwig (1783), who gave it the common name Canada Laurel or Poley Leaved Laurel, but did not describe it. This name first appears with a valid description a few years later (Wangenheim, 1788). He gives its distribution as extending northward from 45 degrees latitude in America, Nova Scotia and the colder parts of Canada. His description, illustration, and the distribution leave no doubt as to the taxon referred to. Recently, Boivin (1967) suggested that the name be spelled *poliifolia* to conform to article 73 of the International Code of Botanical Nomenclature (Lanjouw, 1966). The name *K. glauca* was first used as a synonym of *K. polifolia* by Ludwig (1783) and later described by Aiton (1789). The type was based on a plant from Newfoundland growing at Kew. A specimen in the Kew Herbarium has written on the label "Kalmia glauca Hort. Kews. sp. nov. 1784" and probably represents the type of this name. *Kalmia rosmarinifolia* was used by Dumont de Courset (1802) to distinguish individuals that have narrow leaves with strongly revolute margins. Later, he listed the name as a synonym of *K. glauca* (Dumont de Courset, 1811).

Kalmia polifolia is found in bogs, swamps, and other wet places, commonly forming a border around ponds and lakes. In bogs, its roots usually form dense mats that extend out over the water. It is also found at higher elevations in the mountains of northeastern United States and Canada. This species is the most widely distributed member of the genus, extending from northeastern Alberta, across Canada to the east coast and south to New Jersey. Its entire range, however, is hard to determine with certainty. There are two reports of its occurrence as far north as the Arctic Circle in the Northwest Territories (Gussow, 1933, and Thieret, 1963). Both of these (Maguse Lake, *Gussow* 33; Contwoyto Lake, *Thieret* 9415) are specimens of *K. microphylla* var. *microphylla*. The only specimens of *K. polifolia* seen from the Northwest Territories are from the extreme southern part (Scotter, 1966). In the Great Lakes region this taxon extends as far south as northern Illinois (Fuller, 1944), and along the east coast to New Jersey (Griscom, 1931). This species has also become naturalized in Europe since Scott (1962) reported that it has been collected from Flanders Moss, Perthshire, Scotland.

Besides leaf size and shape, the character most commonly used by previous authors to separate *Kalmia polifolia* from *K. microphylla* is revolute leaf margins. In *K. microphylla*, the leaf margins are not revolute, or only slightly so, while in *K. polifolia* the margins are usually strongly revolute. This characteristic is somewhat variable. In about 80% of the specimens examined, the leaf margins were strongly revolute, resulting in a narrow, linear leaf. In the remaining specimens, some lacked revolute margins entirely, while in others the younger leaves were revolute while older leaves were not. The variability of this characteristic is responsible, in part, for the confused taxonomic status of *K. microphylla*.

The major distinguishing vegetative character that separates *Kalmia polifolia* from the related species, *K. microphylla*, is the presence of purple clavate hairs on the leaf midrib. Boivin (1968) appears to be the first to have made use of this character when he separated variety *microphylla* from variety *polifolia*. He mentions, however, that west of Alberta the distinction of the two varieties becomes meaningless, as most of the British Columbia material is intermediate, the leaves being long and narrow like variety *polifolia*, but glandless on the midrib. It appears that he was confusing *K. polifolia* with the western *K. microphylla* var. *occidentalis,* which is similar vegetatively, except for the glandless midribs. Clavate glands were found on all specimens of *K. polifolia* examined. These glands vary in size, shape and color, and are more plentiful on some specimens than on others. The glands average about 0.3 mm long, are colorless near the base and become deep purple to black toward the swollen apex. In some specimens, however, they are nearly colorless throughout, and in others barely expanded above. Also, their distribution varies, being more common on some leaves than on others. On older leaves, it is not uncommon to find that many of the glands have broken off. The glands on the upper side of the midrib are commonly shorter, darker colored and not as obvious as those on the under side of the leaf. For determining the presence of these glands it is best to look at the developing leaves.

Morphologically and genetically *Kalmia polifolia* ($n = 24$) is most closely related to *K. microphylla* ($n = 12$). The F_1 of a cross between these two species is a highly viable triploid which has a pollen stainability of 0-15% (Jaynes, 1968a). These similarities suggest that these two taxa have probably become specifically distinct as a result of the last ice age and the resulting development of a tetraploid taxon from a wide ranging ancestral diploid species. Jaynes (1969) suggested that these taxa should be considered separate species based on his cytological and genetic studies. *Kalmia polifolia* can also be crossed with other members of the genus, but few viable offspring are produced.

Kalmia polifolia forma **leucantha** Schofield & Smith, Canad. Field Nat. 67: 94. 1953. TYPE: **Newfoundland:** near Hodgewater Line, Trinity South, *E. E. Smith* and *A. C. Smith* 1055 (ACAD).

This white flowering form, which is similar to that found in some of the other species of *Kalmia,* is known from one collection. This single specimen was found in a bog where the typical form was very common.

3. **Kalmia latifolia** Linnaeus, Sp. Pl. **1**: 391. 1753.
TYPE: "Habitat in Marilandia, Virginia, Pennsylvania" (LINN 560.1, lectotype, specimen at the top right).

Chamaedaphne latifolia (L.) Kuntze, Rev. Gen. Pl. **2**: 388. 1891.

Kalmia latifolia var. *acuminata* Raf. Medical Fl. **2**: 17. 1830. (nom. nud.).

Kalmia latifolia var. *alba* Raf. Medical Fl. **2**: 17. 1830. *Kalmia latifolia* f. *alba* (Mouillefert) Rehd. Rhodora **12**: 2. 1910.

Kalmia latifolia var. *arborea* Raf. Medical Fl. **2**: 17. 1830 (nom. nud.).

Kalmia latifolia var. *pavarti* André, Revue Hort. **60**: 541. 1888.

Kalmia latifolia f. *rubra* K. Koch, Dendrologie 2(1) : 152. 1872. *Kalmia latifolia* var. *rubra* (K. Koch) Rehd. in Bailey, Cycl. Amer. Hort. **2**: 854. 1900.

Kalmia latifolia var. *ternata* Raf. Medical Fl. **2**: 17. 1830.

Kalmia latifolia var. *laevipes* Fern. Rhodora **42**: 53. 1940. TYPE: **Virginia**: NORFOLK CO.: dry woods of a "hammock", Great Dismal Swamp, west of Yadkin, *Fernald & Long* 11101 (GH).

Kalmia lucida K. Koch, Dendrologie 2(1) : 152. 1872. (as synonym).

Kalmia nitida Forbes, Hort. Woburn. 93. 1833. TYPE: unknown, probably a living plant.

Much branched shrub to 4 m tall (rarely a small tree); branchlets terete, reddish brown, becoming gray, stipitate-glandular to glabrous; leaves alternate (appearing nearly whorled on slow growing twigs), flat, coriaceous, elliptic to elliptic-lanceolate, 4-12 cm long, 1.5-4 (rarely 5) cm wide, dark green and glabrous above, light green to reddish brown and with short glandular hairs beneath, apex acute, base narrowly cuneate, midrib puberulent above; petiole 1-3 cm long, glabrous to puberulent, sometimes glandular-stipitate; inflorescence a terminal, compound corymb; pedicels 2-4 cm long, puberulent to stipitate-glandular, often floccose, viscid (rarely glabrous), subtended by 2 bracteoles in the axil of a puberulent, lanceolate bract, 1-5 mm long; major inflorescence branches puberulent, usually stipitate-glandular, to 4 cm long; calyx glabrous to stipitate glandular, green to reddish, 5-8 mm broad, the lobes usually oblong, acute; corolla usually light pink (white to deep red) with purple spots around each anther pocket, usually lightly stipitate-glandular outside, puberulent inside, 1.5-3 cm broad; style 1-1.8 cm long; anthers dark purple to brown, 1.2-1.7 mm long; filaments puberulent; capsule depressed globose, stipitate-glandular, 4-7 mm broad, 3-5 mm long; seeds .7-1 mm long, the testa loose and extending slightly past the ends of the seed.

Distribution: Mostly rocky or sandy hardwood forests in eastern United States from southern Maine, west through southern New York to central Ohio, south to southern Mississippi, Alabama, and Georgia and northwestern Florida.

Common Name: Mountain Laurel, Broad-leaved Laurel, Calico-bush, Spoonwood, Ivy, Mt. Ivy, Big-leaved Ivy, Laurel-leaves, Calmoun.

REPRESENTATIVE SPECIMENS

Alabama: CALHOUN CO.: *Pendergrass* (TENN). CHEROKEE CO.: Centre, *Clonts* 95 (ISC). CHOCTAW CO.: Silas, *McDaniel* 4218 (VDB). CLARKE CO.: Tallahatta Creek, *Kral* 19749 (VDB). CLEBURNE CO.: *Kral* 31843 (VDB). CONECUH CO.: Castleberry, *Howell* 760 (US). CULLMAN CO.: Cullman, *Kral* 28911 (VDB). DALE CO.: Newton, *Godfrey* 55477 (TENN). DE KALB CO.: Mentone, *Demaree* 50521 (TENN). ESCAMBIA CO.: Little Escambia River, *Ahles* 7229 (MISSA). FRANKLIN CO.: Russellville, *Kral* 26321 (VDB). HENRY CO.: Headland, *Wiegand & Manning* 2370 (CU). JACKSON CO.: Flat Rock, *Kral* 34948 (VDB). LEE CO.: Chewacla, *Barnes* 119 (VDB). MARION CO.: Hackelberg, *Kral* 20024 (VDB). MARSHALL CO.: Albertville, *Harbison* 15887 (TENN). MOBILE CO.: Mt. Vernon, *Burnham* 84 (VDB). PIKE CO.: Troy, *McDaniel* 7830 (VDB). TUSCALOOSA CO.: Lake Nichols, *Williams* 104 (VDB). WASHINGTON CO.: Bates Creek, *Segars* 191 (WVA). WINSTON CO.: Haleyville, *Kral* 29476 (VDB). **Connecticut:** FAIRFIELD CO.: Wilton, *Eames* 10426 (CONN). HARTFORD CO.: Windsor, *Ahles* 65351 (MASS). LITCHFIELD CO.: Preston, *Lumsden* (MU). MIDDLESEX CO.: Millers Pond, *North* 51 (MICH, US). NEW HAVEN CO.: Milford, *Eames* 2813 (CONN). NEW LONDON CO.: Lantern Hill, *Glea-*

son (DUKE). TOLLAND CO.: Andover, *Travis* 2408 (CONN). WINDHAM CO.: Crystal Lake, *Peterson* (CU). **Delaware:** NEW CASTLE CO.: Arden, *Travis* 1086 (PENN). SUSSEX CO.: Gumboro, *Beaven* 241 (DUKE). **Florida:** ESCAMBIA CO.: McDavid, *Goodale* (MASS). GADSDEN CO.: Sycamore, *Godfrey* 61925 (MSC). HOLMES CO.: Darlington, *Godfrey* 55498 (TENN). LIBERTY CO.: Greensboro, *Karl* 1916 (TENN). OKALOOSA CO.: Laurel Hill, *Godfrey* 61284 (US). WALTON CO.: De Funiak Springs, *Perkins & Hall* 2510 (CU). **Georgia:** CLARK CO.: Middle Oconee River, *Duncan & Duncan* 4358 (ID, IND, ISC, PENN, RENO, TENN, US). CLAY CO.: Cemochechahee Creek, *Thorne* 3453 (CU). DADE CO.: Lookout Mt., *McVaugh* 9023 (MICH). EARLY CO.: Sawhatchee Creek, *Duncan & Thorne* 1778 (CU, TENN). EFFINGHAM CO.: Savannah River, *Harper* 1814 (US). GWINNETT CO.: McGuires Mill, *Small* (US). MORGAN CO.: Hard Labor Creek St. Park, *Jones* 15456 (VDB). PICKENS CO.: Jasper, *Cronquist* 4483 (NO, US). RABUN CO.: Darling Spring, *J.H.M.* E1525 (WVA). RANDOLPH CO.: Cuthbert, *Harbison* 13729 (TENN). SCREVEN CO.: Newington, *Cronquist* 5023 (MICH, US, WS). SUMTER CO.: Americus, *Harper* 523 (US). UNION CO.: Vogel St. Park, *McVaugh & Pyron* 841 (ORE). UPSON CO.: Flint River, *Browne & Browne, Jr.* 6587 (KY). WALKER CO.: Pigeon Mt., *Wilson* 176 (US). WALTON CO.: Athens, *Cronquist* 4468 (MICH, NO, US). WHITE CO.: Cleveland, *Lovett* (DUKE). WHITFIELD CO.: Dalton, *Cronquist* 5045 (MICH, US, WS). **Indiana:** CLARK CO.: Borden, *Deam* 24495 (IND, MIN). CRAWFORD CO.: Riddle, *Deam* 16497 (IND). PERRY CO.: Derby, *Ramsey* 10876 (IND). **Kentucky:** BELL CO.: Pike Mt. St. Park, *Collins* 180 (KY). BREATHITT CO.: Robinson Forest, *Smith* 1726 (KY). CARTER CO.: Cascade Cavern, *Gilbert & McCoy* 3513 (US). CASEY CO.: Liberty, *Wharton* 4366 (KY). EDMONSON CO.: Mammoth Cave Nat'l. Park, *Pittillo* 2452 (KY). ESTILL CO.: South Irvine, *Wharton* 2298b (KY, MICH). FLEMING CO.: Plummer's Mill, *Wharton* 3873 (KY). FLOYD CO.: Hueysville, *Centers & Blair* 77 (KY). GRAYSON CO.: Clifty Creek, *Browne & Browne, Jr.* 6494 (KY). HARLAN CO.: Poor Fork, *Kearney* 182 (ISC, MSC, OS, US). JESSAMINE CO.: Camp Daniel Boone, *Webb* 104 (KY). KNOTT CO.: Littcarr, *Smith* 59 (KY). LETCHER CO.: *Browne & Browne, Jr.* 5400 (KY). LEWIS CO.: Vanceburg, *Wharton* 5012 (KY, MICH). LINCOLN CO.: Ottenheim, *Wharton* 4866 (KY, MICH). MCCREARY CO.: Cumberland Falls, *Rogers* 55 (DUKE, IND, MIN, PENN, TENN, US, WVA). MADISON CO.: Berea, *Nelson* (MICH, MIN, MU). MENIFEE CO.: Frenchburg, *McInteer* 2302 (KY). MORGAN CO.: Ezel, *Oldfield* 57 (KY). POWELL CO.: Stamping Ground, *Singer* (BRY). PULASKI CO.: Mt. Victory, *Warden* 129 (KY). TODD CO.: Clifty, *McCoy* (WVA). TRIMBLE CO.: Bedford, *Born* (KY). WOLFE CO.: Sky Bridge, *McInteer* 1055 (KY). **Louisiana:** WASHINGTON PARISH: Bogalusa, *Cocks* (NO); Varnodo, *Thieret* 23481 (DUKE).

Maine: CUMBERLAND CO.: Richville, *Hyland* 444 (MAINE). OXFORD

CO.: Fryeburg, *Hyland* 446 (MAINE). PENOBSCOT CO.: Carmel, *Harvey* 622 (US). SAGADAHOC CO.: Phippsburg, *Gordon* 592 (MAINE). WASHINGTON CO.: Cherryfield, *Hyland* 760a (MAINE). YORK CO.: Kennebunk, *Hyland* 252 (MAINE). **Maryland:** ALLEGANY CO.: Cumberland, *Richards* 128 (MAINE). ANNE ARUNDEL CO.: Camp Whippoorwill, *Grimes* (WVA). BALTIMORE CO.: Abingdon, *Nieuwland* (ND). CAROLINE CO.: Newton, *Quidas* 37 (MAINE, PENN). CECIL CO.: Elkton, *Randolph & Randolph* 124 (CU). FREDERICK CO.: Hunting Creek, *Earle* 1872 (PENN). GARRETT CO.: Grantsville, *Stone* 14111 (PENN). KENT CO.: Chestertown, *Vanatta* (CHRB). PRINCE GEORGE CO.: Suitland, *Meyer* 9178 (ISC, WVA). QUEEN ANNES CO.: Chester River, *Thatcher* 5 (MIN). ST. MARY'S CO.: Patuxent River, *Grether* 8276 (MICH). TALBOT CO.: Easton, *Earle* 810 (PENN). WASHINGTON CO.: Boonsboro, *Tidestrom* 724a (US). WICOMICO CO.: Sharptown, *Tidestrom* 12228 (MICH). WORCESTER CO.: Ferry Creek, *Redmond* 225 (MICH). **Massachusetts:** BERKSHIRE CO.: Williamstown, *Ames* (MICH). BRISTOL CO.: New Bedford, *Bartlett* 319 (IND, MICH). ESSEX CO.: Newburyport, *Mock* (NHA). FRANKLIN CO.: Mt. Toby, *Elwell* (MASS). HAMPDEN CO.: Granville, *Seymour* 197 (MASS). HAMPSHIRE CO.: Amherst, *Elwell* (MASS). MIDDLESEX CO.: Concord, *Mann* (HNH). NORFOLK CO.: Dedham, *Greenman* 2371 (MIN). PLYMOUTH CO.: Plymouth, *Morong* 1184 (US). WORCESTER CO.: Brookfield, *Markert* (MASS). **Mississippi:** CLARKE CO.: Burstone Cuesta, *Jones* 12050 (VDB). FORREST CO.: McCallum, *Ray, Jr.* 6045 (MISSA). GEORGE CO.: Cedar Creek, *Demaree* 35222 (VDB). HARRISON CO.: Gulfport, *Bomhard* 33 (NO). HINDS CO.: Natchez Trace Parkway, *Price* (MISSA). JACKSON CO.: Van Cleave, *Demaree* 32454 (DUKE). JASPER CO.: Rose Hill, *Reynolds* 96 (MISSA). LAUDERDALE CO.: Meridian, *Hayes* 20 (MISSA). LINCOLN CO.: Boque Chitto, *Ray, Jr.* 7830a (MISSA). PEARL RIVER CO.: Picayune, *Ray, Jr.* 6519 (MISSA). STONE CO.: Perkinson, *Ray, Jr.* 7713 (MISSA). TISHOMINGO CO.: Fisherman Ford, *Ray, Jr.* 7507 (MISSA, VDB). WAYNE CO.: Clara, *Graham* 118 (MISSA). **New Hampshire:** BELKNAP CO.: Center Harbor, *Hodgdon, et. al.* 9507 (NHA). CARROLL CO.: Albany, *Pease* 25358 (MAINE). CHESHIRE CO.: Fitzwilliam, *Hodgdon* 7069 (HNA). GRAFTON CO.: Hanover, *Drew* (HNH). HILLSBORO CO.: Manchester, *Hodgdon & Kent* 7070 (NHA). MERRIMACK CO.: Hooksett, *Hall* (NHA). ROCKINGHAM CO.: Windham Center, *Harris* 430 (NHA). STRAFFORD CO.: Farmington, *Lord* (NHA). **New Jersey:** ATLANTIC CO.: Alsion, *Crow* 126 (MSC). BERGEN CO.: Palisades, *Gershoy* (CU). BURLINGTON CO.: Pemberton, *Palmer* 39752 (MICH, MIN). CAMDEN CO.: Gibbsboro, *Hynes* (PENN). CAPE MAY CO.: Dennisville, *Fender* 5049 (PENN). CUMBERLAND CO.: Gouldtown, *Long* 575 (ARIZ, CAN, CU, IND, ISC, KY. NHA, NO, TENN, UARK, WVA). ESSEX CO.: Millburn, *Rusby* 1710 (MICH). GLOUCESTER CO.: Mantua, *Adams* 258 (PENN). HUNTERDON CO.: Fairmount, *Good* (CHRB). MIDDLESEX CO.: Spotswood, *Laugh-*

ridge & Chrysler (CHRB). MONMOUTH CO.: Clarksburg, *Fogg, Jr.* 14129 (PENN). MORRIS CO.: Longwood, *Davidson* 764 (CHRB). OCEAN CO.: South Lakewood, *MacKenzie* 3116 (US). PASSAIC CO.: Uttertown Bog, *Montgomery* (CHRB). SALEM CO.: Auburn, *Fogg, Jr.* 6606 (CHRB, PENN). SOMERSET CO.: Willowood estate, *Blackburn* (CHRB). SUSSEX CO.: Kittatinny Ridge, *Davidson* 1509 (CHRB). WARREN CO.: Sand Pond, *Large & Clausen* 1280 (CU). **New York:** BRONX CO.: Bronxdale, *Burnham* 428 (CU). CATTARAUGUS CO.: Rock City Park, *Muenscher* 15841 (CU). CHEMUNG CO.: Susquehana River, *Lucy* 6616 (MU). COLUMBIA CO.: Ghent, *McVaugh* 881 (PENN). DELAWARE CO.: Deposit, *Muenscher* 16244 (CU). DUTCHESS CO.: *Clove, Standley & Bollman* 12138 (US). GREENE CO.: Winter Clove Mt., *Gershoy* (CU). NASSAU CO.: Woodbury, *Stewart* (CU). ONEIDA CO.: New London, *House* 27859 (CU). RICHMOND CO.: Haverstraw, *Fosberg & Fosberg* 14897 (PENN). ROCKLAND CO.: Ramapo, *Gershoy* (CU). SCHUYLER CO.: Cayuta Lake, *Muenscher & Brown* 21703 (CU). STEUBEN CO.: Painted Post, *Muenscher* 15842 (CU). SUFFOLK CO.: Southampton, *St. John* 2852 (CU). SULLIVAN CO.: Camp Ranachqua, *Weber* 272 (ISC). TIOGA CO.: Spencer, *Eames & McDaniels* 4765 (CU). TOMPKINS CO.: Enfield, *Palmer* 928 (IND). ULSTER CO.: Lake Minnewaska, *Gillis* 3090 (MSC). WESTCHESTER CO.: Ossining, *Gershoy* (CU, MU).

North Carolina: ALEXANDER CO.: *Keever* 21 (DUKE). BUNCOMBE CO.: Asheville, *McCarthy* (US). BURKE CO.: Shortoff Mt., *Wilbur* 7004 (VDB). CALDWELL CO.: Granite Falls, *Randolph & Randolph* 1085 (CU). CHATHAM CO.: *Costello* 14 (DUKE). CLAY CO.: Perry Gap Road, *Wilbur* 1275 (MIN, DUKE). CUMBERLAND CO.: Rockfish Creek, *Correll & Rankin* 9053 (DUKE). DURHAM CO.: Catsburg, *Wilbur* 12230 (DUKE). EDGECOMBE CO.: Tar River, *Fox & Whitford* 1746 (DUKE). FORSYTH CO.: *Schallert* 1092 (DUKE). GASTON CO.: Kings Mt., *Oosting* 1646 (DUKE). GRAHAM CO.: Thunderhind Mt., *Beardslee & Kofoid* (MU). GRANVILLE CO.: Tar River, *Correll* 516 (DUKE, MASS). HARNETT CO.: Bunnlevel, *Laing* 1104 (MIN). HAYWOOD CO.: Waynesville, *Standley* 5401 (US). HENDERSON CO.: Hendersonville, *Cottam* 11140 (UT). JACKSON CO.: Wesner Bald, *Ramseur* 171 (MAINE). JOHNSTON CO.: Neuse River, *Fox & Whitford* 1293 (DUKE, WS). LEE CO.: Deep River, *Beard* 405 (KY). MCDOWELL CO.: *Rogers* 8358 (DUKE, US). MACON CO.: Mt. Satula, *Harbison* 1848 (TENN). MADISON CO.: Hot Springs, *Wehmeyer* 533 (MICH). MITCHELL CO.: Roan Mt., *Cannon* 143 (CU). MOORE CO.: Carthage, *Harriot* (NO). ORANGE CO.: Hillsboro, *Correll* 325 (DUKE). POLK CO.: Columbus, *Townsend* 236 (CU). ROCKINGHAM CO.: Smith River, *Correll & McDowell* 10695 (DUKE). SCOTLAND CO.: Laurel Hill, *Wiegand & Manning* 2369 (CU). STANLY CO.: Badin, *Fox, Godfrey & Boyce* 1427 (DUKE, TENN, US, WS). STOKES CO.: Sauratown Mt., *Radford* 34665 (ISC). SURRY CO.: Pilot Mt., *Williams* 296 (DUKE). SWAIN CO.: Andrews Bald, *Bruhn* 4 (TENN). TRANSYLVANIA CO.:

Rosman, *Morley* 891 (ISC). UNION CO.: Rocky River, *Ahles & Haesloop* 31521 (UARK). WAKE CO.: Raleigh, *Godfrey* 3765 (US). WATAUGA CO.: Boone, *Ahles & Duke* 43728 (PAC). WAYNE CO.: Mt. Olive, *Rose* 36 (MASS). WILKES CO.: *Wyatt* 832 (ARIZ, BRY, NHA, VDB). **Ohio:** ADAMS CO.: Mineral Springs, *Herrick* (OS). ATHENS CO.: Athens, *Kellerman* (OS). COLUMBIANA CO.: *Sanders* (OS). COSHOCTON CO.: New Castle Twp., *Selby* (OS). CUYAHOGA CO.: Bayville, *Biebel* (OS). FAIRFIELD CO.: Sugar Grove, *Potzger* 2969 (ND). GALLIA CO.: *Jones* (OS). GUERNSEY CO.: Liberty Twp., *Thomas* (OS). HOCKING CO.: Clear Creek, *Stuckey* 2912 (OS). HOLMES CO.: Killbuck Twp., *Herrick* (OS). JACKSON CO.: Liberty Twp., *Bartley & Pontius* (OS). JEFFERSON CO.: Amsterdam, *Cusick* (OS). KNOX CO.: Pipesville, *Moldenke* 12186 (OS). LAWRENCE CO.: Hanging Rock, *Werner* (OS). LICKING CO.: Blackland Gorge, *Stuckey* 6603 (OS). MEIGS CO.: Columbia Twp., *Jones* (OS). MONROE CO.: Adams Twp., *Thomas* (OS). MORGAN CO.: Bur Oak St. Park, *Herrich* (OS). MUSKINGUM CO.: Laurel Hill, *Reed* (OS). PERRY CO.: Jonathan Creek, *Hicks & Dambach* (OS). PIKE CO.: Chimney Rocks, *Crowl* (OS). ROSS CO.: Tar Hollow, *Crowl* (OS). SCIOTA CO.: Cooper Head Fire Tower, *Demaree* 10664 (OS). TUSCARAWAS CO.: Wayne Twp., *Brown* (OS). VINTON CO.: Lake Hope St. Park, *Stuckey* 6407 (OS). WASHINGTON CO.: Vincent, *Walpole* 1129 (BLH). **Pennsylvania:** ADAMS CO.: Birch River, *Tanger* 4434 (PENN, WS). ALLEGHENY CO.: Tom's Run Rd., *Henry & Buker* (PENN). ARMSTRONG CO.: Sherrett, *Henry* (PENN). BEDFORD CO.: Tatesville, *Berkheimer* 982 (PENN). BERKS CO.: Bechtelsville, *Fender* 1022 (PENN). BLAIR CO.: Blue Knob, *Westerfeld* 16177 (PAC). BRADFORD CO.: Canton, *Westerfeld* 907 (PAC, PENN). BUCKS CO.: Janney, *Long* 76067 (PENN). BUTLER CO.: Clintonville, *Brubaker* 2537 (PENN). CAMBRIA CO.: Johnstown, *Tinan* (OS). CAMERON CO.: Sinnemahoning Creek. *Fogg, Jr.* 11555 (PENN). CARBON CO.: Little Gap, *Fogg, Jr.* 11900 (MIN, PENN). CENTRE CO.: Yarnell, *Keener* 2581 (PAC). CHESTER CO.: Harmonyville, *Fender* 1401 (PENN). CLARION CO.: Callensburg, *Wood, Jr.* 2170 (PENN). CLEARFIELD CO.: Troutville, *Ehrle* 2475 (PAC). CLINTON CO.: Booneville, *Wahl* 3198 (PAC). COLUMBIA CO.: Mill Grove, *Pohl* 2554 (PENN). CUMBERLAND CO.: Shippensburg, *Saxe, Jr.* 36 (PENN). DAUPHIN CO.: Pillow, *Berkheimer* 12883 (PAC, PENN). DELAWARE CO.: Darby, *Baker* (PAC). ELK CO.: Medix Run, *McClelland* (PENN). FAYETTE CO.: Wymps Gap, *Buvinger* (PENN). FOREST CO.: Brookston, *Shields* D-2157 (PAC). FRANKLIN CO.: Mercersburg, *Kriner* 104 (PAC). FULTON CO.: Deneen Gap, *Westerfeld* 7798 (PAC, PENN). GREENE CO.: Jefferson, *Wherry & Bell* (PENN). HUNTINGDON CO.: Maddensville, *Westerfeld* 9823 (PAC). JEFFERSON CO.: Sigel, *Wahl* 10944 (PAC). JUNIATA CO.: Cross Keys, *Westerfeld* 14535 (PAC). LACKAWANNA CO.: Montdale, *Adams* 3542 (PENN). LANCASTER CO.: Collins, *Brubaker* 1521 (PENN). LAWRENCE CO.: McConnells Mills, *Russell* 1582 (PENN). LEBANON CO.: Cold Spring, *Travis* 1170 (PENN). LUZERNE CO.: Mountaintop, *Adams* 3484 (PAC). LYCOMING CO.: Cedar Run, *Wahl* 19261 (PAC). MIFFLIN CO.: Standing Stone Creek, *Westerfeld* 3961 (PAC). MONROE CO.: Scotrun, *Niering* 1214 (PAC). MONTGOMERY CO.: Audubon, *Wherry* (PENN). NORTHAMPTON CO.: Wind Gap, *Schaeffer, Jr.* 18252 (PENN). NORTHUMBERLAND CO.: Sunbury, *Wagner* 8987 (PENN). PERRY CO.: Bloomfield, *Adams & Thebes* 1232 (PENN). PIKE CO.: Porter's Lake, *DePue* 136 (PAC). SCHUYLKILL CO.: Delano, *Wagner* 3227 (PENN). SNYDER CO.: Paxtonville, *Wade* 783 (PENN). SOMERSET CO.: Jennerstown, *Fogg, Jr.* 15258 (PENN). SULLIVAN CO.: Laporte, *Westerfeld* 381 (PAC, PENN). SUSQUEHANNA CO.: North Knob, *Adams* 3612 (PENN). TIOGA CO.: Mainesburg, *Fender* 1537 (PENN). UNION CO.: Laurelton, *Ludwig* 1521 (PAC). VENANGO CO.: Franklin, *Wahl* 12633 (PENN). WARREN CO.: Irvington, *Moldenke* 17479 (ND). WAYNE CO.: White Mills, *Adams* 4624 (PENN). WESTMORELAND CO.: Ligonier, *Matthews* 2399 (PAC). WYOMING CO.: Crane Swamp, *Stone* (PENN). YORK CO.: Dillsburg, *Hoover* 3073 (PAC).

Rhode Island: NEWPORT CO.: Tiverton, *Mearns* 211 (US). PROVIDENCE CO.: Pascoag, *Myers* 350 (WVA). WASHINGTON CO.: Kingston Hill, *Reynolds* 649 (HNH). **South Carolina:** ANDERSON CO.: Carpenter's Mill, *Davis* (MICH, MIN, UT). GREENVILLE CO.: Saluda River, *Freckman* 1239 (ISC). LEXINGTON CO.: Batesburg, *McGregor* 297 (US). MARLBORO CO.: Little Pee Dee River, *Radford* 12494 (TENN). OCONEE CO.: Whitewater, *Davis* 392 (MASS). PICKENS CO.: Table Rock, *Rodgers* 540 (DUKE). SPARTANBURG CO.: Campobello, *Erdman* 973 (BRY). SUMTER CO.: Poinsette St. Park, *Holdaway* (DUKE). **Tennessee:** ANDERSON CO.: Coal Creek, *Kearney* (MIN, OS, US). BLOUT CO.: Cades Cove, *Wallace & Jennison* 1621 (TENN). CAMPBELL CO.: Jellico, *Lamb & Williams* (TENN). CHEATHAM CO.: Marrowbone Creek, *De Selm* 1258 (TENN). CLAIBORNE CO.: Lone Mt. Ridge, *Kelley* 2459 (TENN). COFFEE CO.: Old Stone Fort, *Blum* 3732 (VDB). CUMBERLAND CO.: Ozone, *Demaree* 47496 (KY, NO, VDB). DAVIDSON CO.: Nashville, *Hubbard* 9112 (IND). DE KALB CO.: Smithville, *De Selme* 173 (TENN). DICKSON CO.: Sycamore School, *Jobe* (TENN). FENTRESS CO.: Clear Fork, *Sharp* 25648 (TENN). FRANKLIN CO.: Elk River, *Sharp & Adams* 10785 (TENN). GRAINGER CO.: Blaine, *Hodges* 20 (TENN). GREENE CO.: Horse Creek Rd., *Sherman & Sharp* 22280 (TENN). GRUNDY CO.: Mont Eagle, *Stiffler* (CU). HAMILTON CO.: Lookout Mt., *Scribner* (US). HARDIN CO.: *Kral* 36161 (VDB). HAWKINS CO.: Clinch Mt., *Wolfe* 19180 (TENN). HOUSTON CO.: Erin, *Palmer* 17610 (US). JOHNSON CO.: *Barclay* 12B (TENN). KNOX CO.: New Hopewell, *Sharp* 40454 (TENN). LAUDERDALE CO.: Summertown, *Postal* (IND). LAWRENCE CO.: Shoal Creek, *Sharp, Adams & Felix* 11058 (TENN). LEWIS CO.: Trace Creek, *Sharp, Adams & Felix* 10065 (TENN). MARION CO.: Fosters Falls, *Webb* 368 (TENN).

MONROE CO.: Skona River, *Galyon & Sharp* 21603 (TENN). MORGAN CO.: University Forest, *Shanks* 3141 (TENN). POLK CO.: Ocoee River, *Wilson* 3726 (TENN). PUTNAM CO.: Monterey, *Norris & Shanks* 2475 (TENN). RHEA CO.: Spring City, *James* (OS). ROANE CO.: Caney Creek, *Shanks* 22078 (TENN). ROBERTSON CO.: Pleasant View, *Shanks, Woods, & Cooley* 14776 (TENN). SEVIER CO.: Pittman Center, *Jennison* 3350 (TENN). UNICOI CO.: Rich Mt., *Price* 658 (DUKE). UNION CO.: Norris Lake, *Kelley* (TENN). VAN BUREN CO.: Spencer, *Shanks* 1288 (TENN). WASHINGTON CO.: Cherokee Mt., *Sharp* 3819 (TENN). WAYNE CO.: Butler Creek, *Shanks, Woods & Cooley* 9156 (TENN). WHITE CO.: Caney Fork, *Channell* 8956 (VDB). WILLIAMSON CO.: Ferndale, *Major* 6 (VDB). **Vermont:** BENNINGTON CO.: Pownal, *Eggleston* (HNH, US). **Virginia:** ALBEMARLE CO.: Miller School, *Tinsley* (NMC). AUGUSTA CO.: Stuarts Draft, *Churchill* (MSC). BLANO CO.: Suiter, *Kral* 10453 (VDB). CRAIG CO.: Newcastle, *Fogg, Jr.* 13211 (PENN). FAIRFAX CO.: Great Falls, *Bartlet* 1783 (IND). GILES CO.: Salt Pond Mt., *Fogg, Jr.* 12688 (PENN). GREENE CO.: Bear Fence Mt., *Fosberg* 17205 (PENN). ISLE OF WIGHT CO.: Smithfield, *Wise* (KY). JAMES CITY CO.: Gordon Creek, *Fernald & Long* 11393 (DUKE). KING GEORGE CO.: King George, *Muller* 3787 (ND). LOUDOUN CO.: Ashburn, *Pratt* (MU). MADISON CO.: Old Ray Mt., *Fosberg* 16909 (PENN). MONTGOMERY CO.: Blacksburg, *Musselman* 645 (UWM). NANSEMOND CO.: Nansemond River, *Fernald & Long* 13719 (US). NELSON CO.: *Hall* 3755 (VDB). NORFOLK CO.: Great Dismal Swamp, *Fernald & Long* 12147 (TENN). PITTSYLVANLA CO.: Smith Mt., *Zobel* (DUKE). ROANOKE CO.: Sugarloaf Mt., *Ebinger* 4041 (MU). ROCKBRIDGE CO.: G. Washington Nat'l. Forest, *Hall* 3716 (VDB). ROCKINGHAM CO.: Shenandow Forest, *Eggleston* 18624 (US). RUSSELL CO.: Clinch Mt., *Kral* 23850 (VDB). SMYTH CO.: Pond Mt., *Small* (MSC, US). WISE CO.: Norton, *Pennell* 11813 (ISC). **West Virginia:** BARBOUR CO.: Nestorville, *Core* 5922 (WVA). BERKELEY CO.: Back Creek, *Core* 5847 (WVA). BRAXTON CO.: Little Birch, *Harris* (WVA). CALHOUN CO.: Pink, *Harris* (WVA). CLAY CO.: Clay, *Core* 6372 (WVA). DODDRIDGE CO.: West Union, *Bartholomew* (WVA). GRANT CO.: Dolly Sods Mt., *Davis & Davis* 7129 (WS). GREENBRIER CO.: Muddy Creek Mt., *Fox* (WVA). HAMPSHIRE CO.: Ice Mt., *Frye* 1269 (WVA). HARDY CO.: North Mt., *Core & Ludwig* 399 (WVA). HARRISON CO.: Duck Creek, *Martin* 327 (WVA). JEFFERSON CO.: Charlestown, *Harper* (CU). KANAWHA CO.: Nitro, *Greenlee* (WVA). MCDOWELL CO.: Panther, *Music* (WVA). MARION CO.: Pinesville, *Bodola* (WVA). MARSHALL CO.: Calis, *Bartholomew* 1941-217 (WVA). MERCER CO.: Pinnacle Rock, *Fox* (WVA). MINERAL CO.: Patterson Creek, *Brown* (WVA). MINGO CO.: Chattaroy, *Bowen* (WVA). MONONGALIA CO.: Cassville, *Watkins* (WVA). MONROE CO.: Wayside, *Fox* (WVA). MORGAN CO.: Langent, *Core* 5739 (WVA). NICHOLAS CO.: Calvin, *Creasy* (WVA). PENDLETON CO: Seneca Rocks, *Clarkson* 2001

(WVA). POCAHONTAS CO.: Droop Mt., *Ludwig* 77 (WVA). PRESTON CO.: Pisqah Rd., *Meyer* 247 (HNH, PENN, TENN, WVA). RANDOLPH CO.: Roaring Plains, *Core* 3171 (WVA). RITCHIE CO.: Cairo, *Goodwin* 251 (WVA). SUMMERS CO.: Barger Springs, *Boone* (WVA). TAYLOR CO.: Wickwire Run, *Core* 5475 (WVA). TUCKER CO.: Blackbird Knob, *Gibson* 1039 (WVA). UPSHUR CO.: Bucklin, *Pollock* (MIN, US). WAYNE CO.: Hurricane Creek, *Lycan* 59 (WVA). WEBSTER CO.: Camp Caesar, *Fox* (WVA). WETZEL CO.: Smithfield, *Wagner* (WVA). WIRT CO.: Standingstone Creek, *Bartholomew* W-5007 (WVA).

Mountain laurel commonly forms dense thickets in rocky and sandy forests throughout most of its range, particularly where there are openings in the canopy. It is also found in pastures and open fields and commonly forms thickets at the edge of roads. A detailed map of the known range of *Kalmia latifolia* is given by Kurmes (1967) who considers the report of this species from Ontario and New Brunswick to be an error, as is the report from the valley of the Red River in Arkansas (Britton, 1908). The report of this species from Canada probably originates from Pursh (1814), and it has been perpetuated by Brunet (1867), Sargent (1893), and more recently by Munns (1938). There is no evidence that this species is native to any part of Canada. It is possible that these early reports were based on cultivated plants or large-leaved specimens of *K. augustifolia* (Macoun, 1884). Presently the species is known from southern and southeastern Maine (Fernald, 1911; Lamson-Scribner, 1891; Norton, 1913, 1935; and Perkins, 1935), southern New Hampshire (Hodgdon, 1955) and southern Vermont (Deane, 1899).

The ecological requirements of *Kalmia latifolia* in the deciduous forests of eastern United States have been examined by a few authors. Kurmes (1961) studied the ecology of mountain laurel in southern New England and determined its exact range from herbarium material and field observations. The relationship of this species to water run-off and the water-holding capacity of the soil was studied by Colvin and Eisenmenger (1943) and Johnson and Kovner (1956). Studies have also been made of the rate of water-vapor loss from its leaves (Meyer, 1927), the seasonal variation in the moisture content of its leaves (Reifsnyder, 1961) and seasonal changes in cold resistance (Parker, 1961). The competition of mountain laurel with tree seedlings and sprouts has also been studied. Wahlenberg and Doolittle (1950) found that under normal conditions in the southern Appalachian mountains *K. latifolia* forms dense thickets that preclude any natural regeneration of timber trees. Their studies indicate that partial clearing of these thickets followed by planting of desirable tree species is an effective method of forest regeneration. They also found that mountain laurel has a mean annual height growth of 0.4 feet and a lateral growth of 0.3 feet.

Kalmia latifolia is usually a tall, spreading shrub that throughout most of its range rarely exceeds a height of 12 feet. In the fertile valleys between the Blue Ridge and the Alleghany Mountains, however, this species may attain the size of a small tree. Engelmann, Canby, and Gray (1877) observed a number of large individuals growing in the bottom of a dell, back of Caesar's Head, on the extreme western border of South Carolina. One of the trunks measured 4 feet 1¼ inches in circumference about 1 foot above the ground while another in the same area was 3 feet 4 inches above the first fork, and at 1 foot above the ground was 4 feet 4 inches in circumference. Later, Sargent (1893) records its maximum size as 30-40 feet tall with a diameter of 18-20 inches. The largest specimen on record, as listed by the American Forestry Association (1955), is a plant from the Great Smoky Mountains National Park with a circumference of 3 feet 6 inches, a height of 25 feet, and a spread of 45 feet. This specimen is probably located at Forney Ridge, Swain County, Tennessee (*Barksdale & Jennison* 1285).

Besides the numerous studies concerned with the poisonous properties of mountain laurel, some early attempts were undertaken to determine what other substances were present. These early studies reported the presence of arbutin, gums, and tannins (Kennedy, 1875), bark tannins (DeGraffe, 1896) and fat deposits (Stanley, 1931). More recently the effects of herbicides on *Kalmia latifolia* have been studied. Egler (1947, 1948) found that 2,4-D has no permanent effect, causing only temporary stunting and curvature of the foliage. Later, Egler (1949, 1950) found that a weak solution (.25%) of a 2,4-D and 2,4,5-T combination causes temporary cessation of growth, but a strong solution (5%) is necessary to ensure death.

The synonomy of mountain laurel is not very extensive. Most of the names proposed are for forms and varieties which are the result of the extreme variation that exists in flower color, leaf shape and size, plant size and pubescence. In 1940, Fernald described a variety (*laevipes*) of *Kalmia latifolia* from the coastal plain on southeastern United States. He considered this variety in its extreme development as having pedicels that are "quite smooth or with the merest suggestion of sessile glandular spots". In typical *K. latifolia*, in contrast, the pedicels are densely floccose and viscid with stalked glandular hairs. Many individuals with few or no glands on the pedicels are found in Indiana and Ohio, as well as on the coastal plain from Virginia to Louisiana. In some populations specimens with both glandless and glandular pedicels are found. Also, Radford, Ahles, and Bell (1968) mention that this condition is very variable, with a tendency for pedicels to be floccose on plants in the mountains and less glandular on the coastal plain. Because of this variation it appears best to consider these individuals as an extreme that occurs in the southern and western parts of the range of *K. latifolia*.

A total of 7 forms of *Kalmia latifolia* have been recognized by Rehder (1910, 1945, 1949). Many of these were originally described as varieties, but that classification is not appropriate for these taxa in either the horticultural or botanical sense. It is possible that these taxa could be treated as cultivars as done by Holmes (1956) and Dudley (1967), but most are better treated as forms as defined by Davis and Heywood (1963). The genetic evidence indicates that most of these taxa are not unique clones, but rather are sporadic variants distinguished by a single or a few linked characters, without a distinct distribution. Also, they do not represent the normal extremes of most populations, but are the result of the repeated association of recessive genes that are of a limited occurrence in some populations. Of the 7 forms recognized by Rehder, 5 fit the criteria of a form as described above. The remainder, both variations in flower color (alba and rubra), unlike the forms, are not aberrant or disjunct, but are connected to the typical light pink flower by intermediate color types.

Kalmia latifolia f. **angustata** Rehd. Jour. Arnold Arb. **26**: 481. 1945. TYPE: **New Jersey**: CAPE MAY CO.: Dennis township, *H. A. Scribner* (GH).

Kalmia latifolia β. salicifolia Forbes, Hort. Woburn. 93. 1833. (nom. nud.).

This very rare foliage form has narrowly oblanceolate to linear leaves that are 4-8 cm long and 4-10 mm wide. Living material of the type is cultivated at the Arnold Arboretum (Rehder, 1945). The only specimens of f. *angustata* seen by the author are cultivated plants.

Common name: Willow-leaved Mountain Laurel.

Kalmia latifolia f. **fuscata** (Rehd.) Rehd. Rhodora **12**: 2. 1910.

Kalmia latifolia var. *fuscata* Rehd. Möller's Deutsch. Gart. Zeit. **18**: 578. 1903. TYPE: **New York**: Canaan Four Corners, *Dr. Childs* (GH).

Kalmia latifolia var. *coronata* Gray, Amer. Nat. **2**: 324. 1868. TYPE: **Massachusetts**: woods near Framingham, *James Parker* (GH).

Kalmia latifolia var. *maculata* Raf. Medical Flora **2**: 17. 1830. TYPE: unknown.

This form is distinguished by white to pink flowers that have a heavily pigmented, usually continuous, brownish-purple or cinnamon band on the inside of the corolla at the level of the anther pockets. This band breaks up into brownish dots toward the base and the margin of the corolla. It also shows through to the outside of the bud giving it a muddy appearance.

Some variation does exist in the size, shape and color of the band with an interrupted band existing in some of the specimens examined. According to Jaynes (personal communication) controlled crosses with specimens showing this banded characteristic strongly suggests that the character is determined by a single dominant gene.

Common name: Banded Mountain Laurel, Crowned Mountain Laurel.

SPECIMENS EXAMINED

Alabama: near Citronella, *Milligan* (US). **Connecticut:** near Chaplin, *Jaynes* (EIU). **Massachusetts:** near Framingham, *Parker* (GH); Wales, *Clark* (MASS); *Guterman* (MASS). **New York:** Brewster, *Jaynes* 240 (EIU). **North Carolina:** Highlands, *Anderson* (US). **Ohio:** Holden Arboretum, Mentor, *Jaynes* 94 (EIU). **Pennsylvania:** nursery in Stroudsburg, *Jaynes* 168 (EIU).

Kalmia latifolia f. **myrtifolia** (Bosse) K. Koch, Dendrologie **2**(1): 153. 1872.

Kalmia latifolia var. *myrtifolia* Bosse, Vollst. Handb. Blumengart. **2**: 348. 1841. *Kalmia myrtifolia* Andre, Revue Hort. **55**: 10. 1883. TYPE: unknown, probably a living plant.

Kalmia latifolia f. *minor* K. Koch, Dendrologie **2**(1): 153. 1872. TYPE: unknown, probably a living plant.

Kalmia latifolia var. *nana* Lavallée, Arbor. Segrez. 159. 1877. (nom. nud.); Mouillefert, Traité Arb. Arbrisse **2**: 1027. 1897. TYPE: unknown, probably a living plant.

This form is in all respects a miniature mountain laurel, being compact and slow-growing, rarely exceeding a height of 3 feet. In all specimens examined the leaves are much smaller than in typical *Kalmia latifolia*, averaging 2-4 cm long and about 1 cm wide. Also, flower size and length of the internodes are approximately 1/3 to 1/2 normal. Recent evidence (Jaynes, personal communication) suggests that this dwarf condition is controlled by a single recessive gene.

According to Dudley (1967) this form has been grown since 1840 and is occasionally found in gardens where space is limited. Though occasionally mentioned in the early horticulture literature of Europe, the first reference to this form in North American literature appears to be by

Sprague (1871). The only report of wild plants of f. *myrtifolia* appeared in 1895 (Anonymus) which, according to the author, were identical to the cultivated dwarf form.

Common name: Miniature Mountain Laurel, Dwarf Mountain Laurel.

SPECIMENS EXAMINED

Connecticut: Portland, *Jaynes* 25 (EIU). **Massachusetts:** Arnold Arboretum, *Hornby* (MASS).

Kalmia latifolia f. **obtusata** (Rehd.) Rehd. Rhodora **12**: 2. 1910.

Kalmia latifolia var. *obtusata* Rehd. Möller's Deutsch. Gart. Zeit. 18: 577. 1903. TYPE: **Connecticut:** near Pomfret, *Bowditch.*

Kalmia latifolia var. *ovatifolia* Raf. Medical Flora **2**: 17. 1830. (nom. nud.).

This foliage form has leaves that are oval to oblong-obovate and rounded at both ends. In the specimens examined the leaves average 4-7 cm long and 2.5-4 cm broad, are apiculate, and have short petioles that rarely exceed 1 cm in length. According to Rehder (1910) this form is slow growing, forms a compact bush, and has been cultivated at the Arnold Arboretum since 1886 when it was propagated from the type plant. Dudley (1967) suggested that the cultivar 'Ovata' which is available from some European sources is a synonym of this variant.

Common name: Hedge Mountain Laurel.

SPECIMENS EXAMINED

Connecticut: Riverton, *Jaynes* 291 (EIU). **Massachusetts:** 1 mi. east of Ashby, *Ahles* 65135 (MASS); Arnold Arboretum, *Wyman* 2854 (MSC), *Jaynes* 238 (EIU).

Kalmia latifolia f. **polypetala** (Nickolson) Beissner, Schelle, & Zabel, Handb. Laubholz-Benennung 386. 1903.

Kalmia latifolia var. *polypetala* Nicholson, Hand-list Trees Shrubs Arb. 2: 49. 1896. *Kalmia latifolia* f. *polypetala* (Nicholson) Rehd. Rhodora **12**: 1. 1910. TYPE: **Massachusetts:** near South Deerfield, *Miss M. Bryant* (GH).

Kalmia latifolia var. *monstruosa* Mouillefert, Traité Arb.

Arbrisse 2: 1027. 1897. TYPE: Unknown, probably a living plant.

This form has the corolla deeply divided into 5 narrow to fairly broad, strap-shaped petals. In some specimens these petals are extremely narrow and thread-like due to the revolution of the margins. Gray (1871) reports that these narrow petals resemble filaments and are sometimes tipped with imperfect anthers. More commonly the petals are broader, and a few specimens have been found in which the individual flowers appear much like apple blossoms. Other variations include an apetalous type which has been observed in some nursery stock from Massachusetts, and a cultivar named 'Bettina' (Dudley, 1967) in which the corolla is deeply lobed. According to Jaynes (personal communication) the inheritance data fits the hypothesis that the genetic control of the polypetalous condition is by a single recessive gene.

This form was first described by Gray (1871) and later by Sargent (1890), while Bean (1897) mentioned that this unusual form flowers each year at the Kew Gardens. It was given the name var. *polypetala* by Nicholson (1896) and the name var. *monstruosa* by Mouillefert (1897), both based on Sargent's description of 1890. This taxon was first considered as a form by Beissner, Schelle, and Zabel (1903) who use the name *polypetala* and cite Sargent as the author.

This form appears to occur most commonly in Massachusetts. Stone (1909) reported it growing at the edge of a road in Leverett, not far from Mt. Toby, while Britton (1925) reports that Dr. Stone has found it from three different stations, all on or near Mt. Toby. Mt. Toby is close to South Deerfield, the type locality of this form.

Common name: Feather Petal Mountain Laurel.

SPECIMENS EXAMINED

Massachusetts: Arnold Arboretum, *Wyman* 2458 (MSC); Leverett, Mt. Toby, *Henry* (MASS), *Osmun* (MASS), *Stone* (MASS), 67570 (MASS). **North Carolina:** Danbury, Hanging Rock State Park, *Rogers* (EIU).

4. **Kalmia angustifolia** Linnaeus, Sp. Pl. 1: 391. 1753.
TYPE: "Habitat in Pensylvania, Nova Caesarea, Noveboraco" (LINN 560.2, lectotype, specimen on the right).

Chamaedaphne angustifolia (L.) Kuntze, Rev. Gen. Pl. 2: 388. 1891.

Much branched shrub to 1.5 m tall; branchlets terete, reddish-brown, glabrous to pubescent and stipitate-glandular, usually ascending; leaves in whorls of 3 (rarely a few alternate or opposite), slightly coriaceous, evergreen, flat, oblong to elliptic-lanceolate, 2-5 (rarely 7) cm long, 0.5-2 cm wide, usually lightly puberulent above with short white hairs, sometimes glabrate with age, midrib puberulent above, glabrous to puberulent beneath, sometimes stipitate-glandular; petioles to 1 (rarely 1.5) cm long, usually puberulent; inflorescence of numerous corymbiform racemes from the axils of last year's leaves; pedicels 0.5-2 cm long, puberulent and stipitate-glandular, subtended by 2 bracteoles in the axil of a lanceolate bract, 1-6 mm long; main axis of the inflorescence less than 1.5 cm long; calyx puberulent outside, glabrous within, usually green, sometimes the tip reddish, or reddish throughout, 3-6 mm broad, the lobes usually acuminate; corolla reddish-purple to pink (rarely white), puberulent outside, puberulent toward the base within, 6-13 mm broad; anthers purplish-brown, .5-1 mm long; filaments puberulent on the lower half; capsule depressed globose, 3-5 mm broad, 2-3.5 mm long, puberulent and stipitate-glandular; seed stramineous, 0.6-1 mm long, and testa loose and extending past the ends of the seed. Chromosome number $n = 12$.

Kalmia angustifolia is a common species in eastern North America. It is found from northern Ontario, Quebec and Labrador, through the Great Lakes region, and south along the east coast of the United States to the Carolinas. It is primarily a plant of bogs and other wet, open areas, but is also found in open woods and as a weed in open areas, sometimes forming dense thickets.

Genetically this species is most closely related to *Kalmia latifolia*. When *K. angustifolia* is the male parent the cross is not successful because the sheep laurel pollen will not grow down the style of mountain laurel (Jaynes, 1968a). The reciprocal cross, however, resulted in about 18% of the flowers producing capsules which contained some viable seed. These resulting interspecific hybrids were intermediate to the parental types, although leaf arrangement was primarily alternate, as in *K. latifolia.* Jaynes (1968a) also reported that *K. angustifolia* could be crossed with both *K. hirsuta* and *K. polifolia.* Both crosses produced mostly weak, yellow-green individuals that died within the year. A few individuals lived longer, and some produced flowers with sterile pollen.

Small (1903, 1914) considered this taxon as two separate species, a procedure not followed by subsequent authors. Both Fernald (1950) and Gleason (1952) considered this complex as being one species with two fairly distinct varieties, a view that has recently been followed by Radford, Ahles, and Bell (1968). Considering the genetic and morphological similarities of these taxa it is more realistic to follow the latter view and consider it as a single species with two fairly distinct varieties.

KEY TO VARIETIES

1. Calyx densely stipitate-glandular; mature leaves not puberulent beneath. . . . . 4a. var. *angustifolia.*
1. Calyx lacking stipitate-glands, or nearly so; mature leaves densely puberulent beneath. . 4b. var. *caroliniana.*

4a. **Kalmia angustifolia** L. var. **angustifolia.**

Kalmia angustifolia β carnea Ait. Hort. Kew. 2: 64. 1789.

Kalmia angustifolia var. *hirsuta* Jäger, Ziergeholze 278. 1865. *Kalmia angustifolia* f. *hirsuta* Voss, Blumengart. 1: 591. 1894. (without basonym).

Kalmia angustifolia var. *lucida* Lavalée, Arbor. Segrez. 159. 1877. (nom. nud.). *Kalmia angustifolia* f. *lucida* Beissner, Schelle, & Zabel, Handb. Laubholz-Benennung 386. 1903. (nom. nud.).

Kalmia angustifolia var. *minima* Bosse, Vollst. Handb. Blumengart. 2: 347. 1841.

Kalmia angustifolia var. *nana* Bosse, Vollst. Handb. Blumengart. 2: 347. 1841. *Kalmia angustifolia* f. *nana* Voss, Blumengart. 1: 591. 1894. (as snyonym).

Kalmia angustifolia β ovata Pursh, Fl. Amer. Sept. 296. 1814.

Kalmia angustifolia f. *procumbens* Beissner, Schelle, & Zabel, Handb. Laubholz-Benennung 386. 1903. (nom. nud.).

Kalmia angustifolia var. *rosea* Forbes, Hort. Woburn. 93. 1833. *Kalmia angustifolia* f. *rosea* Beissner, Schelle, & Zabel. Handb. Laubholz-Benennung 386. 1903. (nom. nud.).

Kalmia angustifolia var. *variegata* Forbes, Hort. Woburn. 93. 1833.

Kalmia elliptica Raf. Autikon Bot. 87. 1840. (as synonym).

Kalmia ferruginea Raf. Autikon Bot. 86. 1840. TYPE: unknown.

Kalmia media K. Koch, Dendrologie II; 1: 153. 1872. *Kalmia angustifolia* f. *media* Beissner, Schelle, & Zabel, Handb. Laudholz-Benennung 386. 1903. (nom. nud.) TYPE: unknown.

Kalmia intermedia Lange Ind. Sem. Hort. Hauniensi Nom. emendata 3. 1873. *Kalmia glauca β intermedia* Lange Ind. Sem. Hort. Hauniensi Nom. emendata 3. 1873. (as synonym). TYPE: a herbarium specimen in the Botanical Museum of Copenhagen (C) labeled *Kalmia intermedia* Lge ad int. Hort. bot. Haun. 16. Juni 1873, sem. ex hort. Paris s.n.

Kalmia angustifolia β oleifolia Pers. Syn. Pl. 1: 477. 1805. *Kalmia oleifolia* (Pers.) Bosse, Vollst. Handb. Blumengart. 2: 347. 1841. (as synonym). TYPE: unknown.

Kalmia angustifolia var. *pumila* Forbes, Hort. Woburn. 93. 1833. *Kalmia pumila* Bosse, Vollst. Handb. Blumengart. 2: 347. 1841. (as synonym).

Kalmia pumila rubra Bosse, Vollst. Handb. Blumengart. 2: 347. 1841. (as synonym).

Kalmia pumila serotina Bosse, Vollst. Handb. Blumengart. 2: 347. 1841. (as synonym). *Kalmia angustifolia* f. *pumila* Voss, Blumengart. 1: 591. 1894. (without basonym). TYPE: unknown.

Kalmia angustifolia α rubra Ait. Hort. Kew 2: 64. 1789. *Kalmia angustifolia* var. *rubra* (Ait.) Loddiges, Bot. Cab. 6: 502. 1821. *Kalmia rubra* (Loddiges) Bosse, Vollst. Handb. Blumengart. 2: 347. 1841. (as synonym). *Kalmia angustifolia* f. *rubra* Voss, Blumengart. 1: 591. 1894. (without basonym). TYPE: unknown.

Kalmia angustifolia var. *serotina* Bosse, Vollst. Handb. Blumengart. 2: 347. 1841. *Kalmia serotina* Bosse, Vollst. Handb. Blumengart. 2: 347. 1841. (as synonym). TYPE: unknown.

Mature leaves glabrous or with scattered stalked glandular hairs beneath, usually not puberulent; calyx puberulent and strongly stipitate-glandular; corolla glabrous or lightly puberulent on the outside.

Distribution: Bogs, swamps, and other wet open areas from Ontario east to the Atlantic Ocean and southeast through the Great Lakes to Pennsylvania and south along the coast to Virginia.

Common name: Sheep Laurel, Lambkill, Sheepkill, Wicky, Narrow-leaved Kalmia, Dwarf Laurel, Pig Laurel.

REPRESENTATIVE SPECIMENS

UNITED STATES: **Connecticut:** FAIRFIELD CO.: Trumbull, *Eames* 2809 (CONN). HARTFORD CO.: Kensington, *Cowles* (MU). LITCHFIELD CO.: Salisbury, *Ebinger* 697 (MU). NEW HAVEN CO.: New Haven, *Safford* 163 (US). NEW LONDON CO.: Groton, *Jausson* (CONN, UT). TOLLAND CO.: Donovans Bog, *Travis* 1959 (PENN). WINDHAM CO.: Hasting's Woods, *Petersen* (VDB). **Delaware:** NEW CASTLE CO.: Hogswamp Road, *Tatnall* 4858 (GH). SUSSEX CO.: *Canby* (US). **Maine:** ANDROSCOGGIN CO.: Lewiston, *Bean* 14793 (VDB). AROOSTOOK CO.: Knoles Corner, *Neal* 1907 (MAINE). CUMBERLAND CO.: Cape Elizabeth, *Gayle* 766 (US). HANCOCK CO.: Bar Harbor, *Rossbach* 2757 (ACAD, NCU). KENNEBEC CO.: Clinton, *Bean* (MAINE). KNOX CO.:

Glencove, *Friesner* 7721 (MU, RENO, UT, WS, WVA). LINCOLN CO.: Ocean Point, *Fassett* 3946 (DUKE). OXFORD CO.: White Mt. Nat'l. Forest, *Richards* 6066 (MAINE). PENOBSCOT CO.: Old Town, *Davis* (MAINE). PISCATAQUIS CO.: Sangerville, *Fernald* 127 (MIN). SAGADAHOC CO.: Five Islands, *Rehder* 1018 (GH). SOMERSET CO.: Baker Brook, *St. John & Nichols* 2431 (CAN, NY). WALDO CO.: Searsmont, *Rossbach* 1932 (ACAD, MAINE). WASHINGTON CO.: Joe Dyer's Point, *Walker* 3039 (MAINE). YORK CO.: Sand Pond, *Richards* 5951 (MAINE). **Maryland:** ANNE ARUNDEL CO.: Severn Run, *Adams & Wherry* 3200 (GH). CECIL CO.: North East, *Long* 54422 (GH). CHARLES CO.: Waldorf, *Nieuwland* (ND). PRINCE GEORGES CO.: Airport Bog, *Herman* 11546 (NY). WICOMICO CO.: Sharptown, *Tidestrom* 12229 (GH). WORCESTER CO.: Furnace, *Redmond* 237 (MICH). **Massachusetts:** BARNSTABLE CO.: Falmouth, *Greenman* 3043 (MIN). BERKSHIRE CO.: Great Barrington, *Eggleston* 21413 (MIN, NY). ESSEX CO.: Marblehead, *Nelson* 341 (CAN). FRANKLIN CO.: Mt. Toby, *Seymour* 2566 (DUKE, MASS). HAMPDEN CO.: Granville, *Seymour* 137 (MASS, MIN, NY). HAMPSHIRE CO.: Amherst, *Torrey* (MASS). MIDDLESEX CO.: Townsend, *Ahles* 65188 (MASS). NANTUCKET CO.: Polpis, *Mackeever* 504 (PENN). NORFOLK CO.: Medfield, *Batchelder* 234 (NCU). PLYMOUTH CO.: Ellisville, *Erdman* 4223 (BRY). WORCESTER CO.: Mount Wachusett, *Palmer* 43196 (MIN). **Michigan:** ALCONA CO.: Lincoln, *Voss* 4583 (MICH). ALPENA CO.: Alpena, *McVaugh* 11405 (MICH). ARENAC CO.: Omer, *Voss* 6794 (MICH). CHARLEVOIX CO.: Garden Isl., *Cain* 149 (TRT). CHEBOYGAN CO.: Wolverine, *Gleason & Gleason, Jr.* 248 (GH, IND, ISC, NY, WVA). CRAWFORD CO.: Grayling, *Voss* 3098 (MICH). IOSCO CO.: Sand Lake, *Dreisbach* 7243 (CONN). KALKASKA CO.: *Zavitz* 1168 (QUK). MISSAUKEE CO.: Moorestown, *Voss* 3087 (MICH, OS). MONTMORENCY CO.: *Hagenah* 4936 (BLH). OSCODA CO.: Rhodes Lake, *Voss* 3578 (MICH). OTSEGO CO.: Hardwood Lake, *McVaugh* 10888 (BLH, CAN, MICH, MO). PRESQUE ISLE CO.: Emma, *Clover* 26193 (MICH). ROSCOMMON CO.: Roscommon, *Voss* 4258 (MICH). SAGINAW CO.: Sage Lake, *Case, Jr.* (MICH). **New Hampshire:** BELKNAP CO.: Crystal Lake, *Hodgdon & Steele* 9124 (NHA). CARROLL CO.: Albany, *Gale* (NHA). CHESHIRE CO.: Winchester *Manning* (BRY). COOS CO.: Randolph, *Pease* 4696 (GH, MICH). GRAFTON CO.: Pike, *Mathias* 163 (MIN). HILLSBORO CO.: Mt. Monadnock, *Andrews* 895 (ORE). MERRIMACK CO.: Wilmot, *Hodgdon & Steele* 9949 (NHA). ROCKINGHAM CO.: *Harris* 224 (NHA). STRAFFORD CO.: Rochester, *Barrett & Hodgdon* 15522 (NHA). SULLIVAN CO.: Springfield, *Hodgdon & Steele* 9129 (NHA). **New Jersey:** ATLANTIC CO.: Hammonton, *Keefe* 123 (UWM). BERGEN CO.: Carlstadt, *Niederer* (NY). BURLINGTON CO.: Rancocas River, *Leonard* 6314 (US). CAMDEN CO.: Atco, *Painter* 684 (MIN, US). CAPE MAY CO.: Belleplain, *Fender* 4916 (PAC, PENN). CUMBERLAND CO.: Millville, *Adams* 324 (GH, PENN). ESSEX CO.: Franklin, *Rusby* (CHRB).

GLOUCESTER CO.: Repaupo, *Long* 16065 (GH). MIDDLESEX CO.: Milltown, *House* (US). MONMOUTH CO.: Farmingdale, *Long & Brown* 3557 (PENN). MORRIS CO.: Mt. Hope, *Britton* (CHRB). OCEAN CO.: Lakewood, *Mackenzie* 3112 (US). PASSAIC CO.: Uttertown Bog, *Montgomery* (CHRB). SALEM CO.: Auburn, *Fogg, Jr.* 6616 (PENN). SOMERSET CO.: Sourland Mts., *Fogg, Jr.* 12406 (PENN). SUSSEX CO.: Cranberry Lake, *Mackenzie* 717 (ARIZ, IND).

New York: ALBANY CO.: Karmer, *House* 7850 (CAN). CHENANGO CO.: Plymouth Pond, *Wiegand* 6976 (GH). CLINTON CO.: *Rudd* 816 (US). COLUMBIA CO.: Ghent, *McVaugh* 362 (PENN). DUTCHESS CO.: Susan Court, *Ahles* 64464 (MASS). ESSEX CO.: Lake Harris, *House* 8072 (CAN). FRANKLIN CO.: Upper Saranac Lake, *Muenscher, et. al.* 476 (NY). FULTON CO.: Gloversville, *Haught* (WVA). GREENE CO.: *Coville* (GH). HAMILTON CO.: Little Tupper Lake, *Fosberg* 16101 (PENN). JEFFERSON CO.: Perch Lake, *Beschel* 17144 (QUK). LEWIS CO.: Martinsburg, *Hotchkiss* 2654 (GH). NASSAU CO.: Massapequa St. Park, *Cain* 93 (MO, PENN, TENN). ONEIDA CO.: Sylvan Beach, *Maxon* (US). ORANGE CO.: Sutherland Pond, *Mearns* 125 (US). RENSSELAER CO.: West Sand Lake, *Brown* 652 (DUKE). RICHMOND CO.: Staten Isl., *Dowell & Davis* 2224 (GH). ST. LAWRENCE CO.: Norfolk, *Phelps* 756 (GH, NY, US). SARATOGA CO.: Corinth, *Whitney* 4124 (PENN). SUFFOLK CO.: South Haven, *Moldenke* 18685 (NY). SULLIVAN CO.: Wurtshore, *Hess* 1267 (ARIZ). ULSTER CO.: Highland, *Chrysler* (CHRB). WARREN CO.: Luzerne, *Fogg, Jr.* 20309 (PENN). WASHINGTON CO.: Lake Nebo, *Burnham* 2756 (MIN). **Pennsylvania:** BERKS CO.: Hamburg, *Berkheimer* 1734 (PENN). BRADFORD CO.: Troy, *Beardslee* (MU). BUCKS CO.: Bristol, *Adams* 4514 (MAINE, PENN). CARBON CO.: Little Gap, *Adams* 3331 (GH, ISC, PENN). CHESTER CO.: Warwick, *Wherry* (GH). COLUMBIA CO.: Centralia, *Fogg, Jr.* 14256 (NY, PENN). CUMBERLAND CO.: Sand Springs, *Ward* (PAC). DELAWARE CO.: Tinicum, *Baker* (PENN). FRANKLIN CO.: Caledonia St. Park, *Overhots* (PAC). LACKAWANNA CO.: West Mt., *Glowenke* 6528 (MIN, NY). LANCASTER CO.: Smithville, *Small* (US). LEHIGH CO.: Allentown, *Dowell* 1115 (US). LUZERNE CO.: Freeland, *Orton* (PAC). LYCOMING CO.: Bald Eagle Mt., *Keener* 2561 (PAC). MONROE CO.: Tannersville, *Swartley* 791 (MAINE). NORTHAMPTON CO.: Danielsville, *Schaeffer, Jr.* 6184 (PAC). NORTHUMBERLAND CO.: Montandon, *Reed* 235 (CHRB). PIKE CO.: Twin Lakes, *De Pue* 878 (PENN). SCHUYLKILL CO.: Tamaqua, *Kriebel* 8586 (ND). SOMERSET CO.: Salisbury, *Caffrey* (PAC). SULLIVAN CO.: Double Run, *Fogg, Jr.* 14437 (PENN). WAYNE CO.: Big Spring Pond, *Glowenke* 2434 (PENN). WYOMING CO.: Falls, *Glowenke* 2023 (PENN). YORK CO.: McCall's Ferry, *Heller & Halbach* (MIN). **Rhode Island:** KENT CO.: Warwick, *Congdon* (OS). NEWPORT CO.: Newport, *Mearns* 254 (GH). PROVIDENCE CO.: Slaterville, *Palmer* 43348 (ISC, MIN). WASHINGTON CO.: South Kingstown, *Collins* (CONN). **Vermont:** ADDISON CO.:

Bristol Pond, *Eggleston* 21453 (US). BENNINGTON CO.: Manchester, *Day* 267 (GH). CALEDONIA CO.: Barnet, *Blanchard* (HNH, MO). CHITTENDEN CO.: S. Burlington Twp., *Charette* 2190 (BRY, MIN). FRANKLIN CO.: East Berkshire, *Clausen* (MO, US). ORANGE CO.: Fairlee, *Grover* (MU). RUTLAND CO.: Middletown Springs, *Carpenter* (NCU). WASHINGTON CO.: Roxbury, *Countryman* 820 (HNH, NHA). WINDHAM CO.: Westminster, *Robinson* 30 (GH). WINDSOR CO.: Reading, *Kittredge* (NY). **Virginia:** ISLE OF WIGHT CO.: Franklin, *Heller* 1124 (GH, MIN, MO, PENN, US, WS); Lee's Mill, *Fernald & Long* 12146 (GH, MO, NY, US), *Harvill* 15946 (NCU); Zuni, *Fernald, Griscom & Long* 6665 (GH, NY), 6666 (GH, PENN). NANSEMOND CO.: Cherry Grove, *Fernald & Long* 11392 (DUKE, GH, US); County Rd. 665, *Duke* 1067 (NCU); South Quay, *Fernald & Long* 10366 (GH, NY).

CANADA: **Labrador:** Assizes Isl., *Potter & Brierly* 3424 (GH); Cape St. Charles, *Potter & Brierly* 3427 (GH); Cartwright, *Brown* (GH); Forteau, *Long* 28832 (GH); Goose Bay, *Gillett & Findley* 5352 (MIN, MO, TRT, WS), 5584 (ACAD, NY, US); Kenamu River, *Gillett & McKay* 5831 (ACAD, GH); St. Clary's River, *Wallace* 23 (CONN). **New Brunswick:** ALBERTA CO.: Grindstone Isl., *Christie* 1575 (NBM). CARLETON CO.: East Wolf Isl., *Hodgdon & Pike* (NCU). CHARLOTTE CO.: Deer Isl., *Squires & Squires* (NBM). GLOUCESTER CO.: Four Roads, *Roberts & Pugh* 65-4358 (CAN). KENT CO.: Richibucto, *Scoggan* 12135 (CAN). KINGS CO.: Havelock, *Perry* (ACAD). MADAWASKA CO.: St. Leonard, *Malte* 294 (CAN). NORTHUMBERLAND CO.: Mt. Carleton, *Smith & Clattenburg* 20066 (ACAD, QUK). QUEENS CO.: Mill Brook, *Squires & Christie* (NBM). RESTIGOUCHE CO.: Dalhousie, *Scoggan* 11721 (ACAD, CAN). ST. JOHN CO.: Mispec, *Crawford & Patterson* (ACAD). SUNBURY CO.: Mill Settlement, *Christie* 245 (NBM). WESTMORLAND CO.: Johnson Lake, *Beschel* 5508 (QUK). **Newfoundland:** BONAVISTA NORTH DIST.: Glovertown, *Smith, Squires, & Smith* 116 (ACAD), 135 (ACAD). BONAVISTA SOUTH DIST.: Lethbridge, *Rouleau* 8370 (NFLD). BURGEO-LA POILE DIST.: Osmond, *Rouleau* 7375 (NFLD, US). CARBONEAR DIST.: Old Perlican, *Torrey* 25 (CAN, GH). FERRYLAND DIST.: Witless Bay, *Rouleau* 5364 (NFLD). FOGO DIST.: Stag Harbour, *Ludlow* 125 (ACAD). FORTUNE BAY-HERMITAGE DIST.: Wallace Cove, *Rouleau* 8089 (NFLD). GANDER DIST.: Gander, *Rouleau* 6133 (CAN, NFLD, US). GRAND FALL DIST.: Overflow Pond, *Rouleau* 7961 (NFLD). HUMBER DIST.: Corner Brook, *Rouleau* 3960 (ACAD, CAN, GH, NFLD, NY, US). ST. BARBE DIST.: Bonne Bay, *Bishop* 471 (GH, CAN). ST. JOHN'S DIST.: St. John's, *Robinson & Schrenck* 41 (GH, CAN, MIN, MO, NY, P). TRINITY SOUTH DIST.: Whitbourne, *Rouleau* 6069 (NFLD). TWILLINGATE DIST.: Loon Bay, *Rouleau* 4866 (NFLD). WHITE BAY DIST.: St. Anthony, *Savile & Vaillancourt* 2561 (NCU, NFLD, NY). **Nova Scotia:** ANNAPOLIS CO.: Belleisle, *Bent* 12723 (ACAD). ANTIGONISH CO.: Linwood, *Smith, et. al.* 10765

(MAINE). CAPE BRETON CO.: Frenchvale, *Smith, et. al.* 15094 (ACAD). COLCHESTER CO.: Truro, *Malte,* (CAN, QUK). CUMBERLAND CO.: Wharton, *Schofield* 3197 (ACAD). DIGBY CO.: Corberrie, *Jack* 3121 (MAINE, NY, US). GUYSBOROUGH CO.: Canso, *Rousseau* 35450 (CAN). HALIFAX CO.: Halifax, *Jack* 3235 (NY, TENN). HANTS CO.: Bishopville Rd., *Wellwood* 12662 (ACAD). INVERNESS CO.: North Mt., *Smith, et. al.* 11275 (ACAD). KING CO.: Wolfville, *Anderson* (ACAD). LUNENBURG CO.: Beck Lake, *Smith, et. al.* 18551 (ACAD, NCU). PICTOU CO.: Westville, *Sampson* 28 (ACAD). QUEENS CO.: Tobeatic Lake, *Martin* 5210 (CAN). RICHMOND CO.: Grand Lake, *Ershine* 51993 (QUK). SHELBURN CO.: Barrington Passage, *Macoun* 81371 (CAN). VICTORIA CO.: Cape Breton, *Senn* 1553 (MIN, US). YARMOUTH CO.: Seal Isl., *Erskine* 54.977 (ACAD). **Ontario:** BRUCE CO.: Big Bay, *Krotkov* 9295 (NY). CARLETON CO.: Wright's Cove, *Minshall* 236 (MIN, NY). COCHRANE CO.: Abitibi, *Pritchard* 208A (MASS). DUNDAS CO.: Elma, *House* 23357 (PENN). FRONTENAC CO.: Kingston, *Fowler* (US). HALIBURTON CO.: Minden Twp., *Roberts* (TRT). KENORA DIST.: Attawapiskat River, *Porsild, et. al.* 19986 (CAN). LENNOX CO.: Skootamatta, *Jackson* (TRT). MANITOULIN DIST.: Honora, *Soper & Bell* 9819 (CAN, QUK, TRT). MUSKOKA DIST.: Sparrow Lake, *Walden* 110 (TRT). NIPISSING DIST.: Stuarts, *Ross* 2 (TRT). ONTARIO CO.: Cannington, *Thompson* 516 (TRT). PARRY SOUND DIST.: Ahmic Lake, *Soper* 5225 (CAN, TRT). PRESCOTT CO.: Alfred Twp., *Calder & Cody* 922 (PENN). RENFREW CO.: Renfrew, *Stroud* (TRT). STORMONT CO.: Newington, *Jenkins* 8297 (NCU). SUDBURY DIST.: Sudbury, *Ostenfeld* 613 (CAN). THUNDER BAY DIST.: Longlac, *Baldwin & Breitung* 3693 (CAN, TRT). TIMISKAMING DIST.: Cattle Isl., *Moss* 77 (ALTA). WELLAND CO.: Niagara, *Zenkert* (OAC). **Prince Edward Island:** KING CO.: Dundee, *Fernald, Long, & St. John* 7899 (GH). QUEENS CO.: Brackley Beach, *Grandtner* 13518 (CAN). **Quebec:** ABITIBI CO.: Amos, *Morton* 11035 (US). ARGENTEUIL CO.: Lachutem, *Porsild* 6337 (CAN). BERTHIER CO.: Lanoraie, *Scoggan* 370 (CAN). BONAVENTURE CO.: New Richmond, *Chrysler* 1228 (CHRB). BROME CO.: Bolton, *Knowlton* (GH). CHICOUTIMI CO.: Lac Kenogami, *Lavoie, Doyon, & Lord* 600706-01 (ACAD, TRT). GASPE WEST CO.: Mt. Albert, *Cottam* 11852 (UT). GATINEAU CO.: Wilson Corners, *Mitchell* 1750 (TENN). KAMOURASKA CO.: Ouelle, *Gauthier* 65-207 (QUK). LABELLE CO.: Nomininque, *Roy* 1053 (ACAD). LEVIS CO.: Chaudiere, *Forbes* (CAN). MAGDALEN ISLAND CO.: Amherst Isl., *Potter & Brierly* 3425 (NMC, UT). MASKINONGE CO.: Metis Beach, *DuBoulay & DuBoulay* 2589 (QUK). MATANE CO.: Lake Montagne, *Boivin* 786 (PENN). MATAPEDIA CO.: Saint Zenon, *Blain* 321 (CAN). MEGANTIC CO.: Black Lake, *Blais, Deshaies, & Forest* 10379 (CAN, QUK, SASK). MISSISQUOI CO.: Farnham, *Maycock* 1863 (QUK). MONTCALM CO.: Lac Tapani, *Pennell* 16678 (NY). MONTMORENCY CO.: Boischatel, *Cauchon, et. al.* 69-111 (MU, TRT). PORTNEUF CO.: *Marie-Victorin* 9437 (WS). RICHELIEU CO.: Saint-ours, *Rolland-Germain* 43513 (GH). RIMOUSKI CO.: Cap Enrage, *Rousseau* 26877 (GH). RIVIERE DU LOUP CO.: *Soper* 3670 (TRT). SAGUENAY CO.: Mingan, *Townsend* (GH); Natashquan, *Abbe* 1188 (GH); Romaine, *St. John* 90652 (GH); Round Lake, *Gillett* 5208 (GH); Seven Isl., *Harper* 3309 (CAN, HNH, PENN, US), *Robinson* 769 (CAN, GH, NY). SHERBROOKE CO.: Orford, *Martineau* 35 (CAN). TEMISCOUATA CO.: Trois Pistoles, *Fox* (TRT). TERREBONNE CO.: St. Sophe, *Wahl* 19419 (PAC). TIMISKAMING CO.: Ottawa River, *Baldwin* 5823 (CAN, SASK). TWO MOUNTAINS CO.: La Trappe, *Louis-Marie* 10 (GH). WOLFE CO.: Lake Nicolet, *Brisson & Hamel* 11295 (ACAD, OAC, SASK, TRT).

The synonomy of this taxon is fairly extensive. Numerous varietal and forma names have been proposed for the variation that exists, and some of these names have been elevated to specific rank. Many of these lack descriptions or are listed as synonyms under a variety or form name. Except for these subspecific categories only a few other names have been applied to this taxon. One of these was when Kuntze (1891) transferred the specific epithet *angustifolia* to another genus while the others were proposed by Rafinesque (1840).

Most of the subspecific categories that have been proposed for *Kalmia angustifolia* var. *angustifolia* are for variation and extremes in flower color (*carnea, rosea, rubra*), variation in size and habit of the plant (*media, minima, nana, procumbens, pumila*) and variation in shape and color of the leaves (*lucida, oleifolia, ovata, variegata*). In general, the differences in flower color appears to represent natural variation within populations and the above are better treated as cultivars than as forms. This is also true of the variation in leaf shape and color, and, in part, for variation in plant height. Holmes (1956) discusses some of these cultivars.

The dwarf condition reported for *Kalmia angustifolia* var. *angustifolia* is either the result of selection of more northern or high altitude sources or because of inbreeding depression. Jaynes (1968a) found that seedlings from selfed plants average about half the height of seedlings from outcrossed plants. He also found that seed set from self-pollinated plants is 85-90% less than that from cross pollination and that there is a marked reduction in survival of the seedlings from selfed plants. This indicates that this species is only weakly self compatible and that outcrossing usually occurs under natural conditions.

Kalmia angustifolia var. *angustifolia* commonly occurs in bogs, swamps, and other wet places, usually forming dense thickets around ponds and lakes. It is also found in open woods, as a weed in fields, and in moist openings of pine savannas. It is distributed from the northeastern part of the Michigan peninsula and the eastern half of Ontario, east through Quebec, the Maritime Provinces, and Newfoundland; north to at least the Attawapiskat River (Kenora District) in Ontario and to Goose Bay and Cartwright in Labrador; and south in eastern United States through New England and eastern New York, eastern Pennsylvania and Maryland to the coast in New Jersey and Delaware and the southeastern tip of Virginia. One specimen (*Davis & Davis*, 4691) has been seen which is reputed to have come from Randolph Co., West Virginia, but this collection should be considered doubtful. This species has also been reported from Indiana, but according to Deam (1940) this is an error.

It is possible that extracts from sheep laurel may inhibit the growth of other plants, particularly coniferous trees, thereby maintaining open areas for extended periods of time. Peterson (1965) found that the leaves of this species contain a substance that hinders the primary root development of black spruce by destruction of the epidermal and cortical cells. He further suggests that this may be the reason for the abnormally poor growth of trees associated with *Kalmia angustifolia* on upland sites in the boreal region of eastern Canada.

Studies by Jaynes (personal communication) reveal that some incompatibility exists between the two varieties of *Kalmia angustifolia*. This incompatibility is highly variable, depending upon the parents used, with the resulting offspring varying from completely sterile to highly fertile. Many of these hybrids produced a large quantity of viable seed while in others the capsules remained small and lacked seeds. From some crosses, both sterile and fertile individuals were produced. Also, among the offspring that produced no seeds, stainable pollen varied from 64% to 2%.

All artificially produced hybrids between these two taxa are similar to *Kalmia angustifolia* var. *angustifolia,* and except for the lack of seed set in some, could not be distinguished from it. All individuals have glandular calyces and most have leaves that are not puberulent beneath, both characteristics of typical var. *angustifolia.* Only 2 hybrids were found that had leaves which were puberulent beneath. More studies are needed to clarify the status of these taxa, but until more information is available, it seems best to maintain them as varieties.

Kalmia angustifolia L. var. **angustifolia** f. **candida** Fern. Rhodora **15:** 151. 1913.

Kalmia angustifolia var. *candida* (Fern.) Rehd. *In:* Bailey, Stand. Cycl. Hort. **3:** 1734. 1915. TYPE: **Newfoundland:** damp mossy or turfy hollows on hill south of St. John's, *Fernald & Wiegand* 6019 (GH).

According to Jaynes (1971a, 1971b) the presence of pigment in *Kalmia angustifolia* is determined by a single dominant gene, and the true-breeding recessive is white flowered. These white flowered individuals are anthocyaninless with green stems, as contrasted to the normal wild types with reddish stems. This characteristic is particularly obvious in seedlings.

It is possible that the recessive genes for the anthocyaninless condition are farily common in populations of this species, but are rarely expressed. In a population of *Kalmia angustifolia* from Madison, Connecticut, Jaynes (1971b) found that about 24% of the population was heterozygous for the anthocyaninless condition, but no homozygous recessive plants were found. It appears that the anthocyaninless plants are at a selective disadvantage in the wild.

SPECIMENS EXAMINED

UNITED STATES: **Maine:** ANDROSCOGGIN CO.: *Gordon* 407

(MAINE). LINCOLN CO.: *Hyland* 69 (MAINE). **Massachusetts:** Sherborn, *Loomis* (GH).

CANADA: **Newfoundland:** St. Johns, *Fernald & Wiegand* 6019 (GH).

4b. **Kalmia angustifolia** L. var. **caroliniana** (Small) Fern. Rhodora **39:** 476, 498. 1937.

Kalmia caroliniana Small, Fl. Southeast. U.S. 1336. 1903. TYPE: **North Carolina:** Flat Rock, *L. R. Gibbs* (NY).

Kalmia carolina Small, Fl. Southeast. U. S. 886. 1903. *Kalmia angustifolia* var. *carolina* (Small) Fern. Rhodora 39: 437. 1937.

Mature leaves permanently puberulent beneath with a dense covering of whitish, simple hairs, scattered stalked glandular hairs also present; calyx strongly puberulent, lacking stalked glandular hairs; corolla usually strongly puberulent on the outside.

Distribution: Open woods and shrubby bogs in the mountains and sandy woods, pocosins, savannas and bogs on the coastal plains. Extending from extreme southern Virginia through North Carolina to eastern South Carolina and west to eastern Tennessee and northeastern Georgia.

Common name: Sheep Laurel, Lambkill.

REPRESENTATIVE SPECIMENS

Georgia: RABUN CO.: Oakey Mt., *Duncan* 3281 (GH, ID, ISC, MO, NY, TENN, US), 4312 (ISC); Tom's Swamp, *Bookout & McDowell* 65 (GH). **North Carolina:** ALLEGHANY CO.: Edmonds, *Radford* 38191 (NCU). AVERY CO.: Pineola Bog, *Cain & Duncan* 251-3 (IND, ND). BEAUFORT CO.: Chocowinity, *Radford* 33396 (NCU). BLADEN CO.: White Lake, *Kral* 27210 (VDB). BUNCOMBE CO.: Asheville, *McGarthy* (US). CARTERET CO.: Beaufort, *Bentley* (VDB). CHOWAN CO.: Tyner, *Ahles* 39907 (NCU). COLUMBUS CO.: Chadbourn, *Wilbur* 5315 (DUKE). CRAVEN CO.: New Bern, *Harbison* 14080 (NCU), 14932 (NCU). CUMBERLAND CO.: Stedman, *Wilbur* 5169 (DUKE). DARE CO.: Manns Harbor, *Radford* 8197 (NCU). DUPLIN CO.: Charity, *Fogg, Jr.* 5481 (GH, PENN). GATES CO.: Gatesville, *Godfrey* 5214 (DUKE, GH). GREENE CO.: Walstonburg, *Radford* 36508 (NCU). HARNETT CO.: *Blomquist* 4486 (DUKE). HENDERSON CO.: Muddy Creek, *Smith* 221 (ISC, US). HOKE CO.: Timberland, *Ahles* 29514 (IND). HYDE CO.: *Radford & Stewart* 803 (NCU). JACKSON CO.: Cullowhee, *Biltmore*

Herb. 1344e (ALTA, GH, US). JOHNSTON CO.: Benson, *Smith* (IND, NCU). JONES CO.: Hargetts Store, *Radford* 36956 (NCU). LENOIR CO.: Pine Hill, *Radford* 31651 (NCU). MACON CO.: Highlands, *Wilson* 1854 (TENN). MARTIN CO.: Robersonville, *Radford* 35364 (ISC). MONTGOMERY CO.: Pekin, *Radford* 14595 (NCU). NEW HANOVER CO.: Wilmington, *Newber* 165 (UARK). ONSLOW CO.: Dixon, *Moldenke* 1242 (DUKE, MIN, MO, NY, PENN, US). PASQUOTANK CO.: Elizabeth City, *Ashe* (NCU). PENDER CO.: Wards Corner, *Ahles & Bell* 7856 (MISSA, MSC). PERQUIMANS CO.: Beach Spring, *Radford* 5470 (NCU). PITT CO.: Staton, *Radford* 34940 (NCU). RICHMOND CO.: Rockingham, *Coker* (NCU). ROBESON CO.: Allenton, *Ahles & Ramseur* 23770 (ND, PAC). SAMPSON CO.: Tomahawk, *Fox & Boyce* 3792 (KY). SCOTLAND CO.: Wagram, *Correll* 1181 (DUKE). TRANSYLVANIA CO.: Cedar Mt., *Freeman* 58130 (NCU). TYRRELL CO.: Cross Landing, *Radford* 33820 (NCU). WASHINGTON CO.: Hoke, *Radford* 35264 (NCU). WATAUGA CO.: Deep Gap, *Radford* 6239 (NCU). WAYNE CO.: Goldsboro, *Radford* 22006 (NCU). **South Carolina:** DARLINGTON CO.: between Darlington & Society Hill, *Smith* 1068 (NCU). HORRY CO.: *Radford & Stewart* 979 (NCU, NY). ORANGEBURG CO.: Edisto Swamp, *Ravenel* (GH). SUMTER CO.: Poinsette St. Park, *Holdaway* (DUKE). **Tennessee:** JOHNSON CO.: Cole's Bog, *Shanks & Sharp* 1115 (PENN, TENN); Shady Valley, *Barclay* (TENN), *Sharp & Underwood* 1252 (VDB), 1552 (NCU, NY), 3161 (NY). KNOX CO.: Kingston Pike, *Jennison* 717 (TENN). **Virginia:** CARROL CO.: Woodlawn, *Massey* 5058 (GH). NANSEMOND CO.: Whaleyville, *Fernald & Long* 7564 (GH, NY, US). NORFOLK CO.: Dismal Swamp, *Coville & Kearney, Jr.* 91 (OS, US), Portsmouth Ditch, *Grimes* 4517 (MIN, NY). SOUTHAMPTON CO.: Franklin, *Fernald & Long* 10002 (GH).

The name first applied to this taxon was *Kalmia carolina* when Small (1903) separated the plants with puberulent leaves from typical *K. angustifolia.* Later in a list of genera and species in the same publication (page 1336) the name was changed to *K. caroliniana.* It is very possible that this later name is a printing error, particularly since the name *K. carolina* was used by the author in a later publication (Small, 1914). Fernald (1937) transferred the epithet *carolina* to a variety of *K. angustifolia* (page 437), but later in the same publication (page 476, 498) changed the name to variety *caroliniana,* stating that this spelling, "since it accompanied the citation of the type, should prevail."

Kalmia angustifolia var. *caroliniana* has a fairly restricted range. Most of the specimens examined are from the coastal plain and the mountains of North Carolina with the species being extremely common on the pocosins and in bogs. This taxon also has a sporadic occurrence in the coastal plain of South Carolina (Radford, Ahles, and Bell, 1968) and in southern Virginia (Fernald, 1938, 1939), while it has been reported from a few localities in the mountains of extreme eastern Tennessee by Jennison (1935) and Shanks (1952) and from two mountain bogs in the Blue Ridge of northeastern Georgia by Duncan (1948).

The characteristics used to separate *Kalmia angustifolia* var. *caroliniana* are very reliable, but occasionally some overlap does occur. Usually, var. *angustifolia* has glandular calyces and leaves that are not puberulent beneath while in var. *caroliniana* the calyces are eglandular and the leaves are strongly puberulent beneath. All but two specimens of var. *caroliniana* examined had strongly puberulent leaves and even those were lightly puberulent on the undersurface of the leaf. This was also noticed by Radford, Ahles, and Bell (1968) who mentioned that a few specimens of var. *caroliniana* with glabrate leaves were found in the Carolinas. A few specimens of var. *angustifolia* from Nantucket Island and the coast of Massachusetts and Connecticut have leaves that are strongly puberulent beneath. All of these, however, have strongly glandular calyces, typical of var. *angustifolia*, and are referred to that taxon. The best character to separate the two varieties is the presence or absence of stalked glandular hairs on the calyx. Close examination, however, reveals that on some specimens of var. *caroliniana* a few glandular hairs are present on the calyces. The glands are not very numerous, however, and mostly restricted to the margins of the lobes or to the base of the calyx. Even on the holotype a few of these stalked glandular hairs are found. Because of this variability it is probably best to maintain these taxa as varieties of one species rather than as separate species.

A white flowered, anthocyaninless form of var. *caroliniana* also exists. It is similar genetically to *Kalmia angustifolia* var. *angustifolia* f. *candida* in that it is a homozygous recessive plant in which flower color is determined by a single pair of genes (Jaynes, 1971b). A specimen of this form was obtained by Dr. Jaynes from the Garden-in-the-Woods, in Sudbury, Massachusetts. No wild individuals have been found and its origin is not known. The best crossing results obtained by Jaynes (1968a) between *K. angustifolia* and other species of the genus were when this white flowered form was used as the female parent (Jaynes, 1971b).

5. **Kalmia cuneata** Michaux, Fl. Bor.-Amer. 1: 257. 1803. *Chamaedaphne cuneata* (Michx.) Kuntze, Rev. Gen. Pl. 2: 388. 1891. TYPE: In Carolina, *Michaux s.n.,* (GY).

Much branched rhizomatous shrub to 1.5 m tall; branchlets terete, reddish brown, usually adscending, stipitate-glandular and puberulent, becoming glabrous and light gray; leaves alternate, deciduous, flat, oblanceolate to elliptic-lanceolate, 2-6 cm long, 0.5-1.5 cm wide, lightly stipitate glandular beneath, glabrous above, apex obtuse to acute, apiculate, base narrowly cuneate, midrib puberulent above, stipitate-glandular beneath; petiole to 4 mm long; inflorescence a reduced corymbiform raceme or fascicle of 3-10 flowers in the upper axils of the last season's growth, pedicels 1-3 mm long, glabrous to lightly stipitate-glandular, recurved in fruit, subtended by 2 bracteoles in the axil of a small lanceolate bract about 1 mm long, main axis of the inflorescence less than 3 mm long; calyx glabrous to lightly stipitate-glandular, 6-7.5 mm broad, the lobes oblong, apex acute; corolla creamy white with a red band within, lightly stipitate-glandular outside, puberulent near the base within, 1.3-1.8 mm broad; anthers purplish brown, 1-1.3 mm long; filaments puberulent toward the base; style 7-10 mm long; ovary stipitate-glandular; capsule depressed globose, 4-6 mm broad, 2.5-3.5 mm long, stipitate-glandular; seeds light brown, 0.6-0.9 mm long, the testa not loose or extended past the ends of the seed. Chromosome number $n = 12$.

Distribution: Wet thickets and shrub bogs in southeastern

North Carolina and adjacent South Carolina.

Common name: White Wicky.

REPRESENTATIVE SPECIMENS

North Carolina: BLADEN CO.: Colly Creek, *Ashe* (PH); 10 miles north of Elizabethtown, *Ebinger* 11271 (EIU); Jerome Pocosin, *Buell & West* 1740 (MIN). CUMBERLAND CO.: Hope Mill, *Alexander* (NY). MOORE CO.: Pinehurst, *Wicker* (NY). PENDER CO.: Squalling Bluff Rd., *Coville* (MICH, NY, US); Burgaw, *Chrysler* 2262 (CHRB). RICHMOND CO.: Hamlet, *Wiegand & Manning* 2365 (GH). **South Carolina:** DARLINGTON CO.: Hartsville, *Smith* (NY), *Coker* (NY).

A small fragment of the type of *Kalmia cuneata* is at the Gray Herbarium. It consists of one fascicle of 5 flowers and a small stem with a few leaves attached. On the label is written "Ex Herb. Michaux *Kalmia cuneata*." At the present time the rest of the type has not been located.

Kalmia cuneata is very distinct. The only species that it could possibly be confused with is *K. angustifolia* since their general habit and leaf size are similar. *Kalmia cuneata,* however, is the only deciduous member of the genus and the only one in which the flowers are borne in fascicles from the axils of last season's growth. Other distinguishing characteristics are the creamy-white flowers with a red band within, the oblanceolate leaves, and the recurved fruiting pedicels.

Genetically, this species appears to be most closely related to *Kalmia hirsuta*, another alternate leaved species of the southeastern United States. Jaynes (1968a) reported that *K. cuneata* set no seed when used as the female parent, but as the male parent crossed with both *K. angustifolia* and *K. hirsuta*. The cross with *K. angustifolia* produced only inviable hybrids. Most of the hybrids with *K. hirsuta* were also inviable, producing sectors of albino or yellow-green tissue, but one hybrid flowered and was pollen sterile.

This species is one of the rarest shrubs in North America and few early reports exist concerning its distribution. Pursh (1814) reports that it occurs on the mountains of Carolina, while Nuttall collected it between Camden, South Carolina and Statesville, North Carolina (Wood, 1961).

Curtis (1835) reported its occurrence about 30 miles NE of Wilmington, North Carolina. Present studies indicate that it grows only in the sandhills and bay margins of the pocosin ecotones of the Carolinas. It now is known from 8 counties in this region (Radford, Ahles & Bell, 1968).

6. **Kalmia hirsuta** Walt. Fl. Carol. 138. 1788.

Chamaedaphne hirsuta (Walt.) Kuntze, Rev. Gen. Pl. 2: 388. 1891. *Kalmiella hirsuta* (Walt.) Small, Fl. Southeast. U. S. 886. 1903. TYPE: unknown.

Kalmia ciliata Bartram, Trav. N. & S. Carol. v, 7, 94, 171, 242, 1791. (nom. nud.).

Low, sparingly branched shrub, to 6 dm tall with a thick basal caudex; branchlets terete, reddish brown, puberulent and densely hispid; leaves alternate, sessile or with a petiole to 1 mm long, elliptic to ovate, 5-14 mm long, 1.5-8 mm broad, the margins usually slightly revolute, usually puberulent and hispid on both surfaces, small stipitate glands usually present beneath, apex acute, base broadly cuneate to rounded; flowers solitary (rarely in fascicles of 2-5 or in compact racemes) in the axils of the leaves of new growth; pedicels to 1.5 cm long, stipitate-glandular and hispid, subtended by a pair of bracts; calyx green, the lobes foliaceous, lanceolate, 3-8 mm long, hispid, tardily deciduous in fruit; corolla pink (rarely white), marked with red around the anther pockets and a red ring near the base, 1-1.5 cm broad, usually lightly hirsute and stipitate-glandular on the keels outside, puberulent at the base within; anthers purplish brown, 0.7-1.3 mm long; filaments puberulent toward the base; ovary usually stipitate glandular; style 5-7 mm long; fruit 2-4 mm broad, 2-3.5 mm long, subglobose to ovoid, thinly stipitate-glandular; seeds light brown, 0.3-0.5 mm long, the testa not loose or extended past the ends of the seed. Chromosome number $n = 12$.

Distribution: Low, sandy pine savanna, sand hills, dunes and flat pine woods on the coastal plains of southern Alabama and Georgia, northern Florida and the southern tip of South Carolina.

Common name: Sandhill Laurel, Calico-bush.

REPRESENTATIVE SPECIMENS

Alabama: BALDWIN CO.: Gulf State Park, *Webster & Wilbur* 3539 (GH, NY, US). MOBILE CO.: Theodore, *Pennell* 4513 (MICH, NY, PENN, PH). **Florida:** ALACHUA CO.: Cross Creek, *Ford* 2250 (GH, TENN). BAY CO.: Lynn Haven, *Billington* (MICH, US); *Lazor* 5006 (PAC). CLAY CO.: Kingsley Lake, *Henry* 3828 (PH). COLUMBIA CO.: Lake City, *Nash* 2193 (GH, MASS, MICH, MIN, MSC, ND, NY, OS, PH, US). DIXIE CO.: Old Town, *West & Arnold* (PH). DUVAL CO.: Jacksonville, *Curtis* 4359 (ARIZ, ND, NY, US), 4921 (GH, ISC, MIN, MSC, NY, US). ESCAMBIA CO.: Pensacola, *Webster & Wilbur* 3572 (GH, NY, US). FLAGLER CO.: Bunnell, *Ames* (GH). FRANKLIN CO.: Carrabelle, *Mosier* 884 (MIN, NY, PENN, US); *Moldenke* 1134 (MIN, NY, PENN, US). GADSDEN CO.: Quincy, *Sargent* (MIN). GILCHRIST CO.: Trenton, *Ward, West & Will* 2651 (GH, US). GULF CO.: Port St. Joe, *Ward & Ward* 1460 (GH). HAMILTON CO.: *Bowers & Wofford* 71-550 (TENN). HOLMES CO.: Bonifay, *Blanton* 6582 (US). JACKSON CO.: Compass Lake, *Knight & Arnold* (PAC). JEFFERSON CO.: Wacissa, *Godfrey* 53552 (GH). LAFAYETTE CO.: *Smith & Myint* 189 (GH). LEON CO.: Silver Lake, *Godfrey* 53660 (GH, MISSA, NY). LEVY CO.: Bronson, *Godfrey & Lindsey* 56989 (GH). LIBERTY CO.: Bristol, *Small, Small & DeWinkeler* 11448 (GH, NY, PENN, TENN). MADISON CO.: Greenville, *Ramsey* 106 (MSC). MARION CO.: Ocala, *Beardslee, Jr.* (MU). OKALOOSA CO.: Crestview, *McArthur* (GH). PUTNAM CO.: Interlachen, *Fox* 5703 (GH, MICH, MIN, NY, TENN). ST. JOHNS CO.: Anastasia Island, *Crawford* (NY, PH). ST. LUCIE CO.: Fort Walton, *Henry* 1087 (PH). SANTA ROSA CO.: Munson, *Ford & Arnold* 4190 (US). WAKULLA CO.: St. Marks Wildlife Refuge, *Godfrey* 57860 (GH). WALTON CO.: Santa Rosa, *Ripley & Barneby* 10128 (NY). **Georgia:** APPLING CO.: Baxley, *Cottam* 11060 (UT); *Ebinger* 11204 (EIU). BRANTLEY CO.: Waynesville, *Ebinger* 11232 (EIU). BULLOCH CO.: Portal, *Henry* 7311 (PH). CAMDEN CO.: Waverly, *Ebinger* 11228 (EIU). CANDLER CO.: Metter, *Henry* 7277 (PH); *Hermann* 10122 (GH, US). CHARLTON CO.: Folkston, *Harbison* 5816 (GH). COFFEE CO.: *Harper* 687 (GH, US). EFFINGHAM CO.: Harper 961 (GH). GLYNN CO.: Emanuel Church Rd., *Ebinger* 11231 (EIU). JEFF DAVIS CO.: Hazlehurst, *Ebinger* 11195 (EIU). LANIER CO.: *Adams* 50 (KY). LIBERTY CO.: Altamaha River, *Small* (GH, MIN, NY, PH). LOWNDES CO.: Valdosta, *Beardslee, Jr.* (MU). MCINTOSH CO.: Darien, *Cronquist* 5366 (GH, MICH, NY, PH). TATTNALL CO.: Reidsville, *Cronquist* 5340 (GH, IND, MICH, NY, PH, US). THOMAS CO.: Thomasville, *Taylor* (GH, MIN): TIFT CO.: Tifton, *Hardin & Duncan* 13649 (US). WARE

CO.: Suwannee Lake, *Harper* 48 (PH), 298 (GH, NY, PH, US). WAYNE CO:. Grangerville, *Ebinger* 11233 (EIU). WORTH CO.: Poulan, *Pollard & Maxon* 563 (NY, US). **South Carolina:** BEAUFORT CO.: Ferry Landing, *Bell* 3805 (NY). HAMPTON CO.: Hampton, *Leonard & Radford* 1662 (ARIZ, BRY, CHRB, NHA). JASPER CO.: Ridgeland, *Ebinger* 11242 (EIU).

Except for transfers of the specific epithet, *hirsuta*, to other genera, only one other name has been proposed for this taxon. Bartram (1791) used *Kalmia ciliata* for a plant he observed on his travels through the southeastern United States. He used this name a number of times but did not include a description (Merrill, 1945). He did, however, describe "a diminutive but elegant *Kalmia*" (page 18) which undoubtedly refers to *K. ciliata*. This description leaves no doubt that his *K. ciliata* is the same as *K. hirsuta*. The first time the name *K. ciliata* appears with a description is in the work of Dumont de Courset (1811) who attributes the name to Bartram.

Kalmia hirsuta has a relatively limited distribution, occurring along the coastal plain in southeastern United States. Small (1903, 1914) indicated that it extended from Virginia to Florida, perpetuating an error started by Gray (1856). Its occurrence in Virginia is extremely doubtful (Fernald, 1947) and is probably due to a few herbarium specimens with incomplete or erroneous collecting data. Two such specimens have been found during the present study. Both were collected during the middle of the last century and beside the collector's name and the year collected include the name Virginia.

Most of the specimens of *Kalmia hirsuta* examined are hispid on the stems, leaves, and pedicels. A few specimens were found, however, that were completely glabrous, lacking the long coarse hairs as well as the stipitate-glands and smaller hairs commonly found on most parts of the plant. Variation also occurs in the arrangement of the flowers on the plant. Usually the flowers are solitary in the axils of the leaves, but occasionally the flowers occur in fascicles of 2-5, while a few specimens were found in which short racemes occur in the axils of the leaves. In other specimens the flowers appeared as a terminal raceme due to a shortening of the internodes and a reduction in the size of the subtending leaves. The pedicels also vary extensively in length. The flowers of some plants are nearly sessile, while in others the pedicels are 1.5 cm long with the two basal bracts scattered along the stalk.

Genetically *Kalmia hirsuta* appears to be closely related to *K. latifolia* with which it can be crossed to produce viable hybrids with 0-10% pollen stainability. Jaynes (1968a) also reported that it can be crossed with both *K. angustifolia* and *K. cuneata* producing viable but sterile hybrids. Based on habit and morphology *K. hirsuta* is most closely related to *K. ericoides*. These species were placed in the genus *Kalmiella* by Small (1914) since they have a deciduous calyx and their flowers are borne singly in the axils of the leaves. Unfortunately the Cuban member of the genus is not available for genetic studies.

7. **Kalmia ericoides** Wright ex Griseb. Cat. Pl. Cubensium 51. 1866.

Chamaedaphne ericoides (Wright ex Griseb.) Kuntze, Rev. Gen. Pl. 2: 388. 1891. *Kalmiella ericoides* (Wright ex Griseb.) Small, North Amer. Fl. 29: 54. 1914. TYPE: Cuba occ. in distr. Guane, in pinetis arenosis pr. La Grifa, *C. Wright* 2199 (GH, NY, US - Isotypes).

A sparingly branched, erect to spreading shrub, to 10 dm tall with a thick basal caudex; branchlets light gray to reddish-gray, puberulent and commonly densely hispid and stipitate-glandular (rarely glabrous); leaves alternate, persistant, thick, leathery, subsessile or with a puberulent petiole to 1 mm long, linear, 4-13 mm long, 0.6-2 mm broad, the margins strongly revolute, usually lightly hispid and stipitate-glandular on both surfaces, sometimes strongly puberulent (rarely glabrous); flowers solitary (rarely in fascicles or in compact racemes) in the axils of the leaves at the end of the branches, forming a terminal cluster; pedicels to 13 mm long, commonly hispid and stipitate-glandular, subtended by a pair of puberulent bracts 1-3 mm long; calyx green, the lobes foliaceous, lanceolate, 3-6 mm long, usually hispid and stipitate-glandular, tardily deciduous in fruit; corolla light pink to white, 10-17 mm broad, usually lightly hirsute and stipitate-glandular on the keels outside, lightly puberulent at the base within; anthers purplish brown, 0.8-1.2 mm long; filaments puberulent toward the base; ovary usually stipitate-glandular; style 4-7 mm long; fruit 2-4 mm broad, 2-3 mm long, subglobose to ovoid, lightly stipitate-glandular; seeds reddish-brown, 0.4-0.7 mm long, the testa not loose or extending past the ends of the seed.

Kalmia ericoides is the only member of the genus that has not been studied cytologically. Morphologically, however, it is most closely related to *K. hirsuta,* a species restricted to southeastern United States. Both have relatively small leaves (less than 1.5 cm long), that are usually hispid, their flowers are borne singly in the axils of the leaves, and the calyx is tardily deciduous. The two are easily separated, however, since the leaves of *K. ericoides* are thick and leathery with revolute margins while in *K. hirsuta* the leaves are thin and lack a strong revolute margin. Also, the flowers are borne scattered along the stem in the axils of the leaves in *K. hirsuta* while in *K. ericoides,* they are solitary in the leaf axils, but clustered toward the ends of the stems giving the appearance of a terminal corymbiform raceme.

Kalmia ericoides is endemic to savannas and pine barrens of western Cuba. Although it has a very limited distribution, the variation that exists in pubescence and compactness of the inflorescence has resulted in a division of this complex into three species by Alain (1957), while others considered it a single highly variable species (Wood, 1961). Present studies indicate that the compactness of the inflorescence is not completely reliable in separating the taxa. The variation in leaf pubescence, however, is relatively stable. As a result, the following two varieties are recognized.

KEY TO VARIETIES

1. Leaves glabrous or lightly hispid and with a few scattered stalked glandular hairs on the upper surface. .... 7a. var. *ericoides.*
1. Leaves densely puberulent and stipitate-glandular on the upper surface. .... 7b. var. *aggregata.*

7a. **Kalmia ericoides** Wright ex. Griseb. var. **ericoides.**
Kalmiella simulata Britt. & Wils. Mem. Torrey Bot. Club **16:** 93. 1920. TYPE: **Cuba:** vicinity of Los Indios, Isle of Pines, *Britton, Britton, & Wilson* 14205 (NY).

Shrub with ascending, hispid, stipitate-glandular and sometimes puberulent branchlets; leaves scattered, usually only 5-12 per cm of branchlet, glabrous to lightly hispid and stipitate-glandular above, not puberulent, 4-9 mm long, 0.6-1.5 mm wide; pedicels usually longer than the subtending leaves, giving the inflorescence an open appearance; calyx lobes 3-4.5 mm long, hispid and lightly puberulent on the outside, usually glabrous within.

Distribution: Low, white-sand savanna and pine barrens on the Isle of Pines and in the Province of Pinar del Rio, Cuba.

REPRESENTATIVE SPECIMENS

Cuba: PINAR DEL RIO: La Grifa, *Ekman* 18165 (NY, US), *Wright* 2199 (GH, NY, US); Laguna de Alcatraz Grande, *León & Victorin* 18706 (GH, US), 20474 (GH, US); El Sabalo, *Alain* 1326 (GH, US). ISLE OF PINES: Los Indios, *Britton Britton, & Wilson* 14205 (GH, NY), *Killip* 42882 (GH, NY, US), *León & Victorin* 17853 (GH), *Victorin & Alain* 77a (US).

Kalmia ericoides var. *ericoides* has a very restricted range and few herbarium specimens are available. It appears to be a fairly stable variety that varies mostly in the extent of leaf pubescence. All of the specimens seen from the province of Pinar del Rio are typical of the type specimen which has a few scattered glandular hairs and is lightly hispid on the upper leaf surface. In contrast, most of the specimens of this variety from the Isle of Pines are glabrous on the upper leaf surface. These glabrous specimens were separated as *Kalmiella simulata* by Britton and Wilson (Britton, 1920). These glabrous specimens all have small, narrow leaves (less than 9 mm long and 0.6-1.2 mm wide), pedicels that are much longer than the subtending leaves, and calyx lobes that are fairly short (less than 4.5 mm long) all characteristics of variety *ericoides.*

7b. **Kalmia ericoides** var. **aggregata** (Small) Ebinger, *comb. nov.*

Kalmiella aggregata Small, North Amer. Fl. **29:** 54. 1914. *Kalmia aggregata* (Small) Copeland, Amer. Midl. Nat. **30:** 571. 1943. TYPE: **Cuba:** pinelands, Los Indios, Isle of Pines, *Jennings* 324 (NY).

Shrub with adscending, lightly hispid and strongly puberulent branchlets; leaves crowded, usually 15-25 per cm of branchlet, densely puberulent and stipitate-glandular above, 8-13 mm long, 1-2 mm wide; pedicels usually as short as the subtending leaves, giving the inflorescence a compact appearance; calyx lobes 3.5-5.5 mm long, hispid and densely puberulent on the outside, densely puberulent within.

Distribution: Low, white-sand savanna and pine barrens on the Isle of Pines, Cuba.

REPRESENTATIVE SPECIMENS

Cuba: ISLE OF PINES: Beach at Siquanea, *Morton* 10098 (US); between Mina de Oro and Playa del Soldado, *Killip* 43905 (US), 45385 (GH); Lama Daquille, *Ekman* 72492 (NY); Los Indios, *Jennings* 324 (GH, NY, US), *León & Victorin* 18857 (GH, US), *Victorin & Alain* 77 (GH, NY, US), Playa Roja, *Killip* 43001 (GH, NY, US); San Pedro, *Britton, Britton, & Wilson* 14146 (GH, NY, US), *Killip* 43698 (US), 45566 (US), *Morton* 10018 (US), 10053 (US); Siquanea region, *Killip* 44043 (US), 44044 (US), 44753 (US), 44755 (US).

This variety appears to be more robust than the preceding. Specimens to 13 dm have been reported, and the leaves and flowers are, in general, slightly larger than in variety *ericoides.* Besides this difference in size, all of the specimens of variety *aggregata* examined are strongly puberulent throughout. In particular the leaves are strongly puberulent on both surfaces, but this is also characteristic of the branches, pedicels and sepals.

UNCERTAIN OR EXCLUDED NAMES

Kalmia lanceolata Raf. Autikon Bot. 86. 1840. This name should probably be referred to *Kalmia polifolia* but the description could apply to other taxa. No specimen to represent this name has been found.

Kalmia serotina Hoffmgg. Verz. Pflanzenkulturen 70. 1824. Nomen nudum.

Kalmia spuria Bartr. Trav. N. & S. Carol. 303. 1791. Nomen nudum.

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MARINE ALGAE OF RHODE ISLAND

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With increasing marine research activity in the Narragansett Bay area, the need for information about local marine algae has become urgent. Therefore, the available information has been compiled (Wood, in press) and a list of species known to occur in the State is presented.

The earliest serious collecting of algae in Rhode Island seems to have been by S. T. Olney and his associates, and considerable effort was made in the years of 1846-1849. But, also, during the summer of 1846, J. W. Bailey visited Rhode Island and collected with Olney. Bailey, working independently, obtained specimens from Europe and worked up the collections systematically and included the Rhode Island records in his publication of 1847. Olney, on the other hand, sent his material to W. H. Harvey of Dublin, who identified them. The records were published by Olney in 1847, the same year that Bailey's appeared. Whose work appeared first is not clear, but Olney was the first Rhode Islander to publish on the marine algae of the State, while Bailey was probably the first worker to both study and publish on algae of Rhode Island. Subsequent records are those by Harvey (1852-1858), Olney (1871), Farlow (1873, 1875, 1876, and 1881), and Bennett (1888), and the several reports by Collins between 1882 and 1896 which were largely summarized in his works of 1900 and 1909-1918. More recent reports are those by Wood & Palmatier (1954), the dissertation by Villalard (1971), and thesis by Vaughan (1971). In addition, three collections of concern are the "Algae Rhodiaceae" by Olney (1871) and the two large exsiccata sets in which Rhode Island algae occur — Farlow, Anderson & Eaton's (1877-1889) "Algae Exsiccatae Americae-Borealis" and Collins, Holden & Setchell's (1895-1919) "Phycotheca Boreali-Americana."

The senior author (rdw) prepared a list of species recorded from Rhode Island by Taylor (1957), and then searched the literature for other early records. The supporting specimens were sought and examined, especially those at Brown University (courtesy of G. L. Church and W. H. Snell) and at the Farlow Herbarium at Harvard University (courtesy of I. M. Lamb). The complex of identifications and synonyms required careful tracing, but verification of most early names by examination of the actual collections was possible. The background information is to appear elsewhere (Wood, in press). The final list was checked by the junior author (mvb), and the latter also compiled the currently suggested synonyms that appear parenthetically in the list. Lastly, an evaluation of the frequency of occurrence of each taxon, based upon the authors' personal observations, was included. Where identifications were still uncertain, Dr. Wm. Randolph Taylor graciously aided. The final manuscript was examined and edited by Urda K. Wood.

It is hoped that this list will provide a background for future work on the algae of Rhode Island waters.

LIST OF MARINE ALGAE KNOWN FOR RHODE ISLAND

The nomenclature below follows Taylor (1957), but other suggested names and references are indicated parenthetically. However, author citations have been checked, and those involving "in" and "ex" entries include both authors. Species reported for the first time in Rhode Island are designated by an asterisk (*). The earliest known published record for each species in Rhode Island is cited in the second column, the abbreviations being: B = Bailey (1847), BENN. = Bennett (1888), B,O = Bailey (1847) and Olney (1847), C = Collins (1900), F = Farlow (1873), O = Olney (1847), OAR [for Olney's "Algae Rhodiaceae"] = Olney (1871), PBA = in Collins, Holden & Setchell (1895-1919), T = Taylor (1937), (VA) = thesis by Vaughan (1971), (VI) = dissertation by Villalard (1971), W = Wood (1962), W&P = Wood & Palmatier (1954).

Species which should be expected in the state, based on

Taylor's (1957) range records, but for which no adequate report is yet available, are summarized at the end of the list.

The frequency of occurrence of each species based on our combined personal observations is indicated in the third column as: t = trace, rare, + = local and uncommon, ++ = locally common, +++ = general and quite common. Where a rare taxon has been seen by only one of us, it is indicated as by "rdw" or "mvb" for R. D. Wood or M. Villalard-Bohnsack, respectively.

CHLOROPHYTA

	Ulotrichaceae		
	1. *Stichococcus marinus* (Wille) Hazen	T	+
	2. *Ulothrix flacca* (Dillw.) Thuret in Le Jol.	C	+,++
	Chaetophoraceae		
	3. *Pseudendoclonium submarinum* Wille	T	
	Gomontiaceae		
	4. *Gomontia polyrhiza* (Lagerh.) Born. et Flah.		+
	Ulvaceae		
*	5. *Capsosiphon fulvescens* (C.Ag.) Setch. et Gard.	(VI)	+
*	6. [*Enteromorpha ahlneriana* Blid.]	(VI)	+
	7. *E. clathrata* (Roth) J. Ag. (*E. clathrata* (Roth) Grev. — Parke & Dixon, 1964)	OAR	+
	8. *E. compressa* (L.) Grev. (ecotype of *E. intestinalis* (L.) Link — DaSilva & Burrows *in* Norton, 1972, p. 385)	B,O	+
	9. *E. cruciata* Collins	OAR	

	10. *E. erecta* (Lyngb.) J. Ag. (*E. flexuosa* ssp. *paradoxa* (Dillw.) Blid. — Bliding, 1963)	B,O	
*	11. *E. groenlandica* (J.Ag.) Setch. et Gard.	(VI)	++
	12. *E. intestinalis* (L.) Link	B,O	+++
	13. *E. linza* (L.) J. Ag.	C	++
	14. *E. marginata* J. Ag. (*Blidingia marginata* (J. Ag.) Dang. — Dangeard, 1958)	C	
	15. *E. minima* Näg. (*Blidingia minima* (Näg. ex Kütz.) Kylin — Kylin, 1947)	B	+++
	16. *E. prolifera* (Müll.) J. Ag.	C	+
	17. *Monostroma fuscum* (Post. et Rupr.) Witt. (*Ulvaria obscura* (Kütz.) Gayr. — Gayral, 1965)	T	
	18. *M. grevillei* (Thuret) Witt. (*Ulvopsis grevillei* (Thuret) Gayr. — Gayral, 1965)	C	+
*	19. *M. leptodermum* Kjellm. (*Kornmannia leptoderma* (Kjellm.) Blid. — Bliding, 1968)	(VI)	+
	20. *M. oxyspermum* (Kütz.) Doty (*Ulvaria oxyspermum* (Kütz.) Blid. — Bliding, 1968)	C	+
	21. *M. pulchrum* Farlow	B	++
*	22. *Percursaria percursa* (C. Ag.) Rosenv.		t(mvb)
	23. *Ulva lactuca* L.	B	+++
	var. *latissima* (L.) DC.	B,O	++
	Prasiolaceae		
	24. *Prasiola stipitata* Suhr. in Jess.	B	++

Cladophoraceae

25.	*Chaetomorpha aerea* (Dillw.) Kütz.	B	+
	(*Ch. linum* (Müll.) Kütz. — Christensen, 1957)		
26.	*Ch. linum* (Müll.) Kütz.	B	++
27.	*Ch. melagonium* (Web. et Mohr) Kütz.		t(rdw)
28.	*Cladophora albida* (Huds.) Kütz.	F	+
29.	*Cl. flexuosa* (Dillw.) Harv.	C	+
	(*Cl. serica* (Huds.) Kütz. — Hoek, 1963)		
	f. *densa* Collins	PBA	
30.	*Cl. glaucescens* (Harv.) Harv.	F	
	(*Cl. albida* (Huds.) Kütz. — Hoek, 1963)		
31.	*Cl. gracilis* (Griff. ex Harv.) Kütz.	O	++
	(*Cl. serica* (Huds.) Kütz. — Hoek, 1963)		
32.	*Cl. hutchinsiae* (Dillw.) Kütz. var. *distans* (C. Ag.) Kütz.	T	
	(*Cl. hutchinsiae* (Dillw.) Kütz. — Hoek, 1963)		
* 33.	*Cl. laetevirens* (Dillw.) Kütz.	(VI)	+
34.	*Cl. magdalenae* Harv.	F	
	(*Cl. albida* (Huds.) Kütz. — Hoek, 1963)		
35.	*Cl. refracta* (Roth) Kütz.	O	
	(*Cl. albida* (Huds.) Kütz. — Hoek, 1963)		
36.	*Cl. rudolphiana* (C. Ag.) Harv.	C	
	(*Cl. serica* (Huds.) Kütz. — Hoek, 1963)		
37.	*Cl. rupestris* (L.) Kütz.	OAR	+
38.	*Rhizoclonium riparium* (Roth) Harv.	C	t

	var. *implexum* (Dillw.) Rosenv.	C	
	var. *polyrhizum* (Lyngb.) Rosenv.	C	
* 39.	*R. tortuosum* Kütz. (*R. riparium* (Roth) Harv. — Scagel, 1966)	(VI)	+
40.	*Spongomorpha arcta* (Dillw.) Kütz. (*Acrosiphonia arcta* (Dillw.) J. Ag. — Kornmann, 1962)	B,O	++
* 41.	*S. lanosa* (Roth) Kütz. (*S. aeruginosa* (L.) Hoek — Hoek, 1963)	(VI)	t
* 42.	*S. spinescens* Kütz. (*Acrosiphonia arcta* (Dillw.) J. Ag. — Kornmann, 1962)		t(mvb)
43.	*Urospora penicilliformis* (Roth) Aresch.	O?,C	+
	Bryopsidaceae		
44.	*Bryopsis plumosa* (Huds.) C. Ag.	B	+
	Codiaceae		
45.	*Codium fragile* (Sur.) Hariot ssp. *tomentosoides* (van Goor) Silva	W	+++
	PHAEOPHYTA		
	Ectocarpaceae		
46.	*Ectocarpus confervoides* (Roth) Le Jol. (*E. siliculosus* (Dillw.) Lyngb. — South & Cardinal, 1970)	C	++
	var. *pygmaeus* (Aresch.) Kjellm.	T	

47. *E. dasycarpus* Kuck.	C	
48. *E. fasciculatus* Harv.	O	+
49. *E. penicillatus* (C. Ag.) Kjellm.	OAR	
50. *E. siliculosus* (Dillw.) Lyngb.	OAR	++
51. *E. tomentosus* (Huds.) Lyngb. (*Spongonema tomentosum* (Huds.) Kütz. — Kuckuck, 1960)	C	+
52. *Giffordia granulosa* (Smith) Hamel	F	+
53. *G. mitchellae* (Harv.) Hamel (*G. mitchelliae* (Harv.) Hamel — Earle, 1969)	C	
54. *G. ovata* (Kjellm.) Kylin	T	
55. *G. secunda* (Kütz.) Batt.	F	
56. *Pylaiella littoralis* (L.) Kjellm. (*Pilayella littoralis* (L.) Kjellm. — Dixon & Russell, 1964)	B,O	+,++
57. *Sorocarpus micromorus* (Bory) Silva	T	+ (rdw)
58. *Streblonema aecidioides* (Rosenv.) Fosl. (*Entonema aecidioides* (Rosenv.) Kjellm. — Edelstein & McLachlan, 1968)	C	
59. *S. chordariae* (Farl.) De Toni	F	
Sphacelariaceae		
60. *Cladostephus verticillatus* (Lightf.) Lyngb.	B,O	+
61. *Sphacelaria cirrosa* (Roth) C. Ag.	B	
62. *S. radicans* (Dillw.) C. Ag.	F	t
Myrionemataceae		
63. *Ascocyclus orbicularis* Magnus (*Myrionema magnusii* (Sauv.) Lois. — Loiseaux, 1967)	C	

64. *Hecatonema terminalis* (Kütz.) Kylin	C	
65. *Myrionema corunnae* Sauv.	T	
66. *M. foecundum* (Strömf.) Fosl. (*Hecatonema foecundum* (Strömf.) Lois. — Parke & Dixon, 1968)	C	
67. *M. globosum* (Reinke) Fosl. (*Microsporangium globosum* Reinke — Parke & Dixon, 1964)	T	
68. *M. strangulans* Grev.	C	

Ralfsiaceae

69. *Ralfsia borneti* Kuck.	T	
70. *R. clavata* (Harv. in Hook.) Crouan frat.	C	t
71. *R. pusilla* (Strömf.) Batt.	C	
72. *R. verrucosa* (Aresch.) J. Ag.	B	++

Elachisteaceae
(Elachistaceae — Parke & Dixon (1964))

73. *Elachistea chondri* Aresch. (*Elachista chondri* Aresch. — Fritsch, 1945; Parke & Dixon, 1964)	PBA	
74. *E. fucicola* (Vell.) Aresch. (*Elaschista fucicola* Aresch. — Fritsch, 1945; Parke & Dixon, 1964)	O	++
75. *Halothrix lumbricalis* (Kütz.) Reinke	C	

Chordariaceae

76. *Chordaria flagelliformis* (Müll.) C. Ag.	B	++
var. *densa* Farl.	C	
77. *Eudesme virescens* (Carm. ex Harv. in Hook.) J. Ag.	C	t

	78.	*Leathesia difformis* (L.) Aresch.	OAR	++
	79.	*Sphaerotrichia divaricata* (C. Ag.) Kylin	OAR	+
		Stilophoraceae		
	80.	*Stilophora rhizodes* (Turn.) J. Ag.	OAR	
		Desmarestiaceae		
	81.	*Arthrocladia villosa* (Huds.) Duby	C	t
	82.	*Desmarestia aculeata* (L.) Lamour.	B	+
	83.	*D. viridis* (Müll.) Lamour.	B	+
		Striariaceae		
	84.	*Striaria attenuata* (Grev.) Grev.	C	
		Punctariaceae		
*	85.	*Asperococcus echinatus* (Mert.) Grev. (*A. fistulosus* (Huds.) Hook. — Edelstein, Wynne & McLachlan, 1970)	(VI)	+,++
	86.	*Desmotrichum undulatum* (J. Ag.) Reinke	B,O	
	87.	*Litosiphon filiformis* (Reinke) Batt.	PBA	
	88.	*Myriotrichia clavaeformis* Harv.	C	
	89.	*M. filiformis* Harv.	F	
	90.	*Petalonia fascia* (Müll.) Kuntze	BENN.	++
	91.	*Punctaria latifolia* Grev.	BENN.	+
	92.	*P. plantaginea* (Roth) Grev.	O	+,++
	93.	*Rhadinocladia cylindrica* Schuh	T	
	94.	*R. farlowii* Schuh	T	

95.	*Scytosiphon lomentaria* (Lyngb.) Link (*S. lomentarius* (Lyngb.) Link — Farlow, 1881)	B,O	++,+++
	Dictyosiphonaceae		
96.	*Dictyosiphon chordaria* Aresch. (as *Gobia*)	T	
97.	*D. foeniculaceus* (Huds.) Grev.	B,O	+
	Laminariaceae		
98.	*Alaria esculenta* (L.) Grev.	C	
99.	*Chorda filum* (L.) Lamour.	B,O	+
100.	*C. tomentosa* Lyngb.	C	+
101.	*Laminaria agardhii* Kjellm. (*L. saccharina* (L.) Lamour. — Wilce, 1965)	B,O	+++
102.	*L. digitata* (Huds.) Lamour.	B,O	++
103.	*L. intermedia* Fosl. (*L. digitata* (Huds.) Lamour. — Sundene, 1958)	C	
104.	*L. longicruris* De la Pyl.	BENN.	
105.	*L. saccharina* (L.) Lamour.	C	
	Fucaceae		
*106.	*Ascophyllum mackaii* (Turn.) Holmes et Batt. (*A. nodosum* (L.) Le Jol. — Gibb, 1957)		+ (rdw)
107.	*A. nodosum* (L.) Le Jol.	B,O	++,+++
108.	*Fucus edentatus* De la Pyl. (*F. distichus* L. ssp. *edentatus* (De la Pyl.) Pow. — Powell, 1963)	B	+,++
109.	*F. evanescens* C. Ag. (*F. distichus* L. ssp. *evanescens* (C. Ag.) Pow. — Powell, 1963)	C	+ ?

110.	*F. spiralis* L.	B	++
	var. *limitaneus* Montagn.	T	
111.	*F. vesiculosus* L.	B,O	+++

Sargassaceae

112.	*Sargassum filipendula* C. Ag.	B,O	+
*113.	*S. natans* (L.) J. Meyen	(VA)	t(drift)

RHODOPHYTA

Bangiaceae

114.	*Bangia ciliaris* Carm. ex Harv. (*Erythrotrichia ciliaris* (Carm. ex Harv.) Thur. in Le Jol. — Parke & Dixon, 1964)	C	t
115.	*B. fuscopurpurea* (Dillw.) Lyngb.	B,O	++
116.	*Erythrotrichia carnea* (Dillw.) J. Ag.	C	
117.	*Goniotrichum alsidii* (Zanard.) Howe	C	t
118.	*Porphyra leucosticta* Thuret in Le Jol.		t
*119.	*P. miniata* (C. Ag.) C. Ag.	(VI)	+
120.	*P. umbilicalis* (L.) J. Ag.	B,O	++

Acrochaetiaceae

121.	*Acrochaetium daviesii* (Dillw.) Näg.	C	
122.	*A. flexuosum* Vickers	T	
123.	*Kylinia secundatum* (Lyngb.) Papenf. (*Acrochaetium secundatum* (Lyngb.) Näg. — Parke & Dixon, 1968)	C	
124.	*K. virgatula* (Harv.) Papenf. (*Acrochaetium virgatula* (Harv.) J. Ag. — Parke & Dixon, 1968)	C	

125. *Rhodochorton penicilliforme* (Kjellm.) Rosenv.	T	
126. *R. purpureum* (Lightf.) Rosenv.	B	
Helminthocladiaceae		
127. *Nemalion multifidum* (Web. et Mohr) J. Ag. (*N. helminthoides* (Vell. in With.) Batt. — Parke & Dixon, 1964)	O	+
Chaetangiaceae		
128. *Scinaia furcellata* (Turn.) Bivona	B ?,F	
Bonnemaisoniaceae		
*129. *Asparagopsis hamifera* (Hariot) Okam. (*Bonnemaisonia hamifera* Har. — Feldmann & Feldmann, 1942)	(VI), (VA)	++
Gelidiaceae		
130. *Gelidium crinale* (Turn.) Lamour.	C	+ (mvb)
Dumontiaceae		
131. *Dumontia incrassata* (Müll.) Lamour.	T	++
Rhizophyllidaceae		
132. *Polyides caprinus* (Gunn.) Papenf. (*P. rotundus* (Huds.) Grev. — Parke, 1953)	B	++
Squamariaceae		
133. *Hildenbrandia prototypus* Nardo	BENN.	+++

134.	*Rhododermis georgii* (Batt.) Collins (*Rhodophysema georgii* Batt. —Dixon, 1964)	T	

Corallinaceae

135.	*Corallina officinalis* L.	BENN.	++
136.	*Fosliella farinosa* (Lamour.) Howe (*Melobesia farinosa* Lamour. — Hamel & Lemoine, 1952)	C	
137.	*F. lejolisii* (Rosan.) Howe (*Melobesia lejolisii* Rosan. — Hamel & Lemoine, 1952)	C	+
138.	*Lithophyllum corallinae* (Crouan *frat.*) Heydr.	PBA	
139.	*L. macrocarpum* (Rosan.) Fosl. (*Dermatolithon pustulatum* (Lamour.) Fosl. — Edelstein & McLachlan, 1968)	T	
140.	*L. pustulatum* (Lamour.) Fosl.	OAR	
*141.	*L. lenormandi* (Aresch. in J. Ag.) Fosl. (*Phymatolithon lenormandii* (Aresch. in J. Ag.) Adey — Adey, 1966)	(VI)	+,++
142.	*Melobesia membranacea* (Esper) Lamour. (*Epilithon membranaceum* (Esper) Heydr. — Parke & Dixon, 1964)	C	
143.	*Phymatolithon laevigatum* (Fosl.) Fosl. (*Lithothamnion laevigatum* Fosl. — Parke & Dixon, 1964)	T	++

144.	*P. polymorphum* (L.) Fosl. (*Lithothamnion polymorphum* (L.) Aresch. in J. Ag. — Parke & Dixon, 1964)	C	
	Gloiosiphoniaceae		
145.	*Gloiosiphonia capillaris* (Huds.) Carm. ex Berk.	C	t—+ (periodic)
	Kallymeniaceae		
146.	*Euthora cristata* (C. Ag.) J. Ag.	F	t(drift?)
	Choreocolacaceae		
147.	*Choreocolax polysiphoniae* Reinsch	C	
148.	*Harveyella mirabilis* (Reinsch) Reinke	T	
	Solieriaceae		
149.	*Agardhiella tenera* (J. Ag.) Schmitz (as used by Taylor (1957), but designated *A. baileyi* (Harv. ex Kütz.) Taylor in Taylor & Rhyne (1970: 13), and since changed to *Neoagardhiella baileyi* (Harv. ex Kütz.) Wynne & Taylor, Wynne & Taylor, 1973, p. 101)	B	++
	Rhodophyllidaceae		
150.	*Cystoclonium purpureum* (Huds.) Batt.	B,O	++,+++
	var. *cirrhosum* Harv.	C	++
	Hypneaceae		
151.	*Hypnea musciformis* (Wulf.) Lamour.	BENN.	t

Gracilariaceae		
152. *Gracilaria foliifera* (Forssk.) Börg.	O	t
153. *G. verrucosa* (Huds.) Papenf.	W&P	+++
Phyllophoraceae		
154. *Ahnfeltia plicata* (Huds.) Fries	B,O	++
155. *Gymnogongrus griffithsiae* (Turn.) Mart.	C	t(mvb)
156. *Phyllophora brodiaei* (Turn.) Endl.	F	+
(*P. truncata* (Pallas) Newr. et Taylor — Newroth & Taylor, 1971)		
var. *catenata* (C. Ag.) Collins	T	
157. *P. membranifolia* (Good. et Woodw.) J. Ag.	O	++
(*P. pseudoceranoides* (Gmel.) Newr. et Taylor — Newroth & Taylor, 1971)		
158. *P. traillii* Holmes ex Batt.	C	
Gigartinaceae		
159. *Chondrus crispus* Stackh.	B,O	+++
160. *Gigartina stellata* (Stackh.) Batt.	C	++
(*Palmaria palmata* (L.) Stackhouse — Guiry, 1974, p. 219.)		
Rhodymeniaceae		
161. *Rhodymenia palmata* (L.) Grev.	B,O	+++
Champiaceae		
162. *Champia parvula* (C. Ag.) Harv.	B,O	++
163. *Lomentaria baileyana* (Harv.) Farl.	OAR	+,++

*164.	[*L. clavellosa* (Turn.) Gail.]		+ (mvb)
165.	*L. orcadensis* (Harv.) Coll. ex Taylor	OAR	

Ceramiaceae

166.	*Antithamnion americanum* (Harv.) Farl. in Kjellm.	C	
167.	*A. cruciatum* (C. Ag.) Näg.	BENN.	+
168.	*A. plumula* (Ellis) Thuret in Le Jol.	F	
169.	*A. pylaisaei* (Mont.) Kjellm.	C	
170.	*Callithamnion baileyi* Harv.	OAR	t
	var. *laxum* Farlow	T	
171.	*C. byssoides* Arnott ex Harv. in Hook.	OAR	
172.	*C. corymbosum* (Smith) Lyngb.	B	+
173.	*C. roseum* (Roth) Lyngb.	C	+
174.	*C. tetragonum* (With.) C. Ag.	O	
175.	*Ceramium deslongchampii* Chauv. in Duby	O	
176.	*C. diaphanum* (Lightf.) Roth	B,O	+,++
177.	*C. fastigiatum* Harv.	OAR	++
178.	*C. rubriforme* Kylin (prox.)	(VA)	t?
179.	*C. rubrum* (Huds.) C. Ag.	B,O	+++
	var. *pedicellatum* Duby (*C. pedicellatum* DC. — Parke & Dixon, 1964)	C	
	var. *squarrosum* Harv.	OAR	
180.	*C. strictum* Harv.	C	+
181.	*Griffithsia globulifera* Harv.	C	+
182.	*G. tenuis* C. Ag.	O	t
183.	*Pleonosporium borreri* (Smith) Näg. ex Hauck	OAR	
184.	*Plumaria elegans* (Bonnem.) Schmitz	F	+,++
185.	*Ptilota serrata* Kütz.	B?,F	t

186.	*Seirospora griffithsiana* Harv. (*S. seirosperma* (Harv.) Dixon — Dixon, 1964)	OAR	
187.	*Spermothamnion turneri* (Mert.) Aresch. (*S. repens* (Dillw.) Rosenv. — Rosenvinge, 1924)	B	+,++
188.	*Spyridia filamentosa* (Wulf.) Harv. in Hook.	B,O	+
*189.	*Trailliella intricata* (J. Ag.) Batt. (sporophyte of *Asparagopsis hamifera* — Taylor, 1957, p. 291)	(VI)	+,++
	Delesseriaceae		
190.	*Grinnellia americana* (C. Ag.) Harv.	B,O	++
191.	*Phycodrys rubens* (L.) Batt.	B	++
	Dasyaceae		
192.	*Dasya pedicellata* (C. Ag.) C. Ag. (*D. baillouviana* (Gmel.) Mont. — Dixon & Irvine, 1970)	B,O	++
	Rhodomelaceae		
193.	*Chondria baileyana* (Mont.) Harv.	O	+,++
194.	*C. dasyphylla* (Woodw.) C. Ag.	B,O	
195.	*C. sedifolia* Harv.	C	+,++?
196.	*C. tenuissima* (Good. et Woodw.) C. Ag.	W&P	t
197.	*Polysiphonia denudata* (Dillw.) Grev. ex Harv. in Hook.	B	
198.	*P. elongata* Harv. in Hook.	BENN.	++
199.	*P. fibrillosa* (Dillw.) Spreng.	O	++

200.	*P. harveyi* Bail.	O	+++
	var. *olneyi* (Harv.) Collins	O	
201.	*P. lanosa* (L.) Tandy	B,O	++,+++
202.	*P. nigra* (Huds.) Batt.	F	+
203.	*P. nigrescens* (Huds.) Grev.	B	+
204.	*P. novae-angliae* Taylor	B	
205.	*P. subtilissima* Mont.	F	+
206.	*P. urceolata* (Lightf. ex Dillw.) Grev.	C	++
207.	*Rhodomela confervoides* (Huds.) Silva	B,O	+,++
208.	*R. virgata* Kjellm.	C	

SPECIES TO BE EXPECTED IN RHODE ISLAND, AND REPORTED FROM ADJACENT STATES BY TAYLOR (1957)

CHLOROPHYTA

Chlorococcaceae

Codiolum gregarium A. Br.

Ulotrichaceae

Ulothrix implexa Kütz.

Chaetophoraceae

Bolbocoleon piliferum Pringsh.
Entocladia flustrae (Reinke) Batt.
  (*Epicladia flustrae* Reinke — Parke & Dixon, 1968)
E. wittrockii Wille
  (*Ectochaete wittrockii* (Wille) Kylin — Parke & Dixon, 1968)
Pringsheimiella scutata (Reinke) Marchew.
Protoderma marinum Reinke
  (*Pseudendoclonium marinum* (Reinke) Aleem et Schulz — Loiseaux, 1967)

Ulvaceae

Enteromorpha plumosa Kütz.
  (*E. flexuosa* ssp. *paradoxa* (Dillw.) Blid. — Bliding, 1963)

Cladophoraceae

Chaetomorpha atrovirens Taylor
Cladophora crystallina (Roth) Kütz.
  (*Cl. vagabunda* (L.) Hoek; *Cl. glomerata* (L.) Kütz. — Hoek, 1963)
Cl. expansa (Mert.) Kütz.
  (*Cl. vagabunda* (L.) Hoek — Hoek, 1963)

Cl. flavescens (Roth) Kütz.
(a doubtful name — Hoek, 1963)

Derbesiaceae

Derbesia vaucheriaeformis (Harv.) J. Ag.

Bryopsidaceae

Bryopsis hypnoides Lamour.

Phyllosiphonaceae

Ostreobium quekettii Born. et Flah.

XANTHOPHYTA

Vaucheriaceae

Vaucheria litorea C. Ag.
V. thuretii Woronin

PHAEOPHYTA

Ectocarpaceae

Ectocarpus subcorymbosus Farl.
(*Farlowiella onusta* (Kütz.) Kuck. — Kuckuck, 1956)

Elachisteaceae
(Elachistaceae — Parke & Dixon, 1964)

Myriactula minor (Farl.) Taylor

Chordariaceae

Acrothrix novae-angliae Taylor
Eudesme zosterae (Lyngb.) Kylin
(*Cladosiphon zosterae* (J. Ag.) Kylin — Parke, 1953)

Striariaceae

Stictyosiphon subsimplex Holden

Punctariaceae

Desmotrichum balticum Kütz.
(*D. undulatum* (J. Ag.) Reinke — Kylin, 1947a)

Sargassaceae

Sargassum fluitans Börg.

RHODOPHYTA

Bangiaceae

Asterocytis ramosa (Thwaites in Harv.) Gobi ex Schmitz

Acrochaetiaceae

Audouinella membranacea (Magnus) Papenf.

Corallinaceae

Lithothamnium laeve (Strömf.) Fosl.
(*Leptophytum laeve* (Strömf.) Adey — Adey, 1966)

Ceramiaceae

Callithamnion circinatum (Kütz.) J. Ag.

Delesseriaceae

Membranoptera denticulata (Mont.) Kylin

Rhodomelaceae

Bostrychia rivularis Harv.
Polysiphonia flexicaulis (Harv.) Collins

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A BIOSYSTEMATIC REVISION OF *LUPINUS LYALLII*

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Systematics of the genus *Lupinus* is often viewed as one of the most perplexing studies ever attempted. This is attested by the diverse taxonomic treatments of various floras and special publications. While several students of the lupines have recognized many entities, others have found these plants in such confusing mosaics that enormous synonymic reductions were made; neither approach has solved the taxonomic problems formed by lupine diversity.

In a biosystematic revision of the *Lupinus lepidus-L. caespitosus* complex of the Sierra Nevada, Cascade and Rocky Mountains, various techniques of study were employed in an effort to show the degree of relationship between the taxa (Cox 1972a). Over 75 epithets have been applied to various members of this complex since 1828 when *L. lepidus* was described, and these epithets have been considered by some as referable to a single species.

In order to present the concept of the *L. lepidus-L. caespitosus* complex in a digestible and economically feasible form, a taxonomic treatment of only *Lupinus lyallii*, its five subspecies and six varieties will be offered here. More complete distribution maps, cytological and chemotaxonomic data, photographs of typical specimens, and illustrations of typical leaflet and floral parts are given elsewhere (Cox 1972a, 1972b, 1973a, 1973b).

Chromosome numbers: Taxa within *Lupinus lyallii* have chromosome number reports of $2n = 48$ (subsp. *lyallii*, var. *lyallii* and var. *villosus*, and subsp. *minutifolius*) by Cox (1972b). The chromosomes are extremely small and counts are difficult to obtain, undoubtedly explaining the lack of previous reports. Although Phillips (1957) reported a

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chromosome count for *L. lyallii* of $n = 24$, his study plant was *L. minimus*. Chromosome counts have offered little in determining the genetic affinities within the *L. lepidus-L. caespitosus* complex since all reported numbers are $2n = 48$ (Cox 1972b).

Chemosystematic data. Seed proteins: Comparisons were made of seed proteins of four of the *L. lyallii* taxa by polyacrylamide gel electrophoresis (Cox 1972a, 1973b). Considerable variation was found in several polymorphic populations; largely, the electrophoresis disc protein data closely resemble those data from the morphological study in the degree of variation found. Although no protein band occurred in common with all taxa studied, likewise no protein band was found unique to any one taxon. Each population was found to have a distinct combination of proteins, resulting in low percent similarity values between the taxa.

Seed Alkaloids: The seed alkaloids of all of the subspecies and varieties of *Lupinus lyallii* were compared by thin-layer chromatography (TLC) separation by Cox (1973a). Although some interpopulational variation was found, the alkaloids were generally quite consistent. Correlations were made between alkaloid shapes, R_f values, positive color reactions with two different visualizing agents, and comparisons with standards. Percent similarity values were high among the interspecific taxa, and identical alkaloid combinations were shared among a few, these differing only in relative amounts of individual alkaloids.

Morphological and distributional considerations: Field and herbarium-laboratory studies were conducted over a three year period on the *Lupinus lepidus-L. caespitosus* complex. Techniques and preparations of specimens for measurements in the descriptions are given by Cox (1972a).

The following herbaria are acknowledged for the use of over 1000 specimens of the taxa of *Lupinus lyallii:* AEC, ARIZ, BRY, CAN, DS, GH, ISC, JEPS, MIN, MO, NMC, NY, POM, ORE, OSC, RENO, RM, RSA, SMU, UBC, UC, UMO, US, UTC, V, WILLU, WS.

Lupinus lyallii A. Gray

Plants perennial, herbaceous, caespitose or mat-like, less than 18 cm. tall; leaflets few (5-9), oblanceolate, the largest less than 2 cm. long; banners glabrous, usually reflexed below the midpoint.

Distribution: The taxa are primarily found in the high Sierra Nevada and Cascade Mountains with a few populations radiating out into isolated localities (Fig. 1).

KEY TO THE SUBSPECIES AND VARIETIES OF LUPINUS LYALLII

A. Plants with spreading villous-hirsute to shaggy pubescence. . . . . B.
  B. Plants less than 10 cm. tall; flowers 6-7 mm. long; largest leaflets 4-6 mm. long; Sierra Nevada, alpine, dwarf. . . . . . . 1b. *L. lyallii* subsp. *lyallii* var. *danaus.*
  B. Plants usually taller; flowers over 7 mm. long; largest leaflets over 6 mm. long. . . . . C.
    C. Plants decumbent, mat-like; leaflets 6-7, largest 10-13 mm. long; Sierra Nevada, with a few stations in Klamath Co., Ore. . . . . 1f. *L. lyallii* subsp. *lyallii* var. *villosus.*
    C. Plants erect to semi-decumbent, branching, 10-18 cm. tall; leaflets 5-6, largest 9-21 mm. long; Washoe Co., Nevada. . . . . 5. *L. lyallii* subsp. *washoensis.*
A. Plants with appressed to subappressed pubescence. . . D.
  D. Plants erect in densely branching clumps; 12-18 cm. tall; Rogue River-Crater Lake region, Oregon. . . E.
    E. Branching stems mostly woody, less than 1.5 mm. in diameter; leaflets 5-6; racemes 1.3-1.4 cm. in diameter; flowers 6-7.5 mm. long. . . . . . . 1c. *L. lyallii* subsp. *lyallii* var. *fructiculosus.*
    E. Branching stems mostly herbaceous, more robust; leaflets 7-9; racemes 1.9-2.5 cm. in diameter; flowers 7-9.5 mm. long. . . . . 1e. *L. lyallii* subsp. *lyallii* var. *roguensis.*
  D. Plants decumbent or erect and densely caespitose. . . . . F.

F. Plants mat-like, usually less than 10 cm. tall; flowers 6-7 mm. long; largest leaflets 4-6 mm. long; alpine, Sierra Nevada Range. 1b. *L. lyallii* subsp. *lyallii* var. *danaus.*

F. Plants usually larger or flowers longer. . . . . . G.

G. Plants 4-6 cm. tall; flowers 7.5-10 mm. long; largest leaflets 6-9 mm. long, upper surface glabrous; Steens Mts, Harney Co., Oregon. . . . . 3. *L. lyallii* subsp. *minutifolius.*

G. Plants mostly taller; flowers various; largest leaflets various lengths, mostly pubescent (becoming somewhat glabrate in subsp. *alcis-temporis*). . . . . H.

H. Plants mostly decumbent; Clearwater Co., Idaho. . . 2. *L. lyallii* subsp. *alcis-temporis.*

H. Plants erect or mat-like, not decumbent. . . . . I.

I. Leaves all basal, erect, in small tufts; petioles 3-9 cm. long; largest leaflets 9-22 mm. long; SW Idaho & NE Nevada. . . 4. *L. lyallii* subsp. *subpandens.*

I. Leaves cauline, basal, or both, generally ascending or more or less spreading, generally not in small tufts; petioles usually 2-5.5 cm. long; largest leaflets 5-12 mm. long. . . . . J.

J. Flowers 10-12.5 mm. long; racemes 2.5-4.5 (5.5) cm. long, 2.5-3.0 cm. in diameter; leaflets 6-9; high alpine areas of western Cascade Range, Ore. & Wash. . . . . 1d. *L. lyallii* subsp. *lyallii* var. *macroflorus.*

J. Flowers 7.5-10.5 mm. long; racemes 1.5-3 cm. long, 2.0-2.3 cm. in diameter; leaflets 5-7; alpine and subalpine, wide distribution, Sierra Nevada Range, Calif. & Cascade Range,

Ore., Wash. & B. C. .... 1a.
L. lyallii subsp. *lyallii* var. *lyallii.*

1a. **Lupinus lyallii** subsp. **lyallii** var. **lyallii**

Lupinus lyallii A. Gray, Proc. Amer. Acad. 7: 334. 1868. Type: "Summit of the Cascade Mountains, lat 49°, elev. 7500 ft.", *Lyall,* Jul 1860 (Holotype: K; Isotypes: BM, GH, POM). Photos: (RSA, UC, UMO, US).

L. lepidus subsp. *lyallii* (Gray) Detl., Amer. Mid. Nat. 45: 490-491. 1951.

L. alpinus Heller, Muhlenbergia 6: 22. 1910. Type: NEVADA: WASHOE CO.: Mt Rose, *Heller* 9914a (Holotype: Nev. Agr.; Isotypes: GH, ISC, MIN, NMC, NY, POM, RSA, UC, US, WS). Photos: (RSA, UMO).

L. paulinus Greene, Leafl. Bot. Obs. & Crit. 2: 234. 1912. Type: OREGON: DESCHUTES CO.: Paulina Lake, W end, *Leiberg* 550 (Holotype: US; Isotypes: GH, UC).

L. rubro-soli Eastw., Leafl. West. Bot. 3: 203. 1941. Type: CALIFORNIA: MENDOCINO CO.: Red Mt., *Eastwood & Howell* 4674 (Holotype: CAS; Isotype: US). Photos: (RSA, UMO).

Plants perennial, caespitose, forming mat-like radicle clumps, 15-25 cm. in diameter, from a thick, woody caudex which often branches in older plants, 6-17 cm. tall; foliage 2-7 cm. tall; stems poorly developed, less than 1.5 mm. in diameter, semi-prostrate, some sprawling-decumbent, some erect, subappressed silky sericeous throughout, hairs usually less than 1 mm. long; cauline nodes 0-2; petioles slender, 2-5(7.5) cm. long; stipules generally inconspicuous; leaflets 5-7, oblanceolate-linear to elliptic-obovate, apex acute to short mucronate, largest 5-12(18) mm. long, av. 9.95 mm., 1.5-4.5 mm. wide, length to width ratio 2.17-4.0(6.0), av. 3.18, appressed silky-sericeous on both surfaces; peduncles usually much exceeding the foliage, 3-8(10) cm. long; racemes capitate to subcapitate, 1.5-3 cm. long, occasionally to 4.0 cm. at anthesis, 20-23 mm. in diameter, rarely 2× as long as wide; flowers dense, blue, 7.5-10.5 mm. long, av. 9.44; bracts persistent to caducous, 3-6.5 mm. long, subulate to lance-linear; pedicels 1.5-2.5 mm. long; calyx bilabiate, the upper-lip 3.5-6.0 mm. long, bilobed, the notch 1-2.5 mm. deep, the lower-lip 3.8-6.8 mm. long, apex serrate to tridentate, the center tooth to 0.5 mm. long, lips connate 1-2 mm., bracteoles usually present but inconspicuous, to 0.5 mm. long, attached at the sinus, sericeous; banner elliptic-oblong to suborbicular, glabrous, 7-10 mm. long, 5.1-8.0 mm. wide, length to width ratio 1.10-1.57, av. 1.29, reflexed below or near the midpoint, the reflexed to appressed ratio 1-1.3, av. 1.14, angle 120-150°; wings 6.5-9.8 mm. long, 3.5-5.5 mm. wide, length to width ratio 1.56-2.25 av. 1.90, claws 1.0-2.2 mm. long, glabrous; keel 2.5-3.0 mm. wide at the widest point, angle 105-111°, ciliated along the upper margin near the acumen; ovules 3-5; pods 10-15 mm. long, 4-5 mm. wide, short sericeous; seeds 2-4, 1.8-3.0 mm. × 2.6-3.5 mm., 1-1.5 mm. thick, tan, beige, brown and green mottled.

This variety is primarily alpine to subalpine, ranging latitudinally in its distribution from the high Sierra Nevada Mountains of California through the Cascade Range of Oregon and Washington into British Columbia. These plants may be found in several soil types, such as volcanic ash, disintegrated granite, sandy, gravelly rock of several compositions to shale. They usually occur on slopes associated most frequently with *Pinus contorta*, *P. murrayana*, *P. albicaulis* and *Tsuga mertensiana*. Altitudinally, the plants are found above timberline at 3660 m. down to about 2439 m., or in the more northerly latitudes to about 1830 m. Flowering occurs between June and September; the plants flowering during the latter part of the season usually are found in sites of lingering snowbanks.

Representative specimens: CANADA: **British Columbia:** Bomford Mt, Ashnola Dist, *Barr* 9351 (UBC); Chilcotin, *Copley* 472 (V); Lillooet, *Anderson*, Jul 1916 (V); Manning Park, *Hardy*, Aug 1945 (V); Mt McLean, *Anderson* 7987 (V); Mt Moor, *Bird* 3436 (UBC); Nicoamen River head, *Dawson* 5133 (CAN); Noaxe Lake, *Brink*, Aug 1957 (UBC); Yalakom River, *Sugden* 118 (V). USA: **California:** ALPINE CO.: Carson Pass, *Yates* 3980 (UC). EL DORADO CO.: Desolation Valley, *Abrams* 12740 (GH, NY, POM, UC). FRESNO CO.: Humphreys

Basin, headwaters Piute Creek, *Quibell* 5113 (UC). LASSEN CO.: Lassen Volcanic Natl. Park, *Rickett,* Aug 1968 (UMO). MADERA CO.: Mt Lyell, at Moraine Meadows, *Akey* 318 (UC). MARIPOSA CO.: Mt Connes, Tioga Pass, *Ramsey & Ramsey* 2496 (POM). MODOC CO.: Antelope Valley, *Applegate* 847 (US). MONO CO.: Bodie, 2.2 mi N-NW, *Graham* 274 (UC). NEVADA CO.: Mt Stanford, *Sonne* 54 (MO). PLACER CO.: Snow Mt, *Bolt* 103 (UC). SHASTA CO.: Bolam Road, near the S.P. RR, *Cooke* 15003 (UC). SISKIYOU CO.: Bolam Creek Canyon, opposite Coquette Falls, Mt Shasta, *Cooke* 25691 (UC). TEHAMA CO.: King Creek Meadow, Lassen Volcanic Natl. Park, *Heller* 15426 (MO, NY). TRINITY CO.: Fisher Ridge, E of Black Rock, North Yolla Bolly Mts, *Munz* 16743 (RSA). TULARE CO.: Golden Trout Creek, *Hall & Hall* 8417 (UC). TUOLUMNE CO.: Bond Pass, *Winkelman* 276 (UC). **Nevada:** WASHOE CO.: Mt Rose, *Kennedy* 1148 (NY, UC, US). **Oregon:** CURRY CO.: Bear Camp Ranger Station, *Leach* 1692 (ORE). DESCHUTES CO.: Bend, *Farnham & Beach* 97 (OSC). DOUGLAS CO.: Bailey Mt, *Applegate* 4121 (UC). JACKSON CO.: Ashland Peak, *Thompson* 12383 (MO, NY, UC). JEFFERSON CO.: Hoodoo, Big Lake Turnoff, US Hwy 20, *Isely & Isely* 11299 (ISC, UMO). JOSEPHINE CO.: Free and Easy Trail, head of Babyfoot, *Leach* 2661 (ORE). KLAMATH CO.: btn Fort Klamath & Summit, *Furlong et al,* 1901 (UC). CRATER LAKE NATL. PARK: Summit Lake, *Henderson* 9634 (WS). LAKE CO.: Drews Valley, *Austin* 1649 (US). LANE CO.: McKinzie Pass, *Peck* 5467 (WILLU). LINN CO.: Big Lake, *Hawley & Anderson,* Jul 1927 (OSC). WALLOWA CO.: Wallowa Mts, Aneroid, 2 mi S, *Peck* 17985 (UC). **Washington:** CHELAN CO.: Blewett Pass region, *Grant,* Aug 1929 (UC). CLALLAM CO.: Hurricane Ridge, *Thompson* 14226 (GH, NY, US). JEFFERSON CO.: Iron Mt, *Thompson* 11049 (MO, NY, POM, US). OKANOGAN CO.: Bunker Hill summit, *Edwards* 32 (WS). PIERCE CO.: Mt Rainier Natl. Park: Flett's Glacier, *Flett* 3124 (WS). WHATCOM CO.: Mt Baker, Heliotrope Ridge, *Muenscher* 8201 (GH, UC, US, WS). YAKIMA CO.: Hell Roaring Canyon rim, *Langdon* 116 (OSC).

The populations from the Wallowa Mountains (Wallowa Co., Oregon) are isolated from other *Lupinus lyallii* subsp. *lyallii* populations by 322 km.; the subsp. *alcis-temporis* occupies areas along the Clearwater and Selway Rivers in Idaho, but it is quite distinctive. The growth habit of the Wallowa populations appears to be typically that of var. *lyallii* specimens in the normal distribution, with short vegetation to 7 cm. tall, capitate inflorescences 2-2.5 cm. long, small flowers 6-8 mm. long and short leaves 7-10 mm. long. But, these plants hold in common with *L. minimus* a strong woody branching caudex at above ground level, many stems in a clump with leaves appearing basal, not more than 2-3 cauline leaves, and silky pubescence.

The specimens of *Lupinus lyallii* subsp. *lyallii* var. *lyallii* in Deschutes Co., Oregon (*Leiberg* 550 — GH, UC, US), described as *L. paulinus* by Greene, are somewhat larger than other *L. lyallii* plants of the immediate region but closely resemble several populations found in California. The racemes of some plants range from 3-4 cm. to 7.5 cm. long and from 16 mm. to 22 mm. in diameter, with the leaflets 11-15 mm. long, the upper surface of the leaflets sparsely pubescent, flowers approaching 9 mm. long and peduncles 6-7 cm. long. Several plants resemble *L. sellulus* var. *lobbii* with the flowers scattered in verticils somewhat like *L. sellulus* var. *medius* (Cox 1973c). However, the population sample indicates that these variants are more closely related to *L. lyallii* subsp. *lyallii* var. *lyallii* than to any other taxon and not distinctive enough to warrant a separate epithet.

The material found on Mt. Rose in Nevada, which Heller called *Lupinus alpinus*, flowers from late July to late September and occurs at elevations of 2927-3110 m.

The plant habit is low and spreading mats, much like that on Mt. Rainier in Washington. Colonies occur in grassy open meadows, in the alpine belt. Although the plants may be somewhat atypical of the California *L. lyallii* subsp. *lyallii* var. *lyallii* specimens, they are much like those of Oregon and Washington.

1b. **Lupinus lyallii** subsp. **lyallii** var. **danaus** (A. Gray) S. Wats., Proc. Amer. Acad. 8: 534. 1873.

L. danaus Gray, Proc. Amer. Acad. Arts & Sci. 7: 335. 1868. Type: CALIFORNIA: TUOLUMNE CO.: Mt Dana, *Bolander* 5087 (Holotype: GH; Isotype: UC, US).

L. danaus var. *bicolor* Eastw., Leafl. West. Bot. 2: 201. 1939. Holotype: CALIFORNIA: TUOLUMNE CO.: Mt Dana, *Howell* 14539 (CAS). Photos: (RSA, UMO).

L. oreocharis Eastw., Leafl. West. Bot. 3: 171. 1942.

Holotype: CALIFORNIA: TULARE CO.: Little Five Lakes Basin, *Howell* 17392 (CAS). Photos: (RSA, UMO).

Plants differing from *L. lyallii* subsp. *lyallii* var. *lyallii* by matted vegetative growth, 1-4 cm. tall; plant overall height usually less than 10 cm. tall; pubescence frequently sparse, spreading; largest leaflets mostly 4-6 mm. long, rarely to 10 mm. long; peduncles 1.5-3 cm. long, rarely to 8 cm. long; racemes capitate, 1.5-2.0 cm. long; flowers frequently more loosely arranged than in var. *lyallii*, smaller, 6-7 mm. long.

Representative specimens: **California:** FRESNO CO.: Humphreys Basin, headwaters Piute Creek, W of Mt Humphreys, *Sharsmith* 3136 (UC). INYO CO.: Piute Pass, E slope, *Peirson* 2552 (RSA). MADERA CO.: Isberg Pk, 1 mi SW, *Akey* 332 (UC). MARIPOSA CO.: Mt Dana, *Congdon*, Aug 1898 (UC). MODOC CO.: Mt Warren, *Payne* 307 (JEPS). MONO CO.: San Juaquin Peak, *Wright* K3 (POM). TULARE CO.: Mt Whitney, *Clemens*, Jul 1910 (POM, UMO). TUOLUMNE CO.: Gaylor Lakes, *Howell* 20401 (WS).

The depauperate forms of *L. lyallii* subsp. *lyallii* are interpreted here as being ecological variants. Under a particular set of environmental conditions populations of *L. lyallii* dwarfs to the matted form of var. *danaus*. However, frequently within the same population typical var. *lyallii* may occur in the larger form. Both varieties are found in high alpine rocky, sunny areas. Although this depauperate or ecological variant of *L. lyallii* appears to be morphologically blending with the larger variety, it is considered here as a distinct taxon at the varietal level.

A variant of similar vegetative morphology was observed among the *Lupinus lyallii* specimens of Canada and the higher alpine areas of Washington and Oregon, but the reproductive structures differ from that of var. *danaus* in California.

Lupinus oreocharis is reduced to synonymy under var. *danaus*. Although some of these plants range to 14 cm. tall and resemble var. *villosus* in pubescence, and some may differ from var. *danaus* by having slightly elongated stems which may have 1-2 cauline leaves, the available evidence does not indicate the warrant of a special epithet.

1c. **Lupinus lyallii** subsp. **lyallii** var. **fruticulosus** (Greene) C. P. Sm., Bull. Torrey Bot. Club **51:** 303. 1924.

L. fruticulosus Greene, Muhlenbergia 8: 117. 1912. Type: OREGON: KLAMATH CO.: Anna Creek Valley, *Austin* 1650 (Holotype: US; Isotypes: NY, POM). Photos: (RSA, UMO, US).

L. perditorum Greene, Muhlenbergia 8: 117. 1912. Holotype: OREGON: JACKSON CO.: Upper Rogue River, Applegate 2636 (US). Photo: (US).

Plants in dense semi-shrubby clumps, branching profusely, erect to semi-decumbent; stems 12-17 cm. tall, usually less than 1.5 mm. in diameter; leaves cauline; petioles slender, 2-5 cm. long; leaflets 5-6, elliptic-oblanceolate, largest 5-12 mm. long, av. 8.4, 1.8-3.5 mm. wide, length to width ratio 2.78-4.0, av. 3.42, subappressed, strigose-pilose on both surfaces; peduncles 2.5-5.5 cm. long; racemes numerous, 1.5-4.3 cm. long, 13-14 mm. in diameter, capitate and dense to somewhat scattered; flowers blue, 6.0-7.5(8.0) mm. long, av. 6.9 mm.; bracts 1.5-3.0 mm. long; pedicels 0.5-1.5 mm. long; banner elliptic to suborbicular, reflexed below the midpoint; pods 7.5-10 mm. long, 3.3-4 mm. wide; seeds 2-3.

The greatest development of var. *fruticulosus* is along the flood plain of the Rogue River in Klamath Co., Oregon. Plants are found at elevations of 1067-1372 m., flowering in July.

Representative specimens: **Oregon:** JACKSON CO.: Ashland, 9.7 km S, *Sherwood* 842 (WILLU). KLAMATH CO.: Crater Lake Natl. Park, *Evinger* 608 (OSC). LINN CO.: Hunt's Cove, Mt Jefferson area, *Leach* 4485 (ORE).

Variety *fruticulosus* differs morphologically from other variants of *Lupinus lyallii* by its semi-shrubby base, profusely branching clump habit and smaller flowers. A few *L. lyallii* specimens from Washington (mainly var. *macro-*

florus) have thick, woody branching bases, but these are part of the underground caudex system and differ by having distinctively larger inflorescence structures. The Washington material is more robust than *fruticulosus*. Variety *fruticulosus* is one of the most distinctive variations of *L. lyallii* subsp. *lyallii*.

Variety *fruticulosus* is morphologically similar to var. *roguensis*, of the same general geographical region, and to subsp. *alcis-temporis* of the Clearwater and Selway Rivers in Idaho. It may be separated from these two taxa on the basis of its flower morphology, more scattered flower arrangement on the racemes and smaller size, as well as differences in vegetative traits. These plants exhibit a more erect woody branching habit with more filiform petioles and stems than any closely related entities. They are generally not as leafy, and the leaflets are fewer (5-6 per leaf), smaller, and arranged in the upper portion of the branching clump.

1d. **Lupinus lyallii** subsp. **lyallii** var. **macroflorus** B. J. Cox, var. nov. Type: WASHINGTON: PIERCE CO.: Mt Rainier, Yakima Park, *Thompson* 11086 (Holotype: MO; Isotypes: NY, POM-in part, US). Photo of holotype: (Cox 1972 a).

Plantae perennes, humiles; caules ex caudice profuse ramificanti lignoso, 5-17 cm. alti, 1-15 mm. diametro, nodis 0-2(8); petioli 3-5.5 cm. longi; foliola 6-9, oblanceolata, maxima 5.5-11.3 mm. longa, 2.5-5.0 mm. lata; pedunculi 3.0-5.5 cm. longi, supra folia 1-2 cm. extensi; racemi 2.5-5.5 cm. longi, 2.5-3.0 cm. diametro, capitati usque subcapitati, floribus 5-17 in 1-5 verticillis; flores caerulei 10-12.5 mm. longi; calyx gibbosus; vexillum suborbiculatum usque obovatum; ovula 3-5; legumina 13-15 mm. longa, 4-5.5 mm. lata.

Plants perennial, in dense low mats; stems from a profusely branching woody base, 5-17 cm. tall, 1-1.5 mm. in diameter, pubescence appressed to ascending, some spreading, cauline nodes 0-2(8); petioles 3-5.5 cm. long; leaflets 6-9, oblanceolate, largest 5.5-11.3 mm. long, av. 8.29 mm., 2.5-5.0 mm. wide, av. 2.56 mm.; peduncles 3.0-5.5 cm. long, exceeding the foliage by 1-2 cm. or more; racemes 2.5-5.5 cm. long, 2.5-3.0 cm. in diameter, capitate to subcapitate, flowers 5-17 in 1-5 verticils; flowers blue, 10-12.5 mm. long, av. 11.2 mm. long; calyx gibbous at the base; banner suborbiculate to obovate, glabrous; keel densely ciliated near the acumen to glabrous in some; ovules 3-5; legumes 13-15 mm. long, 4-5.5 mm. wide.

Populations of var. *macroflorus* are found on the western side of the Cascade Mountain Range on both sides of the Columbia River in Washington and Oregon. They are found on Mary's Peak in Benton Co., on Mt. Hood of Clackamus and Hood River Counties, Santiam Pass in Linn Co., Oregon, and Mt. St. Hellens of Skamania Co., and Mt. Rainier of Pierce Co., Washington. Like var. *lyallii*, var. *macroflorus* occurs at the upper vegetational limit between timberline and snowline at elevations of 1524-2378 m. Plant communities commonly associated include the species: *Pinus contorta, P. albicaulis, Abies lasiocarpa, Tsuga mertensiana* and less frequently *Pseudotsuga menziesii*.

Representative specimens: **Oregon:** BENTON CO.: Corvallis, W at Mary's Peak, *Gilbert* 108 (OSC, US). CLACKAMUS CO.: Mt Hood, Jct of Hwys 26 & 35, *Downey* 4B (UMO, UTC). HOOD RIVER CO.: Mt Hood, *Abrams* 9445 (MO, POM, RM, WILLU). LINN CO.: Santiam Pass, *Cronquist* 7853 (GH, NY, RSA, UC, WS). **Washington:** PIERCE CO.: Mt Rainier Natl. Park, Burrough's Mt & Frozen Lake, *Flett* 3121 (WS). SKAMANIA CO.: Mt St Hellens, *Buzzettii*, Aug 1848 (OSC).

Variety *macroflorus* is distinct primarily on the basis of its larger flower size (10-12.5 mm. long) from var. *lyallii* flower size (7.5-10.5 mm. long). There are several intermediates between the variations of *L. lyallii*, but in general var. *macroflorus* is the extreme in flower morphological deviation.

1e. **Lupinus lyallii** subsp. **lyallii** var. **roguensis** B. J. Cox, var. nov. Type: OREGON: JACKSON CO.: Farewell Bend Forest Camp, 1.6 km N of Union Cr, on Rogue River flood plain, *Hitchcock & Martin* 4997 (Holotype: RSA; Isotypes: MO, NY, UC, WS). Photo of isotype: (Cox 1972a).

Plantae perennes, herbaceae, caespites densos ramificantes formantes, 2.5-3.5 dm. diametro, 12-18 cm. altae; caules humifusi usque erecti, 1-3 mm. diametro, ex caudice dense ramificanti lignoso, nodis 6-10, ad nodos ramificantes; foliola 7-9, maxima 8-13 mm. longa, 2.5-3.0 mm. lata; racemi capitati usque subcapitati 1.5-3.5 mm. longi, 4.5 mm. longi fructiferi, 1.9-2.5 mm. diametro; flores 7-9.5 mm. longi; vexillum et alae glabrae.

Plants perennial, herbaceous, in dense branching clumps, 2.5-3.5 dm. in diameter, 12-18 cm. tall; stems procumbent to erect, 1-3 mm. in diameter, from densely branching woody base, nodes 6-10, branching at the nodes; leaflets 7-9, largest 8-13 mm. long, 2.5-3.0 mm. wide; racemes capitate to subcapitate, 1.5-3.5 mm. long, 4.5 mm. long in fruit, 1.9-2.5 mm. in diameter; flowers 7-9.5 mm. long; banner and wings glabrous; keel ciliated along the upper margin near the acumen.

Variety *roguensis* is found at Diamond Lake, Huckleberry Mt., Davis Lake, and on the flood plain of the Rogue River, in Jackson and Klamath Counties, Oregon. These plants occur in sandy soil in pine forests at elevations of 915-1067 m. Flowering is from mid-June to mid-July.

Representative specimens: **Oregon:** JACKSON CO.: Huckleberry Mt, Rogue River Natl. Forest, *Thompson* 13035 (MO, RSA, UC, WILLU, WS). KLAMATH CO.: Davis Lake, W shore, *Hitchcock & Martin* 4935 (RSA).

Morphologically, these plants are most closely related to var. *fructiculosus*, but they differ in several significant characteristics. They are more robust, have larger branching procumbent to erect stems, have larger flowers that are more densely arranged in racemes, and have more leafy foliage. The leaves are more numerous and are scattered throughout the clump, and the leaflets are larger with more leaflets per leaf. The manner of branching resembles that of *L. aridus*, especially subspecies *lenorensis* (Cox 1972a) found along the Clearwater and Selway Rivers in Idaho. Although the general branching pattern is often difficult to detect, careful scrutiny finds verticillate spreading branching from an erect shoot; these branches become somewhat decumbent, but secondary and tertiary branches arise from them either adaxially or twisting around the decumbent stems and growing upward forming erect clumps.

Several color variations are found in this segment of *Lupinus lyallii*. Many plants of var. *roguensis* have albino flowers (white to cream color — *Maguire & Holmgren* 26493 — GH, NY, UC, US); however, others within the same population are intermediate in flower color to the albino and typical blue form (white to cream colored petals except for the purple banner and keel tip — *Maguire & Holmgren* 26494 — GH, MO, NY, UC, US, WS).

1f. **Lupinus lyallii** subsp. **lyallii** var. **villosus** Jeps., Jepson, Fl. Calif. 2: 267. 1936. Holotype: CALIFORNIA: ALPINE CO.: Carson Pass, *Jepson* 8100 (JEPS).

L. hypoleucus Greene, Leafl. Bot. Obs. & Crit. 1: 74. 1904. Type: CALIFORNIA: White Chief Peak, *Culbertson* 16, Jul 1904 (distributed by *Baker* 4416 — specimen not located.) Paratype: CALIFORNIA: Mt. Goddard, *Hall & Chandler* 707 (US).

Plants densely caespitose; stems decumbent to semi-erect, from a thick branching woody caudex, sericeous with ascending to long spreading white hairs turning reddish-brown with age; petioles 4-5 cm. long; leaflets 6-7, elliptic-oblanceolate, apex acute-mucronate, largest 10-13 mm. long, 3-5 mm. wide, villous on both surfaces; peduncles 3-7 cm. long; racemes densely verticillate 2.5-5 cm. long; bracts persistent, 4-6 mm. long; pedicels 1-1.5 mm. long; banner and wings glabrous; keel ciliate near the acumen; pods 10-11 mm. long, 4 mm. wide.

This variety occurs scattered throughout much of the distributional range of *L. lyallii* in several counties of California in the Sierra Nevada northward to several populations in Klamath Co., Oregon.

Representative specimens: **California:** ALPINE CO.: Carson Pass, *Higgins* 1752 (BRY). FRESNO CO.: Bubbs Creek, *Peirson* 531 (RSA). HUMBOLDT CO.: Grouse Mt, back of Clear Lake, *Tracy* 16672 (UC). LASSEN CO.: Grass Valley, *Fisher & Johnson* F203 (UC). MADERA CO.: Garnet Lake, *Howell* 16421 (RSA, UC, US). MARIPOSA CO.: Donohue Pass, *Schreiber* 1767 (UC). MENDOCINO CO.: South Yolla Bolly, *Jepson* 57t (JEPS). MONO CO.: San Juaquin Mt, *Howell* 16875 (WS). PLACER CO.: Mt Lincoln, *Howell* 18670 (US). SHASTA

Yolla Bolly, *Jepson* 57t (JEPS). MONO CO.: San Juaquin Mt, *Howell* 16875 (WS). PLACIER CO.: Mt Lincoln, *Howell* 18670 (US). SHASTA

CO.: Squaw Valley Creek Meadows, *Cooke* 13651 (NY). TRINITY CO.: Trinity Center, 3 mi S, E of Scott Ranch, *Cantelow*, Aug 1936 (RSA). TUOLUMNE CO.: Gaylor Lakes, *Howell* 20418 (GH). **Oregon:** KLAMATH CO.: Llao Rock, *Baker* 6245 (NY, OSC, UC, WS).

Variety *villosus* is recognized primarily on the basis of its dense pubescence. In *L. lyallii*, pubescence ranges from puberulent-sericeous to woolly-villous approaching spreading hirsute. Several populations exhibit different forms of pubescence within a single colony; this is especially true of those specimens viewed from the Carson Pass vicinity (the type locality of var. *villosus*), Alpine Co., California.

2. **Lupinus lyallii** subsp. **alcis-temporis** (C. P. Sm.) B. J. Cox, comb. nov.

Lupinus alcis-temporis C. P. Sm., Sp. Lup. 558. 1946. Type: IDAHO: CLEARWATER CO.: Pierce, 17.7 km. E, Crystal Creek Grade, *Christ* 14634 (Holotype: DS; Isotypes: NY, US). Photos: (RSA, UMO).

Plants sprawling caespitose, branching profusely from a slender woody base, in clumps 11-30 cm. in diameter; stems subdecumbent, 8-15 cm. long, strigose-sericeous with dense coarse ascending hairs, nodes 4-6; cauline petioles 2-4 cm. long; stipules 7-9 mm. long, connate to the petioles 3-4.5 mm., filiform; leaflets 5-7, elliptic-oblanceolate, apex acute to short mucronate, longest leaflets 2-18 mm., av. 10 mm. long, 0.8-5 mm. wide, length to width ratio 2.33-4.33, av. 3.18, strigose-pilose to villous on both surfaces, some more sparsely so on the upper surface to glabrous; peduncles 1.5-3.5 cm. long; racemes capitate, 2-3.5(6) cm. long, densely verticillate; flowers blue with yellow sulcus, 7-8.2 mm. long; bracts 5-9 mm. long, subulate-attenuate, sericeous to villous; pedicels 1.2-1.8 mm. long; calyx upper-lip 4.0-5.0 mm. long, bilobed, notch 2-3.5 mm. deep, lower-lip 5.0-6.0 mm. long, apex tridentate, center tooth 0.2-0.5 mm. long, lips connate 1.0-1.5 mm.; bracteoles 0.8-1.5 mm. long, attached at the sinus, villous; banner elliptic-oblanceolate, 7.0-8.0 mm. long, 4-4.5 mm. wide, length to width 1.56-1.88, av. 1.74, reflexed to appressed ratio 1.25-1.50, av. 1.37, angle 148-158°; wings 6.0-7.3 mm. long, 3.0-3.4 mm. wide, length to width ratio 1.97-2.35, av. 2.16; keel 2 mm. wide at the widest point, angle 111-122°, ciliated sparsely near the acumen; ovules 2-3; pods 8.5-9.5 mm. long, 3.4-4.0 mm. wide, densely short woolly; seeds 2-3, 1.8-2.0 mm. × 2.0-2.2 mm., 0.9-1.1 mm. thick, tan color.

Subspecies *alcis-temporis* is found in sandy and gravelly slopes on road cuts, generally in otherwise barren areas. One population occurs in a *Pinus monticola* forest; the Christ & Smith collection (15385 — NY) was found on "forest soil bordering beds of *Boykinia major;* the Daubenmire collection (47150 — WS) was made in a Spruce-Fir Zone. Plants occur at 915-1220 m. elevation.

Representative specimens: **Idaho:** CLEARWATER CO.: Pierce, 17.7 km E at the confluence of Big Breakfast Creek and Crystal Creek, *Christ & Smith* 15385 (NY); Washington and Lodge Creeks, S31, T39N, R7E, *Lingenfelter* 466 (NY, RSA, UC, WS).

This taxon was first described by C. P. Smith from a Christ "little number picked up in Clearwater County (Idaho) during elk season in October." Hence the name "Christ's Elk-Season Lupine", *Lupinus alcis-temporis* in Smith's Latinum utilizes the genitive for both elements of the compound name (*alces* — elk and *tempus* — season). Both Christ and Smith were deeply interested in the fact that a lupine in anthesis could be found in Clearwater Co. in the middle of October "without a trace of fruit or seed, and at only 4,000 feet elevation."

Several stages of development are found in more extensive study of other collections of these lupines, all of which have been collected on July 10th or July 11th. Small clusters of young herbaceous-stemmed, procumbent plants may be found flowering the same time as older plants with semi-woody branching stems, sprawling 30-45 cm. in diameter. The isotype material viewed from NY and US appears merely to be atypically late in reaching anthesis. It is in anthesis with some fruit in the initial stages of enlargement, and all branches are woody including secondary and tertiary branches; only the leaves and inflorescences remain herbaceous at this late seasonal date.

3. **Lupinus lyallii** subsp. **minutifolius** (Eastw.) B. J. Cox, comb. & stat. nov.

Lupinus minutifolius Eastw. Leafl. West. Bot. 2: 267. 1940. Holotype: OREGON: HARNEY CO.: Fish Lake, Steens Mts., *Henderson* 8132 (CAS). Photos: (RSA, UMO).

Plants acaulescent; foliage to 4.5 cm. tall; stems 4-6 cm. tall, appressed hispidulose with more coarse scaberose hairs; petioles filiform, 2.5-4 cm. long; leaflets 5-7, elliptical, glabrous above to sparse pubescence on the margins, short coarse appressed hairs below, largest 6-9 mm., av. 6.8 mm., 2-2.8 mm. wide, av. 2.45 mm., length to width ratio 2.4-3.0, av. 2.75; peduncles 6-8 cm. long or only 3 cm. long in immature plants; racemes 1.5-3.0 cm. long, 3-4 compact verticils, ascending or erect from nearly prostrate stems; flowers 7.5-10 mm. long, mostly blue with nearly white banners and purple tipped keels; bracts caducous, 4.5-6 mm. long, subulate; pedicels 1.0-2.0 mm. long; calyx upper lip 4-5 mm. long, bilobed, notched 2.5-2.7 mm. deep, lower-lip 4.5-5.0 mm. long, apex entire-serrate to tridentate with the center tooth approaching 0.7 mm. long, lips connate 1.2-1.3 mm., bracteoles 0.2 mm. long, attached at the sinus, strigose to short ascending pilose; banner elliptic-oblong, 8-8.5 mm. long, 4.2-5.5 mm. wide, length to width ratio 1.45-1.90, av. 1.65, reflexed to appressed ratio 1.08-1.57, av. 1.34, angle 150-160°; wings 8.8-9.0 mm. long, 3.8-4.2 mm. wide, length to width ratio 2.10-2.57, av. 2.34, claws 1.0-1.8 mm. long, glabrous; keel 2.0-2.2 mm. wide at the widest point, angle

118-123°, ciliated along the outer half of the upper margin, densest toward the acumen; ovules 3; pods 9.0-10.5 mm. long, 3.5-4.2 mm. wide, short appressed; seeds 2-4.

Subspecies *minutifolius* is found in the Steens Mountains of Harney Co., Oregon, geographically replacing subsp. *lyallii*. These plants are found on rocky, gravelly, gentle basaltic slopes but frequently occur in alpine meadows on hillside areas with grasses and sedges in sloping rocky habitats. Several specimens have been collected in beds of lingering snowbanks where snow has accumulated and remained during the winter and spring. Anthesis generally occurs during the latter part of July. Plants are found at elevations of 2439-2896 m.

Representative specimens: **Oregon:** HARNEY CO.: Big Fish Creek Canyon, *Maguire & Holmgren* 26789 (GH, NY, UC, US); Frenchglen, 31.4 km due E-SE, *Hansen* 490 (OSC).

Although some populations of subsp. *minutifolius* resemble subsp. *lyallii* var. *danaus*, they have several distinct morphological characteristics. The flowers of subsp. *minutifolius* generally have more oblong shaped banners, more linear wings, and therefore a greater length to width petal ratio than subsp. *lyallii*. Although the vegetative morphology of subsp. *minutifolius* resembles the alpine var. *danaus* and other northern forms of subsp. *lyallii*, it shows distinction in the filiform petioles from the basal clumps of less than 4.5 cm. tall, and frequently by the fewer (4-7, av. 5) leaflets that are glabrous on the upper surface. The plants of the Cronquist collection (8694 — NY, OSC, RM, RSA, UC, WS) are morphologically larger than normal for the taxon. The foliage of these specimens approach 5 cm. tall, overall plant height approaches 9.5 cm.; flowers are an intermediate 8.5 mm. long; the leaflets are larger 10 mm. × 3.5 mm.; peduncles are larger 6.5-7 mm. long, and racemes approach 4 cm. long.

4. **Lupinus lyallii** subsp. **subpandens** C. P. Sm. ex Dunn, El Aliso 3: 171. 1955. Type: NEVADA: ELKO CO.: Elko,

113 km. NW, *Holmgren,* Jun 1938 (Holotype: UTC; Isotypes: NA, NEV, AGR.). Photos: (RSA, UMO).

Plants with many small tufts from a profusely branching woody caudex, erect; foliage 4.5-9.0 cm. in height, mostly less than 6 cm. tall; stems 7-18 cm. tall, usually less than 1 mm. in diameter, appressed strigose-pilose pubescence less than 2 mm. long; leaves in basal clusters; petioles slender, 3-9 cm. long; stipules inconspicuous, 6-10 mm. long, connate to the petioles 4-5 mm. subulate; leaflets 5-6, linear-oblanceolate, apex acute, largest 9-22 mm. long, 2-5 mm. wide, length to width ratio 3.5-6.3, av. 4.8, sericeous-strigose below, more sparsely so above with glabrous apex and midrib; peduncle 5-9 cm. long, usually exceeding the foliage by 2-5 cm.; racemes capitate to subcapitate, 1.5-4 cm. long; flowers dense, blue, 9.5-11.5 mm. long; bracts 4-8.5 mm. long, appressed to ascending pilose; pedicels 1-2 mm. long; calyx upper-lip 4.2-5.5 mm. long, notch 1.3-3.2 mm. deep, lower-lip 4.5-5.5 mm. long, apex deeply serrate to tridentate, center tooth to 0.5 mm. long, lips connate 1.0-1.5 mm., bracteoles slender, inconspicuous, 0.5-1.0 mm. long, attached to the sinus, strigose-sericeous, hairs to 2 mm. long; banner elliptic, 8-9.5 mm. long, 5-6.5 mm. wide, length to width ratio 1.45-1.90, av. 1.56, reflexed to appressed ratio 1.13-1.71, av. 1.44, angle 146-150°; wings 8.2-9.8 mm. long, 3.4-4.8 mm. wide, length to width ratio 2.04-2.65, av. 2.36, claws 1.5-2.0 mm. long, glabrous; keel 2.2-3.0 mm. wide at the widest point, angle 108-120°, ciliated along the outer half of the upper margin, most densely near the acumen, cilia to 0.7 mm. long; ovules 3-5; pods 11-14 mm. long, 5-5.5 mm. wide, dense strigose to short villous; seeds 2-3, 2.0-2.2 mm. × 2.8-3.0 mm. 1.3 ± 0.1 mm. in thickness, beige to tan with darker brown mottling.

These plants are found in dry, rocky creek beds and open well-drained draws in northeastern Nevada, in Elko Co., and southwestern Idaho, in Camas and Owyhee Counties. The most common associate is *Artemisia* sp. Plants flower from mid-July to the first part of August. Altitudinally, they are found at 1677-1982 m., with one population found on Alleghany Creek at 2439 m.

Representative specimens: **Idaho:** CAMAS CO.: Fairfield, 16 km. SE, *Ripley & Barneby* 10671 (NY). OWYHEE CO.: Mud Flat, 4.8 km. SW, on road to Juniper Mt, *Maguire & Holmgren* 26305 (GH, POM, UC, US, UTC, WS). **Nevada:** ELKO CO.: O'Neil, 16 km. S, *Holmgren, Cooper & Cain* 181 (GH, OSC, UTC); Wells, 48 km. N, *Jones*, Jul 1901 (POM).

Dunn (1955) interpreted *Lupinus lyallii* subsp. *subpandens* as an acquisition of a combination of the characters of *L. aridus* with those of *L. lyallii.* The pubescence type and system of branching from the caudex, as well as certain flower morphology, is characteristic of *L. aridus,* whereas the small caespitose habit with elongated peduncles and capitate inflorescences with small flowers is more indicative of *L. lyallii.* Dunn further suggests that the plant's occupancy of the flatland *Artemisia* habitat of 1677-1982 m. elevation indicates a considerable amount of the *L. aridus* physiological adaptations, contrasting the higher altitudinal *L. lyallii* habitat.

This study concurs with Dunn's interpretation of the affinity of subsp. *subpandens* with *L. lyallii.* These plants inhabit a geographically distinct region, also having both morphological and physiological distinction. Although each subsp. *subpandens* population has acquired a unique combination of characteristics, the plants can usually be recognized by the erect habit of both flowering culms and petioles as well as by the glabrous apex and midrib of the upper leaflet surfaces.

The specimens from Camas Co., Idaho (*Ripley & Barneby* 10671 — NY) have larger flowers than the taxon mean, with banners only slightly reflexed and frequently with one node on the flowering culm above 2 cm. from the basal cluster of leaves, and racemes of 3-5 cm. long, being about 2 cm. in diameter.

The specimens collected south of O'Neil, Nevada (*Holmgren, Cooper & Cain* 181 — GH, OSC, UTC) are more slight in habit, having shorter petioles with smaller leaflets that are more glabrous on the upper surface, and shorter, more capitate racemes with the banners less reflexed.

The Mud Flat, Owyhee Co., Idaho specimens (*Maguire & Holmgren* 26305 — GH, POM, UC, US, UTC, WS) have fewer leaflets than other populations, and the petioles are more elongated and slender.

5. **Lupinus lyallii** subsp. **washoensis** (Heller) B. J. Cox, comb & stat. nov.

L. washoensis Heller, Muhlenbergia **6**: 72. 1910. based on *L. pinetorum* Heller, Muhlenbergia **6**: 25. 1910, not *L. pinetorum* Jones, Contr. West. Bot. 8: 25. 1898. Type: NEVADA: WASHOE CO.: Ridge S of Alum Creek, *Heller* 9748 (Holotype: Nev. Agr.; Isotypes: DS, GH, ISC, MO, NY, ORE, POM, UC, US, WS). Photos: (RSA, UMO).

L. aridus var. *washoensis* (Heller) C. P. Sm., Bull. Torrey Bot. Club **51**: 303. 1924.

Plants 10-18 cm. tall, in dense caespitose clumps, 15-30 cm. in diameter, from woody vertical caudex branching at ground level, with 10-18 racemes flowering simultaneously; stems procumbent to erect, 1-2.5 mm. in diameter, villous to hirsute-shaggy white pubescence 2-4 mm. long; 2-3 nodes; cauline petioles 4.5-8 cm. long, pubescence as on the stems; basal petioles on immature plants 4.5-7 cm. long; stipules 6-10 mm. long, connate to petioles 4-6 mm., densely white bearded pubescence; leaflets 5-6, oblanceolate to elliptic-oblong, apex short mucronate, largest 9-21 mm. long, av. 13.7 mm., 3-7 mm. wide, length to width ration 1.86-3.27, av. 2.71, silvery appressed to ascending pubescence below, more sparsely so above, upper surface appearing more greenish; peduncles 3-5 cm. long, generally exceeding the leaves; racemes 3-6 cm. long, 1.6-1.9 cm. in diameter, densely subverticillate; flowers blue to violet, banner with a white sulcus, 8-9 mm. long; bracts 3-5.5 mm. long, subulate-attenuate, pilose-sericeous; pedicels 1.5-2.0 mm. long; calyx upper-lip 3.5-4.5 mm. long, bilobed, the notch 0.8-1.2 mm. deep, lower-lip 4-5.5 mm. long, apex serrate, lips connate 1-2 mm., bracteoles 0.5-1.0 mm. long, attached at the sinus, villous; banner elliptic-oblong, 7.8-8.0 mm. long, 5.0-6.0 mm. wide, length to width ratio 1.33-1.67, av. 1.52, reflexed to appressed ratio 1.25-1.35, angle 140-150°; wings 7.5-8.0 mm. long, 4-4.5 mm. wide, length to width ratio 1.74-2.00, av. 1.87, claws 1.5-2.0, glabrous; keel 2.5-3.0 mm. wide at the widest point, angle 118-125°, ciliated along the upper margin near the acumen; ovules 2-3; pods 9-13 mm. long, 5-6 mm. wide, villous to ascending woolly; seeds 1-3, 1.8-2.2 mm. × 2.4-2.7 mm., 0.9-1.2 mm. thick, tan with brown mottling.

Subspecies *washoensis* has a restricted habitat on the eastern slopes of the Sierra Nevada in the southern part of Washoe Co., SW of Reno, Nevada. Plants occur on gravelly montane open pine slopes at elevations of 1524-2134 m., flowering in June.

Representative specimens: **Nevada:** WASHOE CO.: Dinsmore Camp, Hunter Creek Canyon, *Kennedy* 1614 (MO, NY, UC); Reno, *Hillman* (POM); 10-13 km. SW, Hunter's Creek Road, *Archer* 6090 (NY).

The general appearance of some of these plants indicates relationship with *Lupinus aridus*, a portion of the racemes being exceeded in height by the foliage. Affinity is also indicated with *L. sellulus* var. *lobbii* in general morphological structure (Cox 1972a, 1973c). Considering the total conformation — narrow, short subcapitate or longer racemes, and the procumbent, branching, sprawling vegetative habit — this study concludes that the *washoensis* affinity lies most closely with *L. lyallii*. These plants replace *L. lyallii* subsp. *lyallii* geographically and ecologically, aso being recognizably distinct by somewhat larger stature, having longer racemes, larger leaves, more yellow-green color and spreading silvery stem and petiole pubescence.

The Dinsmore population (*Kennedy* 1614 — MO, NY, UC), which is only a few miles north of the type locality in Hunter Creek Canyon, has been used in sheep feeding experiment (Nev. Agr. Exp. Sta. Bull. 71: 30. 1909). The plants are said to be relished by the sheep, proving to be a good forage plant.

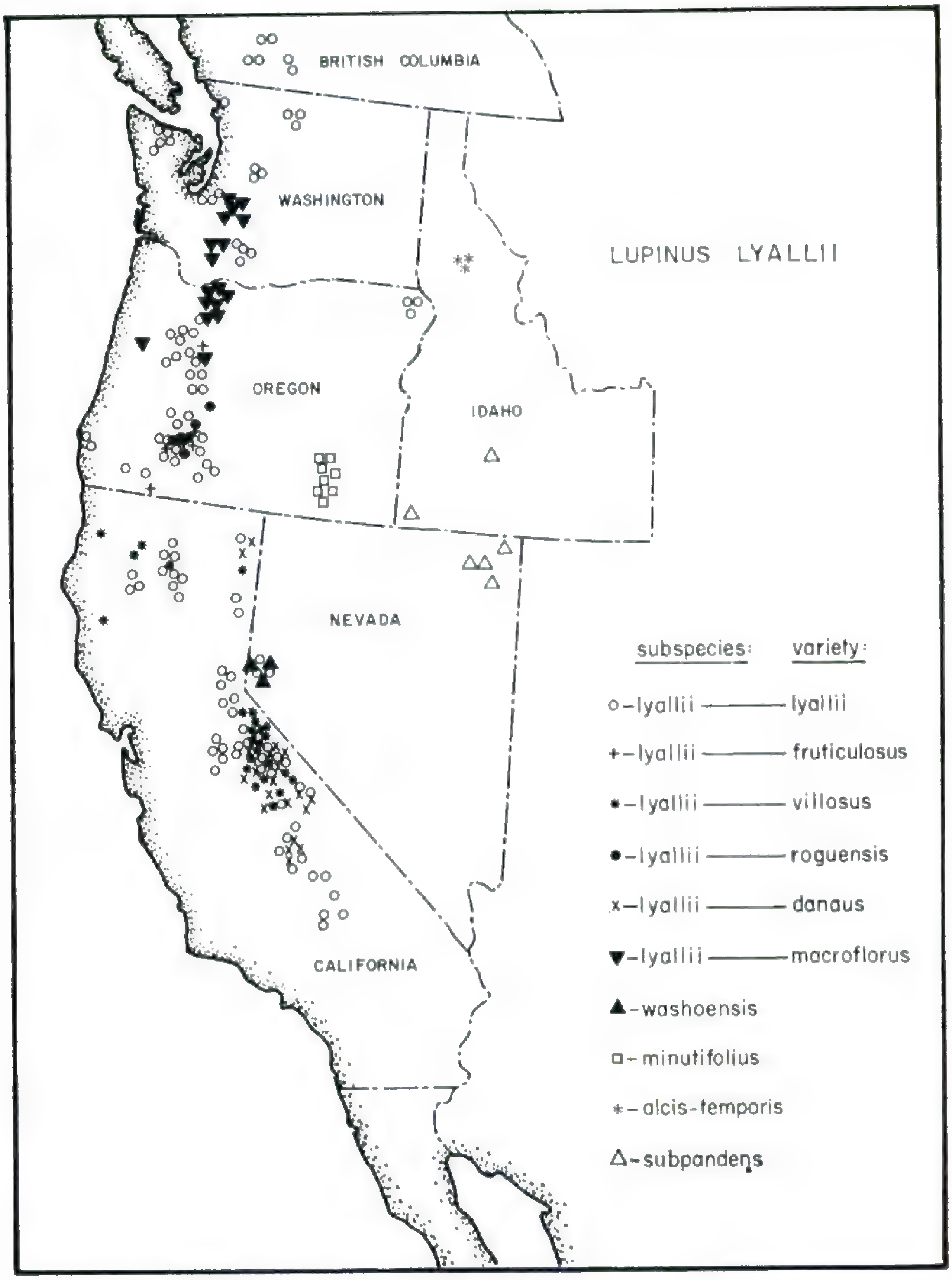

Figure 1. Distribution of *Lupinus lyallii*.

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THE ROLE OF SOME HALORAGACEAE IN ALGAL ECOLOGY

L. C. COLT, JR., AND C. BARRE HELLQUIST

While collecting vascular aquatic plants in several ponds in east-central Massachusetts we found that there was a considerable accumulation of algae upon some of the vascular species, but very little on others. The present paper is the result of our futher observations on and examination of the relationship between the algae and the vascular plants upon whose surfaces they were found.

There is little published data elaborating the substrate preferences of fresh-water algae. Water chemistry, light, temperature, water density, pH, and a wide variety of metabolic processes have been treated frequently (see Jackson, 1964, and Smith, 1950) as environmental factors in algal growth. Reference texts (e.g., Prescott, 1962) indicate that some species of algae are epilithic, endophytic, or epizooic, or that many are epiphytic upon vascular plants or larger algae. Other than Chapman (1962) there seems to be no treatment of situations in which the algae have the opportunity to grow on or in association with a variety of substrates and in which clearly some means of preference for one another is established. Tiffany (1951), for example, suggested that the amount of substrate available to the spores for fixation is of major importance to algal growth, but he fails to include any discussion of the character of the substrate itself, or of the various environmental factors that might be operative in the selection and utilization of a particular substrate. Chapman suggests that, (1) the age and nature of the substrate flora are important, (2) diatoms are more likely to be on older leaves, (3) epiphytes are most numerous on well lighted surfaces, (4) epiphytes are most numerous on submerged material, (5) depressions between cells of the host surface seem to provide better substrate for attachment, and (6) ponds with muddy bottoms have a reduced number of epiphytes. With few epiphytes occurring in our collections we tend to agree with the last premise, but we have insufficient evidence to either support or refute the other ideas. We might generally suggest, however, that rather similar principles may operate for both tychoplankters and epiphytes.

Our examination of material from different ponds clearly showed that algae grew profusely upon some vascular plants but sparsely or rarely on others. We also found that both the number of species and the types of tychoplankter algae varied with similar plants in different environments. In order to identify, if possible, the operative environmental factors, we selected two sites in which the algal habitats might be contrasted. In both instances, (1) a small leaved aquatic plant was the primary algal substrate, (2) the substrate plant grew in the shallower portions of the pond, (3) both ponds and collecting sites were in virtually identical locations beside highways, and (4) there was no shading of the collecting stations by macrovegetation on or near the banks of the pond.

THE POND STATIONS

1. Pratt Pond. This pond is located at the junction of Grove Street, Hopkinton Road, and Westboro Road in the town of Upton, Worcester County, Massachusetts.

All collections were made in the western sector of Pratt, from water varying between 1.5 and 2.0 meters in depth. Most of the remainder of the pond is sufficiently deep so as to permit swimming and diving. The bottom of the pond is sandy-mud throughout. The pH averaged 6.5 and the alkalinity was 3 ppm.

The dominant vascular aquatic in the collection area of Pratt was *Myriophyllum heterophyllum* Michx., occurring over more than one-third of the center of the bay. In so far as we were able to determine during the several months of field work, no other vascular plant grew in or near the stand of *Myriophyllum*. This resulted in a clear zone around the stand extending to within several meters of the pond's edge.

In this shallower water a few other rooted aquatics grew sparsely. Of these *Nymphaea odorata* Ait., *Pontederia cordata* L., and *Potamogeton spirillus* Tuckerm., were the most common.

2. Icehouse Pond. This pond is beside West Main Street, 0.9 kilometers east of Interstate Route 495, in the town of Hopkinton, Middlesex County, Massachusetts.

Samples were collected from water up to 0.5 meters in depth along the southern edge of the pond. The deepest portion of this pond was approximately 1.5 meters, the bottom being mud and gravel. Water loss from this pond during the late summer months left some of the westerly edges as exposed mud and rocks. The pH averaged 6.1, and the alkalinity was 3.5 ppm.

The shallow waters of this pond were densely populated with a variety of rooted aquatic plants. Algae were associated most profusely with *Proserpinaca palustris* L., which grew in scattered stands of a few plants each. Other common vascular plants in the collection area were *Potamogeton pulcher* Tuckerm., *P. capillaceus* Poir., *Eleocharis acicularis* (L.) R. & S., *Pontederia cordata* f. *taenia* Fassett, *Nymphaea odorata* Ait., *Nuphar variegatum* Engelm., *Brasenia schreberi* Gmel., *Ludwigia palustris* var. *americana* (DC.) Fern. & Grisc., *Callitriche verna* L., *Myriophyllum humile* (Raf.) Morong, and *Utricularia purpurea* Walt.

PROCEDURE

Samples of the vascular plants were collected from the two pond stations and the species determination made using Fassett (1966) and Fernald (1950). Representative specimens were pressed and are in the herbarium at Boston State College.

Samples of the primary substrate plants were collected, some portions retained fresh for immediate scrutiny, and the remainder preserved in a solution of 3% formalin. Determination of the associated algal species was made from Smith (1924), Irenee-Marie (1939), Prescott (1964), and Patrick & Reimer (1966). Microscope slides were made of some algae using the Kaiser Glycerin-Gelatin method in order to facilitate drawing by camera lucida. All other samples were placed in Transeau's Fluid for permanent storage.

DISCUSSION

Twenty-one species of algae were found on or in association with *Myriophyllum heterophyllum* in Pratt Pond. Sixty-one algal taxa were discovered in various degrees of association with *Proserpinaca palustris* in Icehouse Pond. Seven species were common to each pond. The wide disparity in numbers despite virtually simultaneous collection times strongly suggests that *Proserpinaca* offers a more favorable habitat to the algae than does *Myriophyllum.* Inasmuch as a difference in surface characteristics might lead to the difference in habitats, it was the first possibility examined. We were not able to substantiate such a premise on any physical basis. One of the problems, however, is that only five genera of epiphytes were recorded during the study. *Stigeoclonium* and *Characium* each had one species present infrequently in Pratt Pond, while *Bulbochaete* and *Gloeotrichia* each had one commonly found species in Icehouse Pond, and *Oedogonium* with one common species and one infrequently encountered, both in Icehouse Pond. The pattern of occurrence of these was generally the same as for the tychoplankters and appeared to be due to the overall differences in the habitats rather than individual differences between the substrate plants.

Thus it seemed likely that there was a combination of factors operating in each situation, with sufficient variance between the two habitats such as to account for the difference in algal populations. This view is strengthened by the difference in tychoplankter populations, Icehouse Pond having approximately twice as many taxa. Inasmuch as the tychoplankters do not adhere to a particular substrate, but live in association with the substrate, they would not necessarily be affected by physical characteristics.

Some previous work gave direction to our scrutiny. Anderson & Walker (1920) concluded from an investigation of some shallow Nebraska lakes that light and mechanical support are of primary influence to algal growth. They also suggested that shallow water and wind protection give rise to as nearly uniform conditions as possible. Needham & Lloyd (1916) showed that in shallow waters with abundant vegetation currents are reduced or eliminated and there is little possibility of wind disturbance. The authors' own experience has been that tychoplankter populations are particularly rich among the wet sphagnum of New England bogs.

Comparison of the two sites on these bases yielded some rather interesting results. It has already been stated that sunlight was readily and equally available to the water in which both sets of substrate plants grew. The collecting area in Icehouse Pond, however, was much shallower than that of Pratt Pond. This difference was negated by the position of the tychoplankter algae in Pratt Pond; they were all within ½ meter of the surface of the water. The only living algae below that level in Pratt Pond were diatoms, and they were usually obscured by the detritus on the lower branches of plants of *Myriophyllum*.

Physically, Icehouse Pond is protected from surface winds by the mixed deciduous-coniferous forest around it. Although its total surface area approximates that of the section of Pratt Pond from which we collected, we were unable to observe more than mere surface ripples on Icehouse Pond during any visit to the site. Part of the reason for this is the dense vegetation within the water itself. At Pratt Pond, however, we were able to note considerable surface disturbance by even relatively light wind currents.

We were unable to observe any current within Icehouse Pond. This is largely due to the dense aquatic vegetation. Water movement could easily be discerned in Pratt Pond. As we collected samples in Pratt Pond, broken pieces of *Myriophyllum* would rise within the stand of plants then drift "downwind." Our observation of this phenomenon showed that the drag of the wind on the surface of the water caused the upper portion of the water to move, creating an effective pull on the lower water body. Water then rose through the plants and downwind. Davis (1955) suggested that tychoplankters would be unable to adapt evolutionarily to such current conditions. On the basis of our limited work we concur, finding no evidence of specialized attachment structures or polymorphism which would give any species an advantage in maintaining its position. It appears to us that the lack of water movement within Icehouse Pond is conducive to an optimum interchange of chemical nutrients. On the other hand, the flow within Pratt Pond apparently reduces a similar interchange, thus inhibiting population growth to some degree.

Our final consideration was the growth habit of the small leaved algal substrates and the associated macroflora. In Pratt Pond *Myriophyllum* produced vertical axes greater than the depth of the water. Near the surface of the water the distal portions of the plants would bend with the drag of the surface water. This appeared to produce a matting effect at the surface which would effectively reduce the light available to lower levels. The *Proserpinaca* in Icehouse Pond grew only to the surface of the water and distal flexing was rare and then of a minor nature. Light could pass easily through the finely dissected leaves to lower levels. Moreover, the densely crowded vegetation of Icehouse Pond effectively reduced lateral "waving" by the plant. *Proserpinaca* occurred in larger clumps than any of the other small leaved plants in Icehouse Pond (e.g., *Myriophyllum, Utricularia*).

Examination of the broader-leaved aquatics in each pond did not reveal any substantial amount of algae growing on or associated with them. The most frequent species were diatoms, *Tabellaria,* for example, being the most common.

SUMMARY

From our observations we conclude that for the optimum growth of tychoplankter algae there are at least three basic requirements. Not necessarily in order of importance they are: (1) a substrate which provides both maximum surface area and exposure to the available light; (2) an absence of strong or prolonged water currents; and (3) the presence of a varied flora which provides a broad spectrum of nutrients within the system.

Based on our observations at both ponds we suggest that small leaved plants will most often provide the optimum habitat for tychoplankter algae. We are not convinced, however, that monospecific stands provide the optimum environment for tychoplankters, although such stands may be the best of the available substrates. We have found comparable situations in bogs, as it has been our experience that the sphagnum bogs with the greatest variety of macroflora usually yield the largest number of algal species.

We further suggest that pH and water temperatures are primarily useful only in contrasting regions with geographical and/or geological differences. It can be reasonably inferred that evolution has already adapted local algal species to pH and water temperature as they occur in the algal habitat.

Finally, we concur with previous workers who have suggested that quiet, stable and uniform water conditions are best for the growth of tychoplankter algal populations.

The list of algae below follows the sequence of Smith (1950). Nomenclature of the Bacillariophyceae is according to Patrick & Reimer (1966). Location and frequency are indicated by the following: IP — Icehouse Pond, PP — Pratt Pond, R — rare (less than 5 collected in all samples), F — frequent (averaged up to 10 in all samples), C — common (averaged more than 10 in all samples), E — epiphyte, T — tychoplankter.

CHLOROPHYTA

Stigeoclonium subsecundum Kuetzing	PP-R-E
Bulbochaete Furberae Collins	IP-C-E
Oedogonium michiganense Tiffany	IP-C-E
O. pseudoplenum Tiffany	IP-C-E
Characium ornithocephalum A. Braun	PP-R-E

Pediastrum Boryanum (Turp.) Meneghini	IP-R-T
P. duplex var. *cohaerens* Bohlin	IP-R-T
P. tetras (Ehrenberg) Ralfs	IP, PP-R-T
P. tetras var. *tetraodon* (Corda) Rabenhorst	IP-C-T
Nephrocytium lunatum W. West	PP-R-T
Kirchneriella contorta (Schmidle) G. M. Smith	PP-R-T
Scenedesmus abundans var. *brevicauda* G. M. Smith	IP-R-T
S. bijuga (Turp.) Lagerheim	IP, PP-C-T
S. dimorphus (Turp.) Lagerheim	IP-R-T
S. quadricauda var. *maxima* West & West	IP, PP-C-T
Actinastrum Hantzschii Lagerheim	IP, PP-C-T
Spirogyra spp.	two easily separable species were common in the vegetative state in Icehouse Pond.
Gonatozygon pilosum Wolle	IP-C-T, PP-R-T
Triploceras gracile Bailey	IP-R-T
Closterium Jenneri Ralfs	IP-R-T
Cl. parvulum Naegeli	IP-R-T
Cl. Ralfsii var. *hybridum* Rabenhorst	IP-F-T
Cl. setaceum Ehrenberg	IP-F-T
Pleurotaenium coronatum (Breb.) Rabenhorst	IP-F-T
P. subcoronulatum var. *detum* West & West	IP-R-T
P. Trabecula (Ehrenb.) Naegeli	IP-C-T
P. Trabecula var. *rectum* (Delp.) W. West	IP-R-T
P. Trochiscum var. *tuberculatum* G. M. Smith	IP-R-T
Euastrum abruptum f. *minor* West & West	PP
E. binale (Turp.) Ehrenberg	IP-R-T
E. ciastonii Raciborski	IP-R-T
E. gemmatum Brebisson	IP-R-T
Micrasterias Nordstedtiana Wolle	IP-R-T

Cosmarium Blytii Wille	IP-R-T
C. difficile var. *dilatatum* Borge	IP-R-T
C. furcatospermum West & West	IP-R-T
C. granatum Brebisson	IP-R-T
C. isthmium W. West	IP-F-T
C. ornatum Ralfs	IP-F-T
C. portianum Archer	IP-F-T
C. pseudoconnatum Nordstedt	IP-F-T
C. pseudopyramidatum Lundell	PP-R-T
C. pyramidatum var. *transitorium* Heimerl	PP-R-T
C. tumidum Lundell	IP-R-T
Staurastrum dejectum Brebisson	IP-F-T
S. gracile var. *nanum* Wille	IP-R-T
S. gracile var. *tenuissima* Ralfs	IP-F-T
S. Leptocladum Nordstedt	IP-R-T
S. Ravenelii var. *spinulosum* Irenee-Marie	IP-R-T
Spondylosium planum (Wolle) West & West	IP-C-T
Desmidium Aptogonum Brebisson	IP-R-T
D. Baileyi (Ralfs) Nordstedt	IP-F-T
Xanthidium cristatum Brebisson	IP-F-T

CHRYSOPHYTA

Tabellaria fenestrata (Lyngb.) Kuetzing	IP-C-T
T. flocculosa (Roth) Kuetzing	IP-C-T
T. quadrisepta Knudson	PP-C-T
Meridion circulare (Grev.) Agardh	IP, PP-C-T
Eunotia elegans Ost.	IP-C-T
E. formica Ehrenberg	IP-F-T
E. pectinalis (O.F.M.) Rabenhorst	PP-F-T
E. pectinalis var. *ventricosa* Grunow	PP-F-T
E. praerupta var. *bidens* (Ehr.) Grunow	IP-F-T
E. tenella (Grun.) Cleve	PP-F-T
E. serra var. *diadema* (Ehrenb.) Patrick	IP-F-T
Hannaea arcus Patrick	PP-R-T
Pinnularia flexuosa Cleve	IP-F-T
P. formica (Ehrenb.) Patrick	IP-R-T
Frustulia rhomboides (Ehrenb.) de Toni	IP-C-T

E. vulgaris Thwaites	IP-F-T
Gomphonema acuminatum var. *coronatum* (Ehrenb.) W. Smith	IP, PP-C-T
G. augur Ehrenberg	PP-C-T
CYANOPHYTA	
Microchaete tenera (Thuret) de Toni	PP-F-T
Hapalosiphon intricatus West & West	IP-C-T
Gloeotrichia Pisum (C. A. Agardh) Thuret	IP-F-E

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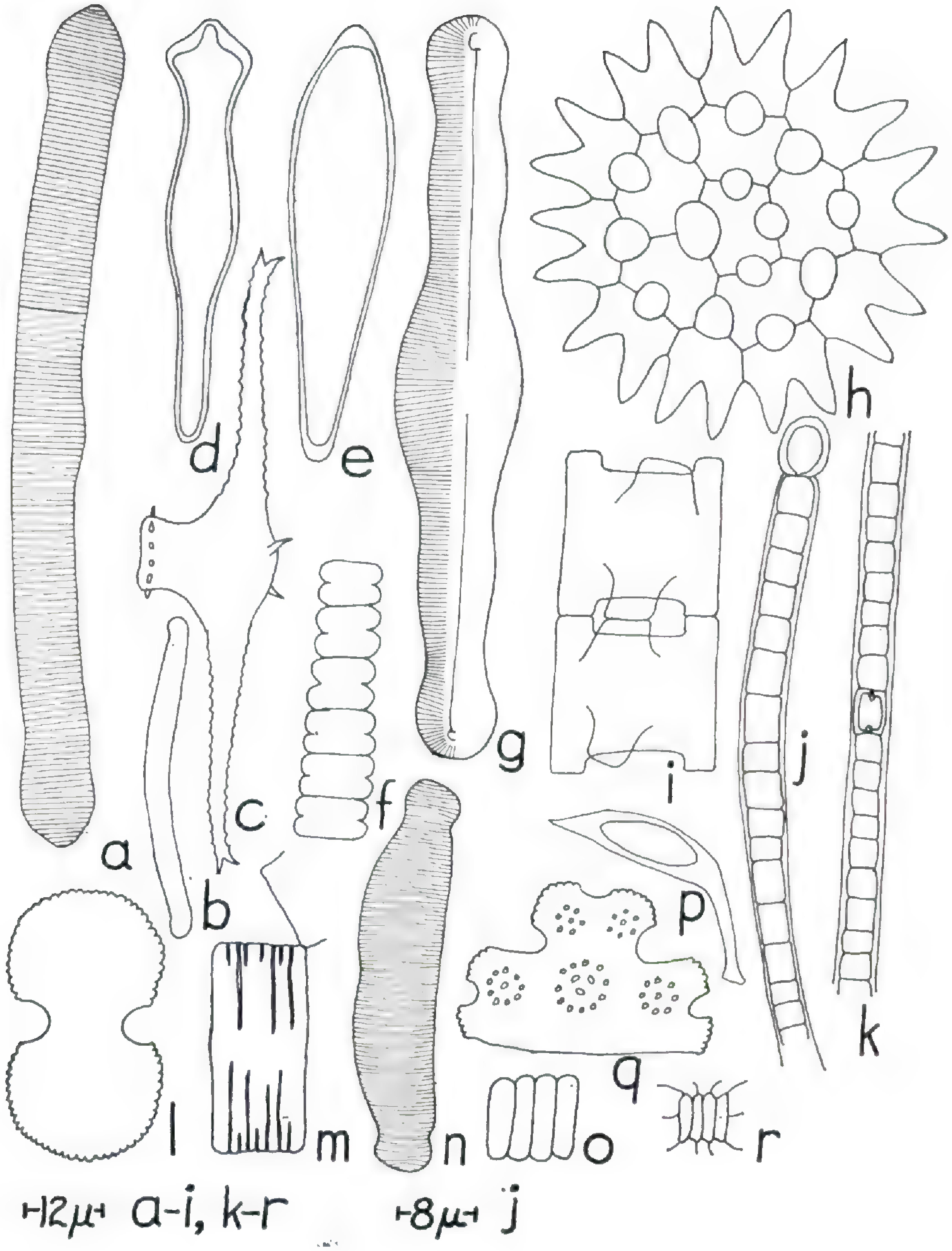

Plate 1

Plate 1:

a) *Eunotia formica* Ehrenberg
b) *E. elegans* Ost.
c) *Staurastrum leptocladum* Nordstedt (semicell)
d) *Gomphonema acuminatum* var. *coronata* (Ehr.) W. Smith
e) *G. auger* Ehrenberg
f) *Spondylosium planum* (Wolle) West & West
g) *Pinnularia formica* (Ehr.) Patrick
h) *Pediastrum duplex* var. *cohaerens* Bohlin
i) *Desmidium Baileyi* (Ralfs) Nordstedt
j) *Gloeotrichia Pisum* (C. A. Agardh) Thuret
k) *Scytonema crispum* (C. A. Agardh) Bornet
l) *Cosmarium isthmium* W. West
m) *Tabellaria flocculosa* (Roth) Kuetzing
n) *Eunotia praerupta* var. *bidens* (Ehr.) Grunow
o) *Scenedesmus bijuga* (Turp.) Lagerheim
p) *Characium ornithocephalum* A. Braun
q) *Euastrum gemmatum* Brebisson (semicell)
r) *Scenedesmus abundans* var. *brevicauda* G. M. Smith

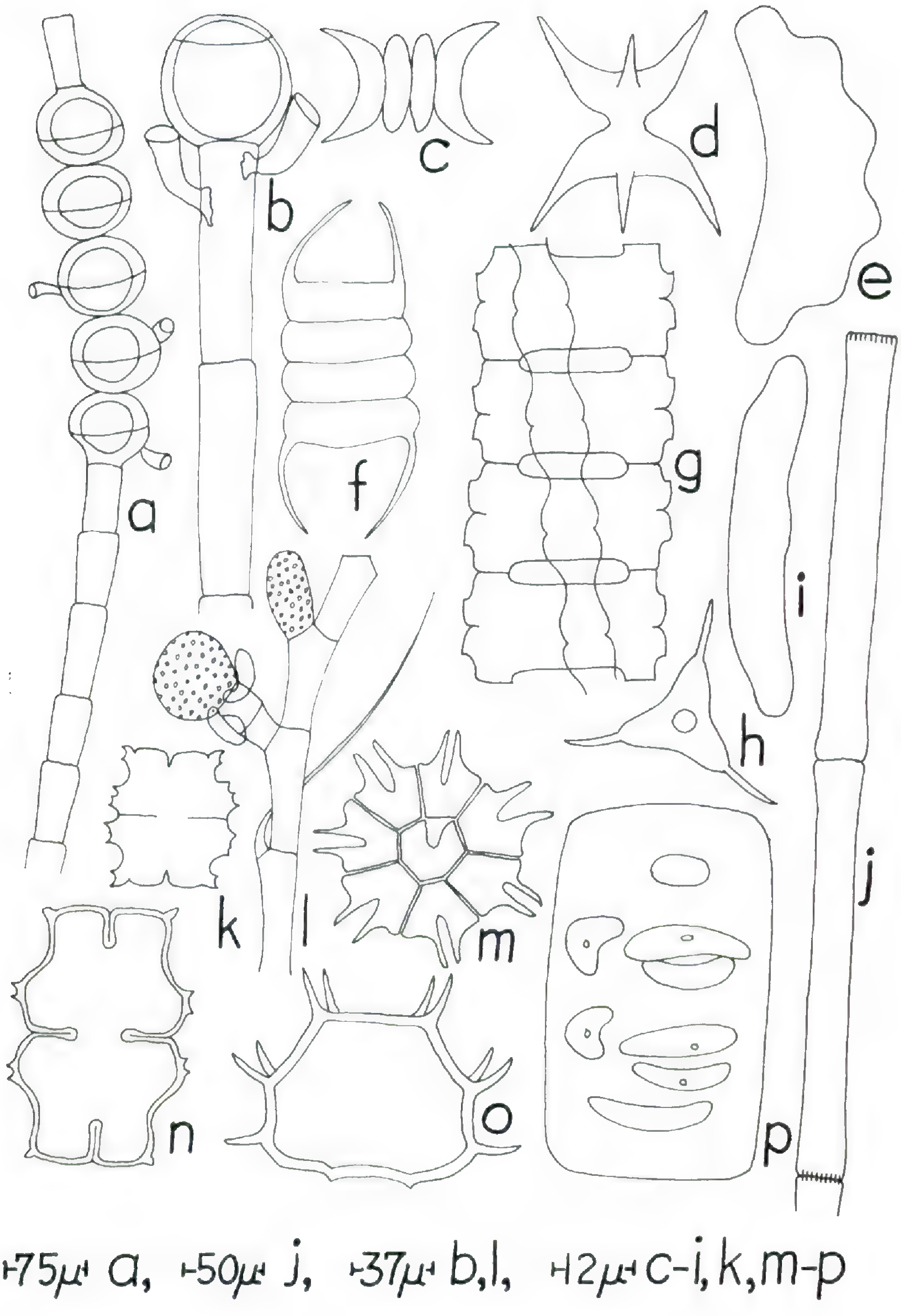

Plate 2

Plate 2:

a) *Oedogonium pseudoplenum* Tiffany
b) *Oe. michiganense* Tiffany
c) *Scenedesmus dimorphus* (Turp.) Kuetzing
d) *Staurastrum dejectum* Brebisson
e) *Eunotia serra* var. *diadema* (Ehr.) Patrick
f) *Scenedesmus quadricauda* var. *maxima* West & West
g) *Desmidium aptogomum* Brebisson
h) *Staurastrum curvatum* var. *elongatum* G. M. Smith
i) *Eunotia pectinalis* (O.F.M.) Rabenhorst
j) *Pleurotaenium subcoronulatum* var. *detum* West & West
k) *Euastrum abruptum* fa. *minor* West & West
l) *Bulbochaete furberae* Collins
m) *Pediastrum tetras* var. *tetraodon* (Corda) Rabenhorst
n) *Euastrum ciastonii* Rabenhorst
o) *Xanthidium cristatum* Brebisson (semicell)
p) *Nephrocytium lunatum* W. West

ILLINOIS FIELD AND HERBARIUM STUDIES

ROBERT H. MOHLENBROCK AND DAN K. EVANS

Further field and herbarium studies of Illinois plants have added several new taxa to the state flora. Several are adventive species from the Chicago area, while others represent native species of taxonomically difficult groups and are treated in some detail. Appreciation is accorded to Mr. Floyd Swink and his colleagues at the Morton Arboretum who kindly made available some of their recent collections. All records cited are in the herbarium of Southern Illinois University (SIU), the Morton Arboretum (MOR), or the Missouri Botanical Garden (MO).

Poa bulbosa L. The bulbous blue grass, native to Eurasia, is previously unreported from Illinois. Collections have been made of this from cultivated beds at the Morton Arboretum. DU PAGE CO.: Morton Arboretum, within the shrub collection in Lacy Land, May 20, 1971, *F. Swink* (MOR).

Phleum pratense L. f. **viviparum** (S. F. Gray) Louis-Marie. Vivipary, whereby plantlets or vegetative buds replace the flowers in part or all of the inflorescence, may be encountered in several genera. The phenomonon seems most frequent in the Gramineae, especially such cool season grasses as *Poa* and *Festuca.* Vivipary in *Scirpus atrovirens* (Cyperaceae) is also commonly encountered. Because of the apparent rare occurrence of this type of apomictic reproduction in *Phleum pratense,* this report seems worthwhile. DU PAGE CO.: In the Morton Arboretum, July 27, 1971, *F. Swink* (MOR).

Fuirena scirpoidea Michx. The previously known range of this species was along the coastal plain of Georgia, Florida, Alabama, and Louisiana. Its discovery in Illinois at the Dolan Lake Conservation area marks a range extention of more than 500 miles. One colony was found in shallow water growing beside *Eleocharis obtusa.* Svenson

(1957), the most recent monographer of the genus, combines *F. pumila* Torrey and *F. breviseta* Coville with *F. squarrosa* Michx. The three species now attributed to the Gray's Manual region may be identified in the following key.

1. Leaves reduced to sheaths without blades. *F. scirpoidea.*
1. Leaf blades well developed. . . . . 2.
   2. Achene dark brown with the beak pubescent; scale awn terminal. . . . . *F. squarrosa.*
   2. Achene yellow-brown with the beak glabrous; scale awn arising below the apex. . . . . *F. simplex.*

Although *F. squarrosa* (*F. pumila*) has been attributed to Illinois (Fernald, 1950; Jones 1950, 1963; Patterson, 1876), a thorough search by the senior author has failed to reveal any such specimens from this state. HAMILTON CO.: Shallow water, Dolan Lake shore in Dolan Conservation area, June 13, 1970, *N. Tracy* (SIU).

Salix × myricoides Muhl. This taxon is a reputed hybrid between *S. rigida* Muhl. and *S. sericea* Marsh., although it appears to have more of the characteristics of *S. sericea.* It differs from *S. sericea* by its canescent twigs and thinly sericeous capsules, while *S. sericea* has glabrous or glabrate twigs and densely sericeous capsules. We have recently collected it from Jackson County for its first known locality in Illinois, but it undoubtedly occurs elsewhere in the state. JACKSON CO.: Along rocky stream, Giant City State Park, August 30, 1971, *R. H. Mohlenbrock* (SIU).

Populus × smithii Boivin. This is the hybrid between *P. grandidentata* Michx. and *P. tremuloides* Michx., first described from Michigan by Wagner in 1970. It is intermediate in several characters between the parent species, the most obvious being the number of dentations along the leaf margins. The following key will serve to distinguish this hybrid from its parents.

1. Margin of leaf dentate, with 5-25 teeth (averaging 10-20); buds pubescent. . . . . 2.

2. Margin of leaf with 5-15 teeth (averaging 10); petiole 5-10 cm long (averaging 7 cm). .... *P. grandidentata.*
2. Margin of leaf with 12-25 teeth (averaging 20); petiole 3-6 cm long (averaging 5.5 cm). .... *P. × smithii.*

1. Margin of leaf finely crenate, with 20 or more teeth (averaging 31); buds glabrous or nearly so. .... *P. tremuloides.*

LA SALLE CO.: Starved Rock State Park, June 16, 1943, *G. N. Jones* 15791 (MO). PEORIA CO.: Horse Shoe Bottom, July 27, 1919, *V. H. Chase* 3217 (MO).

Carya pallida (Ashe) Engl. & Graebn. Correspondence with Dr. Wayne Manning, noted authority on the genus *Carya,* suggested the possibility of *C. pallida* in Illinois, since it occurs in western Kentucky and southern Indiana. Consequently, the senior author has kept a close vigil for this species in southern Illinois and was rewarded with the discovery of a specimen from Union County referable to *C. pallida.* The distinction between *C. pallida* and *C. texana* Buckl. is difficult. Both have yellow-lepidote buds, and the fruits are not different, although the fruits in *C. pallida* are usually smaller. *Carya pallida* usually has at least a few leaves with tomentose rachises, while *C. texana* usually does not except in var. *villosa* (Sarg.) Little. In the spring, *C. texana* has distinctive red hairs, while *C. pallida* does not. UNION CO.: Dry, acidic woods, along Grapevine Trail, May 21, 1972, *R. H. Mohlenbrock* (SIU).

Quercus velutina Lam. f. **missouriensis** (Sarg.) Trel. This form of Black Oak has the lower surface of the leaves densely and permanently pubescent. In this respect, f. *missouriensis* resembles *Q. falcata* Michx., but differs from this species in leaf shape and bud and acorn characteristics. SALINE CO.: Edge of dry woods, Old Stone Face, July 3, 1971, *R. H. Mohlenbrock* (SIU).

Chenopodium. While preparing the treatment of *Cheno-*

podium for The Illustrated Flora of Illinois series, the senior author has studied many collections of the genus and has re-evaluated the species previously known from the state. He has followed closely the treatment by Steyermark (1963) in Flora of Missouri in order to make more uniform the treatment of this genus in the central midwest. Three additional recognizable species from Illinois emerged from the study.

Chenopodium pallescens Standl. In general, all Illinois *Chenopodium* with white-mealy, narrow, entire leaves have been designated either *C. leptophyllum* Nutt. (Fernald, 1950; Gleason, 1952) or *C. pratericola* Rydb. (Jones, 1963). Illinois material can be separated reliably into two taxa, one to be called *C. pallescens* Standl., the other *C. desiccatum* A. Nels. var. *leptophylloides* (Murr.) Wahl. The following key serves to separate these taxa.

1. Leaves 1-nerved, linear; pericarp firmly attached to seed. . . . . *C. pallescens.*
1. Leaves 3-nerved, oblong or narrowly lanceolate; pericarp readily removed from seed. . . . . *C. desiccatum* var. *leptophylloides.*

Chenopodium pallescens is found in rocky ground and in waste areas, primarily in the north-central counties of the state. *Chenopodium dissectum* var. *leptophylloides* is almost always in waste ground in the northern half of Illinois.

Chenopodium bushianum Aellen. Although Jones (1963) combined this species with *C. album* L., the conspicuous honeycombed surface of the seeds of *C. bushianum* makes it a readily recognizable species. It is found occasionally throughout the state in fields, woods, and waste places.

Chenopodium strictum Roth var. **glaucophyllum** (Aellen) Wahl. This taxon is related to *C. album* L. and *C. missouriense* Aellen. It differs from *C. album* by its smaller seeds (0.8-1.2 mm broad), and from *C. missouriense* by its coarsely toothed lower leaves and its calyx lobes which do not cover the fruit. JACKSON CO.: Waste ground, one mile north of Carbondale, September 3, 1971, *R. H. Mohlenbrock* (SIU).

Draba verna L. var. **boerhaavii** Van Hall. This variety differs from typical var. *verna* by its fruits that are never twice as long as broad and by the seeds fewer than 40 per fruit. It is naturalized from Europe and adventive in a mowed field in Illinois. JACKSON CO.: Field, Southern Illinois University campus, Carbondale, April 4, 1972, *R. H. Mohlenbrock* (SIU).

Draba reptans (Lam.) Fern. var. **micrantha** (Nutt.) Fern. This variety, unreported previously from Illinois, occurs occasionally in northern Illinois where it sometimes is found growing with var. *reptans*. Variety *micrantha* differs by its hispidulous fruits.

Suaeda depressa (Pursh) S. Wats. This species is normally found in the naturally occurring saline soils of southern Canada, through the plains states, and south to Texas. In an apparent response to salting by the highway department, the plant grew along the highway median in the Chicago area. COOK CO.: Median strip, one mile north of Illinois 22, one mile south of Everett Pond, October 7, 1972, *R. Schulenberg* (MOR).

Spergularia media (L.) C. Presl. Another adventive element new to the Illinois flora is this member of the pink family. The previous range of this species appears to be the natural saline soils of central and coastal New York as well as coastal California and Oregon. Illinois collections were made near Elgin along a tollway where salt is frequently used by the highway department. KANE CO.: 3½ miles west of the Elgin toll booth on the Northwest Tollway right-of-way bank, in sterile clay, September 3, 1972, *R. Read* (MOR).

Pyrus pyrifolia (Burm. f.) Nakai. The Chinese Pear is an occasional cultivated plant in Illinois. A specimen about thirty-five feet tall has been found growing along a rocky stream in Giant City State Park. This species differs from the more common *P. communis* L. by its rounder fruits, slightly larger flowers, and sharply toothed leaves. JACKSON CO.: Along Stonefort Creek, Giant City State Park, September 11, 1970, *R. H. Mohlenbrock* (SIU).

Crataegus marshallii Egglest. This is one of the few species of *Crataegus* in Illinois which has the veins of the leaf running to the sinuses as well as to the points of the lobes. It differs from *C. phaenopyrum* (L. f.) Medic. by its petioles much longer in relation to the length of the blade, its fewer stamens with reddish anthers, and by its usually two nutlets per fruit. Its habitat in swampy woods is also distinctive. JACKSON CO.: Swampy woods, Greentree Reservoir, 2½ miles southwest of Gorham, *R. Anderson* (SIU).

Triadenum virginicum (L.) Raf. The discovery of this species in Lake County brings to four the number of species of *Triadenum* known from Illinois. The following key separates these four species.

1. Leaves without punctations. . . . . *T. tubulosum.*
1. Leaves punctate, at least on the lower surface. . . . . . 2.
    2. Leaves petiolate. . . . . *T. walteri.*
    2. Leaves sessile. . . . . 3.
        3. Sepals obtuse, up to 5 mm long; styles up to 1.5 mm long. . . . . *T. fraseri.*
        3. Sepals acute, 5-8 mm long; styles 2-3 mm long. . . . . *T. virginicum.*

LAKE CO.: Boggy ground, Illinois Beach State Park, August 3, 1972, *R. H. Mohlenbrock* (SIU).

Mentzelia decapetala (Pursh) Urban & Gilg. This species is native to dry prairies and plains west of the Mississippi River. In Grundy county, apparently its easternmost site, it was collected along a railway where it occurred with other such adventives as *Kochia scoparia, Setaria viridis, Helianthus annuus,* and *Grindelia lanceolata* f. *latifolia.*

GRUNDY CO.: Cinder and gravel ballast, at Eileen, along right-of-way of Santa Fe RR, August 13, 1972, *R. Schulenberg, D. Kropp, & D. Ladd* (MOR).

Polypremum procumbens L. This species was expected to occur in southern Illinois since it is known from Kentucky to the south and five counties in nearby southeastern Missouri. Collections were made from a sandy field in the Horseshoe Lake Conservation area. The inconspicuous corolla, procumbent habit, and slender leaves probably have resulted in this species being overlooked in other localities. ALEXANDER CO.: Low, sandy field, Horseshoe Lake, August 11, 1971, *J. Huston* 920 (SIU).

Jacquemontia tamnifolia (L.) Griseb. This species is native to the southeastern United States and represents a genus new to the Illinois flora. This probable adventive was collected from a disturbed habitat where it grew in association with *Agropyron repens, Ipomoea purpurea,* and *Euphorbia dentata.* The following key serves to distinguish *Jacquemontia* from *Ipomoea, Convolvulus,* and *Calystegia* in Illinois.

1. Stigma 1, capitate or with 2 to 3 lobes. . . . . . . *Ipomoea.*
1. Stigmas 2, noncapitate, without lobes. . . . . 2.
    2. Stigmas elliptic, oblong or flattened. . *Jacquemontia.*
    2. Stigmas filiform or subulate. . . . . 3.
        3. Calyx not concealed by large bracts; fruit 2-locular. . . . . *Convolvulus.*
        3. Calyx concealed by 2 large bracts; fruit 1-locular. . . . . *Calystegia.*

GRUNDY CO.: Railroad tracks at Gardner, October 15, 1972, *R. Schulenberg & E. Lace* (MOR).

Vinca major L. The large-flowered periwinkle, an introduced European cultivar, was previously known in the wild in the coastal states from North Carolina south to Mississippi. In Illinois the species was collected around an old homestead in Pope County where it grew without cultivation. POPE CO.: Randolph Farm, *V. Randolph* (SIU).

Matelea decipiens (Alex.) Woodson. This climbing member of the milkweed family is widely distributed in central and southern Missouri, but the record cited below is apparently the first from Illinois. All three Illinois representatives of this genus are restricted to the southernmost counties. They may be distinguished by the following key.

1. Flowers greenish-yellow; pedicels glabrous; follicles smooth, angular. .... *M. gonocarpa.*
1. Flowers rose, maroon, or rarely cream; pedicels pubescent; follicles rounded, muricate. .... 2.
    2. Petals 3-6 mm wide, maroon. .... *M. decipiens.*
    2. Petals 1.5-2.5 mm wide, rose or rarely cream. .... *M. obliqua.*

WILLIAMSON CO.: Low floodplain woods, natural levee of Big Muddy River, north of Colp, May 28, 1972, *M. Swayne & J. Swayne* (SIU).

Physalis macrophysa Rydb. This plant, treated variously as a species, variety, or form, differs from *P. subglabrata* Mack. & Bush by its translucent leaves and its large, pyramidal calyces when in fruit. The calyx becomes 3-6 cm long during fruiting. Illinois specimens, previously labelled *P. subglabrata,* have been seen from Champaign and Peoria counties.

Antirrhinum orontium L. The often cultivated lesser snapdragon has been collected from a cultivated oat field. Although it has probably escaped elsewhere in Illinois, this is the first report of such an occurrence. DU PAGE CO.: Oat field, National Accelerator Laboratory near Warrenville, September 28, 1972, *F. Swink* (MOR).

Penstemon cobaea Nutt. This sometimes cultivated beards-tongue was previously known from southern Missouri northwest to Nebraska, south to Texas, and east to Arkansas. Within this range the typical habitats are prairies, glades, and bluffs. In Illinois this species was collected from a dry meadow where it grew in association with such prairie elements as *Asclepias verticillata, Poa compressa,* and *Physalis subglabrata.* Although this species is not known to be native to northeastern Illinois, the plant associates as well as the prairie habitat might suggest an indigenous condition. KANE CO.: Flat, dry meadow, west of Montgomery, near Kendall County line, June 25, 1972, *J. Phillips, D. Young, & R. Schulenberg* (MOR).

Lagenaria siceraria Standl. This highly variable gourd is frequently planted in Illinois and occasionally escapes from cultivation. An early collection from Hancock County and a recent one from Jackson County verify its existence in Illinois.

Cucurbita pepo L. var. **ovifera** (L.) Alef. This variety of the common Field Pumpkin has extremely variable fruits, many of them the source of interesting ornamental gourds such as the Pear, the Bell, the Apple, the Egg, and the Orange. A single collection has been made for this plant in Illinois. UNION CO.: in disturbed soil along a stream, 2 miles north of McClure, July 31, 1971, *R. H. Mohlenbrock* (SIU).

Sherardia arvensis L. This new element of the Illinois flora is adventive but well established in areas of the SIU campus at Carbondale. It may be confused with *Galium* but is distinguished by its long, funnel-form, blue corolla and narrow leaf-like involucres that subtend the flowers. In addition to our location, the species is local in Nova Scotia, southeastern Canada, Missouri, Tennessee, and North Carolina. JACKSON CO.: Lawn, SIU campus by the Forest Service Laboratory, April 30, 1971, *D. Evans* 11408 (SIU).

Campanula rotundifolia L. var. **velutina** A. DC. The occurrence of typical *C. rotundifolia* from the rocky environs of northeastern Illinois is not uncommon. However, variety *velutina* is heretofore reported only from a single collection by E. J. Hill from Cheboygan County in northern Michigan. We have this taxon from near Apple River Canyon State Park. Here the plant grows in the crevices of an east-facing limestone wall which borders Apple River. Associated species include the typical form, *Aquilegia canadensis, Carex granularis,* and the cliff fern *Cryptogramma stelleri.* Considering the close habitat association with the markedly different typical form, it seems unlikely that this pubescent variety is a mere ecological variant as claimed by some. JO DAVIESS CO.: East-facing limestone wall bordering Apple River, 1/4 mile northeast of Apple River Canyon State Park, June 13, 1972, *D. Evans* 1156 (SIU).

Grindelia lanceolata Nutt. f. **latifolia** Steyerm. Prior to this report from Grundy County, f. *latifolia* was unknown in Illinois. The typical form remains unreported from the state. The closest occurrence of this new taxon to the Illinois site is the type locality in Stone County, Missouri. Collections are also known from Oklahoma. GRUNDY CO.: At Eileen, in N 1/2 of Sect. 36, T33N, R6E, August 13, 1972, *R. Schulenberg & D. Ladd* (MOR).

Senecio jacobaea L. Collections from railways and roadsides often produce rare or unusual adventive species. This waif recently has been collected from a railway in the Chicago area. DU PAGE CO.: Great Western RR at Euclid Avenue, Villa Park, August 17, 1972, *F. Swink* (MOR).

Thelesperma gracile (Torr.) Gray. The natural habitat and range of this unusual composite are the prairies and plains from Nebraska to Wyoming, south to Arizona, and east to Texas and Oklahoma; also Mexico and South America. In addition, Steyermark (1963) reports two adventive sites in Missouri. This roadside collection from Kane county represents the easternmost extension of its range in North America. KANE CO.: Along Ancutt Road, west of Montgomery, July 4, 1972, *F. Swink* (MOR).

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TWO NEW COLOR-FORMS FROM SOUTHERN MAINE

While collecting in the Ocean Park section of Old Orchard Beach, York County, Maine, in recent summers, I have noticed certain plants of *Spiraea latifolia*, Meadowsweet, with deep-pink flowers. Some of these plants have pubescent panicles; others are glabrous. I have found this form growing both in open wet spots and in shaded woodland stations.

Spiraea latifolia (Ait.) Borkh. forma *rosea* T. W. Wells, forma nova. TYPE: **Maine:** YORK CO.: Old Orchard Beach, 11 October, 1969, T. W. WELLS (NEBC). Differt a forma *latifolia* floribus valde roseis.

While collecting in salt-marshes along Goose Fare Creek, which is the southern boundary of Ocean Park, I found plants of *Polygonum ramosissimum* which differ from the typical in that the sepals have bright-white margins.

Polygonum ramosissimum Michx. forma *alba* T. W. Wells, forma nova. TYPE: **Maine:** YORK CO.: Old Orchard Beach, 5 September, 1970 T. W. WELLS (NEBC). Differt a forma *ramosissimum* sepalis albomarginatis.

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RANGE EXTENSIONS AND NEW RECORDS FOR THE BAHAMA FLORA

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In recent years the flora of the Bahama Islands has again aroused the interest of several taxonomists, who have found *The Bahama Flora* of N. L. Britton and C. F. Millspaugh (1920) to be inadequate in many respects. Not only have numerous nomenclatural changes been proposed, but also since that time collections of species new to the islands have been made (Howard, 1950; Howard & Dunbar, 1964; Lewis, 1971). At the present time The Fairchild Tropical Garden is undertaking the much-needed revision of the outdated work.

This writer has made two collecting trips to the Bahamas; the first from April 28 to May 16, 1970, on New Providence Island, Long Island, and Inagua Island, and the second from May 18 to June 3, 1972, on Long Island alone. Both trips were as an undergraduate at Bates College, Lewiston, Maine, and were under the guidance and direction of Dr. Harold E. Hackett of the Department of Biology at that institution. Four collections were from New Providence, 147 from Long Island, and 51 from Inagua. It was noted that the flora of Long Island, a flora which seems to resemble that of the eastern coast of Cuba, was particularly poorly known. Long Island is an "out island" nearly one-hundred miles long and four miles wide, trending north-south, and bisected by the Tropic of Cancer. Since the flora was poorly known, Walter Cerbin, SSJ, of Clarence Town, Long Island agreed to collect in his area, with the processing of specimens to be done at the New York Botanical Garden. To date Father Cerbin's collections number 76 (nos. 102-167 from Long Island, and 1001-1010 from Inagua). These are deposited in this writer's personal herbarium (designated as SRH) housed at the New York Botanical Garden, with duplicates at New York and the Arnold Arboretum.

According to Britton and Millspaugh (1920), five collectors had gathered specimens on Long Island up to the time of their work, and of their collections only 173 numbers were cited (nos. 495-520, 524 of William C. Coker, 1903; and nos. 6225-6307 of Britton and Millspaugh, 1907). The two others considered to have collected on the island were Swainson (1830-42), whose collections were not known to the authors of *The Bahama Flora,* and H. F. A. von Eggers (1888), whose collections were apparently not sufficiently well-known to be cited. Among those who have touched upon Long Island since that time are Dr. Harold E. Hackett of Bates College (53 numbers in the Duke University Herbarium), Father Walter Cerbin, and this writer.

The results of the recent collections include several new records: 49 species newly reported for Long Island, 4 new to Inagua, and 8 new to the Bahama Islands. The collections also include the rediscovery of a species formerly known only from the type, *Zamia lucayana* Britton. It is interesting to note that many of these new records are of rather common species in the West Indies, reflecting the paucity of the collections from the area to date. Cultivated plants have been included since they commonly escape on the islands and become a part of the local flora.

The list of taxa is divided into four sections: 1) species newly reported for Long Island, 2) species newly reported for Inagua, 3) species newly reported for the Bahamas, and 4) a rediscovery. The citations after the collection number refer to those institutions in which the specimen is housed, and the abbreviations are as in the *Index Herbariorum* (Lanjouw and Stafleu, 1964).

The author wishes to thank Dr. William T. Gillis for his help in reviewing the manuscript, Dr. Harold E. Hackett for his guidance and encouragement while in the Bahamas and at Bates College, Drs. Arthur and Noel Holmgren, Dr. Gerrit Davidse, and Mr. Kenneth Becker for their help with certain determinations, and Dr. John T. Mickel, his advisor at the New York Botanical Garden.

I. Species Newly Reported for Long Island.

A. Native or long established species.

POLYPODIACEAE: *Acrostichum danaeifolium* Langsd. & Fisch.: *Hill* 840 (SRH) sinkhole, Village Road, S. Clarence Town.

Asplenium dentatum L.: *Hill* 834 (A, SRH) sinkhole, Deadman's Cay.

Pteris longifolia L.: *Hill* 819b (SRH) moist depression, Mangrove Bush.

Thelypteris normalis (C. Chr.) Moxley: *Hill* 125, 835 (SRH) sinkholes, Village Road, S. Clarence Town.

GRAMINEAE: *Chloris petraea* Sw.: *Hill* 467 (SRH) Clarence Town. Det. G. Davidse.

Distichlis spicata (L.) Greene: *Hill* 123 (A, SRH) Harbor Point, Clarence Town. Det. A. Holmgren.

Uniola paniculata L.: *Hill* 826 (A, SRH) Harbor Point, Clarence Town.

AMARYLLIDACEAE: *Agave sisalana* (Engelm.) Perrine: *Hill* 824 (SRH) Clarence Town.

Hymenocallis declinata (Jacq.) M. Roem.: *Hill* 829 (A, SRH) Turtle Cove.

BROMELIACEAE: *Tillandsia usneoides* L.: *Hill* 670b (US, A, SRH) Galloway's Cave, South Clarence Town.

Tillandsia utriculata L.: *Hill* 529 (SRH) Village Rd., S. Clarence Town.

COMMELINACEAE: *Rhoeo spathacea* (Sw.) Stearn: *Hill* 244 (SRH) Clarence Town.

ORCHIDACEAE: *Encyclia bahamensis* (Griseb.) Britton: *Hill* 532 (US, A, SRH) 4 mi. W. of Clarence Town.

POLYGONACEAE: *Antigonum leptopus* H. & A.: *Cerbin* 120 (NY, A, SRH) Clarence Town.

Coccoloba swartzii Meisner: *Hill* 471, 841 (SRH) Clarence Town.

NYCTAGINACEAE: *Commicarpus scandens* (L.) Standley: *Cerbin* 104 (NY, A, SRH) Turtle Cove.

Guapira bracei (Britt.) Little: *Hill* 848 (SRH) Turtle Cove.

BATIDACEAE: *Batis maritima* L.: *Hill* 531 (SRH) Clarence Town.

MIMOSACEAE: *Acacia farnesiana* (L.) Willd.: *Cerbin* 144 (NY, A, SRH) Village Road, South Clarence Town.

Albizia lebbeck (L.) Benth.: *Hill* 540 (SRH) Clarence Town.

CAESALPINIACEAE: *Cassia biflora* L.: *Cerbin* 116 (NY, A, SRH).

ZYGOPHYLLACEAE: *Kallstroemia maxima* (L.) T. & G.: *Hill* 952 (SRH) Clarence Town.

EUPHORBIACEAE: *Pedilanthus tithymaloides* (L.) Poit.: *Hill* 139 (SRH); *Cerbin* 139 (NY, A, SRH) Clarence Town.

Ricinus communis L.: *Hill* 542 (SRH) common escape in Clarence Town.

MALVACEAE: *Abutilon trisulcatum* (Jacq.) Urban: *Cerbin* 160 (NY, A, SRH) Clarence Town.

Cienfuegosia yucatanensis Millspaugh: *Hill* 1015 (SRH) moist depression between Hamilton's and Buckley's. Identified by Dr. Paul Fryxell.

Thespesia populnea (L.) Soland.: *Hill* 129 (A, SRH) Clarence Town.

TURNERACEAE: *Turnera diffusa* Willd.: *Hill* 845 (SRH) Harbor Point, Clarence Town.

PASSIFLORACEAE: *Passiflora bahamensis* Britton: *Hill* 515b (A, SRH); *Cerbin* 166 (NY, A, SRH) Clarence Town.

CARICACEAE: *Carica papaya* L.: *Hill* 142 (A, SRH) occasional in Clarence Town.

SAPOTACEAE: *Mastichodendron foetidissimum* (Jacq.) Cronq.: *Hill* 839 (A, SRH) Turtle Cove.

APOCYNACEAE: *Plumeria obtusa* L.: *Hill* 831 (SRH) Turtle Cove.

ASCLEPIADACEAE: *Cryptostegia grandiflora* (Roxb.)

R. Br.: *Hill* 128 (SRH); *Cerbin* 153 (NY, SRH) Clarence Town outskirts.

CONVOLVULACEAE: *Evolvulus squamosus* Britton: *Cerbin* 113 (NY, A, SRH) Mangrove Bush.

Merremia dissecta (Jacq.) Hall: *Cerbin* 117 (NY, A, SRH) Morrisville.

SCROPHULARIACEAE: *Stemodia maritima* L.: *Hill* 947 (SRH); *Cerbin* 119 (NY, A, SRH) 4 miles west of Clarence Town. Determined by Dr. Noel Holmgren.

ACANTHACEAE: *Blechum brownei* Juss.: *Cerbin* 126 (A, NY, SRH) Clements.

Ruellia tuberosa L.: *Hill* 846 (SRH) Clarence Town.

RUBIACEAE: *Casasia clusiifolia* (Jacq.) Hitch.: *Cerbin* 141, 152 (NY, A, SRH) Salt Pond.

ASTERACEAE: *Bidens pilosa* L.: *Cerbin* 111 (NY, A, SRH) Mangrove Bush.

Wedelia trilobata (L.) Hitchc.: *Cerbin* 136 (NY, A, SRH) Salt Pond.

Verbesina encelioides (Cav.) Benth. & Hook.: *Cerbin* 159 (NY, A, SRH) Clarence Town. Determined by K. Becker.

B. Cultivated or escaped.

AMARYLLIDACEAE: *Hippeastrum puniceum* (Lam.) Urban: *Hill* 1017 (SRH) Hamiltons.

FABACEAE: *Sesbania grandiflora* (L.) Pers.: *Cerbin* 102 (NY, A, SRH) Turtle Cove.

EUPHORBIACEAE: *Codiaeum variegatum* (L.) Blume: *Cerbin* 122 (NY, A, SRH) Clarence Town.

ARALIACEAE: *Polyscias guilfoylei* (Bull.) Bailey: *Cerbin* 114 (NY, A, SRH) Morrisville.

APOCYNACEAE: *Thevetia peruviana* (Pers.) K. Schum.: *Hill* (A, SRH) Clarence Town.

OLEACEAE: *Jasminum fluminense* Vell.: *Cerbin* 140 (NY, A, SRH) Salt Pond.

SCROPHULARIACEAE: *Russellia equisetiformis* Schl. & Cham.: *Cerbin* 133 (NY, A, SRH) Deadman's Cay.

CUCURBITACEAE: *Momordica charantia* L.: *Cerbin* 125 (NY, A, SRH) Clements.

II. Species Newly Reported for Inagua.

LILIACEAE: *Sansevieria hyacinthoides* (L.) Druce: *Cerbin* 1001 (NY, A, SRH) Along road to Northwest Point.
PASSIFLORACEAE: *Passiflora bahamensis* Britton: *Hill* 515 (SRH) Union Creek.
APOCYNACEAE: *Nerium oleander* L.: *Hill* 488a & b. (SRH) Matthew Town.
CONVOLVULACEAE: *Merremia dissecta* (Jacq.) Hall: *Hill* 489 (SRH) Matthew Town.

III. Species Newly Reported for the Bahama Islands.

AMARYLLIDACEAE: *Crinum asiaticum* L.: *Cerbin* 124 (NY, A, SRH) Clarence Town, Long Island. Cultivated and possibly escaped in moist places.

Zephyranthes citrina Baker: *Hill* 827 (A, SRH) Clarence Town, Long Island.

Zephyranthes puertoricensis Traub: *Hill* 836 (SRH) Hamilton's, Long Island. Also in cultivation from this population at NY.

AMARANTHACEAE: *Alternanthera brasiliana* (L.) Kuntze: *Cerbin* 127 (NY, A, SRH) Clements, Long Island. Determined by Mr. Kenneth Becker, NYBG.
CAESALPINIACEAE: *Bauhinia variegata* L.: *Hill* 566 (SRH) Nassau, New Providence. Commonly cultivated and escaped.
MALPIGHIACEAE: *Malpighia glabra* L.: *Cerbin* 1005 (NY, A, SRH) Matthew Town, Inagua. Cult. Cultivated and possibly escaped.
CACTACEAE: *Opuntia rubescens* (Salm-Dyck) Lemains: *Hill* 476 (SRH) Matthew Town, Inagua. Dooryard.
SOLANACEAE: *Datura inoxia* Mill.: *Hill* 850 (SRH) Clarence Town, Long Island. Roadside. Also *Nash and Taylor* 1357, formerly determined as *D. metel* L. but re-identified by H. N. Moldenke. Inagua.

IV. Rediscovery.

CYCADACEAE: *Zamia lucayana* Britton: *Hill* 828 (MO, K, US, A, F, BM, TRIN, SRH, NY). Found in limestone and sand 100 yards from the sea, about five miles north of the type locality; Turtle Cove, Long Island. Formerly known only from the type collection "In a sandy coastal thicket Clarence Town, Long Island, only one plant found after a long search (*Britton and Millspaugh* 6271)" (Britton, 1907). This writer discovered an extensive colony with many old plants as well as a thriving understory of seedlings and hermit crabs which were feeding on the fleshy seed coats. Plants in the shade generally exhibited much longer leaves than those in sun, those specimens in shade agreeing more closely with the type. Male and female cones were collected, and living material is in cultivation at NYBG, Harvard, and the Fairchild Tropical Garden.

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A NEW SPECIES OF LECHEA (CISTACEAE) FROM PENINSULAR FLORIDA

Robert L. Wilbur[1]

A dozen years ago a strikingly different *Lechea* was noted (Rhodora 63: 117. 1961.) among collections from southern Florida. It then seemed unwise, however, to describe the population that they represent as a distinct new taxon since the specimens available were not as complete or mature as would be desired in proposing a new entity in such a perplexing and technical genus. However, additional collections from southern Florida and the low-keyed but persistent hints from Dr. Olga Lakela that something wasn't quite satisfactory with available treatments finally prodded me into taking another look. Her own collections have largely eliminated one of my reservations about formally proposing a new taxon, although additional collections from throughout the growing season are still very much to be desired. Practically nothing is known of the plants except in the fruiting stage and although that is the most important stage for the accurate identification of members of this genus, it still would be most desirable to know something more about the vegetative features of this species. Leaves in this species are almost completely lacking by the time fruits are ripening. Still it seems probable that more of a stimulus for additional collections of this taxon and of the other highly distinctive representatives of the genus in peninsular Florida will be forthcoming if the taxon is formally proposed now than if we wait for more collections.

KEY TO THE PENINSULAR FLORIDIAN SPECIES OF LECHEA

1. Pubescence of aerial stems mostly strongly divergent and spreading. . . . . 2.

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[1] This study was supported by NSF GB-13815, for which grateful acknowledgment is made.

  2. Internal sepals conspicuously V- or U-shaped in cross-section with thin scarious margins and a roughened, often sparsely pilose keel (the sepal otherwise glabrous) ; leaves often over 1.5 cm. long; capsule thin-walled, readily splitting into 3 valves at maturity, subglobose, about equaling the calyx in length. .... 1. *L. mucronata* Raf. (*L. villosa* Ell.).
  2. Internal sepals but slightly bowed in cross-section with texture appearing uniform and pubescence scattered across surface; leaves all less than 1 cm. long; capsule thick-walled, indehiscent, ellipsoid or somewhat rounded- barrell-shaped, exserted from the calyx for at least 1/3-1/2 its length. .... 2. *L. divaricata* Shuttlew. ex Britt.

1. Pubescence of aerial stems mostly closely appressed or lacking. .... 3.
  3. External sepals equaling or exceeding the internal sepals in length. .... 4.
    4. External sepals at least one-fifth longer than the inner sepals and usually equaling or exceeding the capsule in length; capsule equaling or exceeding the inner sepals by not more than one-fifth its length; cauline leaves usually elliptic to elliptic-oblong, usually less than 5 times as long as wide, those below the inflorescence commonly appearing whorled and often more than 2 mm. wide. . . .. 3. *L. minor* L.
    4. External sepals about equaling the inner sepals and never equalling the capsule in length; capsule usually exceeding the inner sepals by about 1/3-1/2 its length; cauline leaves narrowly oblong to linear, usually 6 times (or more) as long as wide, those below the inflorescent alternate and less than 2 mm. wide. .... 4. *L. sessiliflora* Raf. (*L. patula* Legg.).
  3. External sepals shorter than the internal sepals. . 5.
    5. Leaves pubescent on both upper and lower sur-

faces (at least those of the basal shoots conspicuously pilose above and below while the cauline and rameal leaves are usually inconspicuously pubescent over entire surface); flowers or fruits mostly clustered in 2's or 3's; capsule wall thickened and indurate. .... 5. *L. cernua* Small.

5. Leaves variously pubescent below but glabrous on upper surface; flowers or fruits not appearing fascicled (but obviously attached separately); capsule wall thin or at least not conspicuously indurate. .... 6.
    6. Aerial stems perennial, suffruticose, clearly woody at base, with wiry woody branches; capsule exserted from the often spreading calyx by 1/3-1/2 its length; calyx sparingly short-pubescent to glabrous. .... 6. *L. deckertii* Small.
    6. Aerial stems annual, herbaceous, dying to the base each year; capsule equaling the calyx or exserted not more than 1/5 its length from the closely enveloping sepals; calyx moderately to densely pilose. .... 7.
        7. Leaves abruptly tapering at apex into a hardened, shiny, conical callosity about 0.25 mm. long; inner sepal clearly 3-nerved (often best demonstrated by moistening); pedicels averaging over 1.5 mm. long; capsule exceeding the sepals by about 1/5 its length; seeds mostly 2. .... 7. *L. pulchella* Raf. (= *L. leggettii* Britt. & Holl.).
        7. Leaves pointed but not differentiated into a callosity; inner sepal 1-nerved; pedicels averaging less than 1.5 mm. long; capsule almost completely enveloped by the sepals; seeds mostly 3-6. .... 8.
            8. Calyces densely appressed pilose; stems and under surface of the leaves

or at least the midvein and often the margins appressed pilose; capsules equaling or slightly shorter than the closely enveloping inner sepals. . . . . 8. *L. torreyi* Legg. ex Britt.

8. Calyces glabrous; stems and leaves completely glabrous; capsules very slightly exceeding the inner sepals at maturity . . . . 9. *L. lakelae.*

Lechea lakelae Wilbur, sp. nov.

Caudex simplex vel paucis aliquotve ramis; folia ramealia peranguste linearia-elliptica, acuta, 0.6-1.2 cm. longa et 0.3-1.0 mm. lata, subtus costa et margine glabra; pedicelli glabri, (0.8) 1.0 (1.2) mm. longi; calyx fructifer obovoideus, 1.5-1.9 mm. longus et 1.2-1.6 mm. latus; sepala interiora glabra et leviter carinata, 1.5-1.9 mm. longa et 1.2-1.6 mm. lata; sepala exteriora glabra linearia vel anguste lanceolata 1/2 vel 2/3 plo breviora quam sepala interiora; capsula c. 1.2-1.6 mm. longa; semina 3, c. 0.8 mm. longa.

Caudex simple or with few to several branches; basal resting shoots unknown; aerial (*i.e.* flowering and fruiting) stems 1 to several, 2-3 (4) dm. tall, branching mostly above the middle and forming a rather compact, wiry-stemmed, bushy top with completely glabrous axes; cauline leaves lacking on all specimens seen; rameal leaves very narrowly linear-elliptic, tapering to both the apex and base, 0.6-1.2 cm. long and 0.3-1 mm. wide, completely glabrous above and below with the midvein somewhat elevated beneath; fruiting branches and pedicels glabrous, the pedicels (0.8) 1.0 (1.2) mm. long; fruiting calyx obovoid, broadest above the middle and tapering into the broadly obpyramidal, coriaceous base, drying dark reddish brown, completely glabrous; inner sepals about 1.5-1.9 mm. long, including the indurate, obpyramidal base, and 1.2-1.6 mm. broad, slightly exceeded by the mature capsule, very broadly elliptic to almost orbicular, apically broadly rounded, only the strongly elevated or slightly keeled midvein clearly visible; outer sepals linear to narrowly lanceolate, about 1/2-2/3 as long as the inner; capsules broadly barrel-shaped, cylindrical, about 1.2-1.6 mm. long and 1-1.2 mm. in diameter, the valves firm, indurate, tardily dehiscing about 1/2-2/3 the distance from apex to base; seeds 3, equilateral, dorsiventrally compressed, about 0.8 mm. long and 0.4 mm. wide, blackish.

TYPE: Collier Co., Florida: Marco Island, moist level grassy area, higher beach of recently made lake. 7 August 1967. *Lakela* 30953 (Holotype, DUKE; Isotype, USF).

OTHER SPECIMENS EXAMINED: Collier Co.: coastal strand, *Serenoa-Ceratiola* scrub, growing with *Cyperus* in white sand, *Lakela* 31879 (DUKE); Marco Island, coastal strand — *Pinus elliottii* association, *Lakela & Almeda* 31567 (DUKE); Marco Island with *Indigofera, Polygonella,* in *Ceratiola-Quercus* scrub, on U.S. 92, *Lakela* 27852A (USF); lagoon head, upper beach, *Lakela* 31673 (DUKE).

My recollection and rather brief notes made more than a dozen years ago indicate that the species also occurs or occurred on Florida's eastern coast in Broward Co.: sandy scrub above Fort Lauderdale, *Buswell* 24 July 1936 (BUS!).

The apparent nearest relative of the new species, *Lechea lakelae,* is *L. torreyi.* The most obviously distinctive features are indicated in the key, but the two taxa may be readily distinguished at a glance. Obviously I feel that both merit recognition at specific rank. In the mind of some there still may remain a nagging suspicion that the strikingly distinctive plants of the newly described taxon are merely a glabrous form of *L. torreyi.* I feel, however, that the apparently consistently longer capsules when compared to the length of the inner sepals suggest that *L. lakelae* is more than that.

This species is named in recognition of Dr. Olga Lakela upon whose keen eye and careful collections our present knowledge of this taxon is largely based. It is humbling to recall that her recent significant contributions to southeastern botany were made in her "retirement" years after an active career as a teacher and researcher in Minnesota.

Not many botanists are destined to write floras of as distant regions as one of Minnesota's northeastern counties and Florida's southern tip.

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PIMPINELLA SAXIFRAGA L. (UMBELLIFERAE) IN WISCONSIN: This species, adventive from Eurasia, has heretofore been reported to extend from Newfoundland and New Brunswick to Delaware and the District of Columbia, west to Pennsylvania, Ohio, and Indiana (Mathias & Constance, 1944. Umbelliferae, *in* North American Flora 28B (1): p. 133; Fernald, Gray's Manual, 1950; Gleason, Illustrated Flora, 1952; Gleason & Cronquist, Manual of Vascular Plants, 1963). Jones (Flora of Illinois, 1950) and Steyermark (Flora of Missouri, 1963) do not mention the plant, so it appears not to have spread westward. I report here its discovery in Wisconsin: WINNEBAGO CO.: roadside at junc. Country Club Road and Black Wolf Point Road, sect. 24, T17N, R16E, 24 September 1967, *Below* 146; in roadside ditch ca. ⅛ mile from the junc. of county trunks YY and N, on N, sect. 20, T17N, R16E, 26 September 1972, *Rhyner* 044.

The two specimens are deposited in the herbarium here at Oshkosh. The curators of the herbaria at MIL, UWM, and WIS have no records of the plant from Wisconsin; Iltis at WIS has kindly confirmed the identifications. The plant's occurrence at two sites four miles apart and spanning a five-year period warrants its inclusion as an element in the Wisconsin flora.

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A SECOND REPORT OF THE PROTHALLIA OF LYCOPODIUM INUNDATUM IN NORTH AMERICA[1]

DAVID M. LANE AND A. LINN BOGLE

Gametophytes of *Lycopodium inundatum* L., first recorded for North America in 1972 (Bruce, 1972) from two localities in Michigan, were found growing at the edges of shallow wet depressions along the margins of a sandy access road on the shore of an inactive and flooded sandpit (Figs. 1, 2) in Somersworth, Strafford Co., New Hampshire. The mature sporophytes of *L. inundatum* var. *inundatum* (compare Gillespie, 1962) are abundant along the shoreline, often forming dense mats (Fig. 3).

Samples of sandy soil containing the smallest visible sporophytes were collected in October and examined according to Bruce's technique. Some of the young sporophytes were still attached to living gametophytes, as adjudged by the green color, turgidity, and characteristic lobing of the latter. Gametophytes were also found which had not yet produced sporophytes.

Gametophytes ranged in size from less than one mm. in diameter for one which bore no sporophyte, up to about three mm. in diameter among those bearing sporophytes. Included in the latter category were one gametophyte bearing a sporophyte which had produced about ten microphylls, and two gametophytes each bearing two young sporophytes (Fig. 4). In contrast, however, some very young sporophytes were found to have no attached gametophytes, the latter apparently having rotted away, even though the sporophytes bore only one or two microphylls. This condition appeared particularly prevalent where the soil particles were overgrown with moss protonemata and algae.

In addition to variation in size discussed by Bruce, variations in occurrence and condition, as well as in form (Bold, 1973), of the gametophyte in relation to differences in the

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[1] Published with the approval of the Director of the University of New Hampshire Agricultural Experiment Station as Scientific Contribution No. 756.

microhabitat suggest the need for microecological studies in the field and laboratory. These would complement laboratory study of the culture and development of gametophytes of other species (Freeberg, 1962; Freeberg and Wetmore, 1957) and of the embryogeny of the sporophyte of *Lycopodium inundatum* (Bruce, 1972).

The fact that spores of *Lycopodium inundatum* germinate readily and produce green photosynthetic gametophytes which live on the surface of the soil is of potential value to biology teachers (Bierhorst, 1964) in areas where the species occurs in New England (Fig. 5; for circumpolar range map see Hultén, 1968, p. 26), for the gametophytes might be grown on artificially denuded patches of soil next to the sporophytes. Although gametophytes of mosses and ferns are readily available and commonly used for study in biology classes, few students ever see the live, fleshy gametophytes of *Lycopodium*. It is possible that careful searching in suitable locations near colonies of mature sporophytes would produce numerous live gametophytes for class use.

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Figure 1. Typical macrohabitat with abundant mature sporophytes along brook (to left) and pond (to right) of access road (center). Note area of Fig. 2 (box).

Figure 2. Microhabitat of gametophytes at edges of depression (left of center) darkened by growth of moss protonemata and algae.

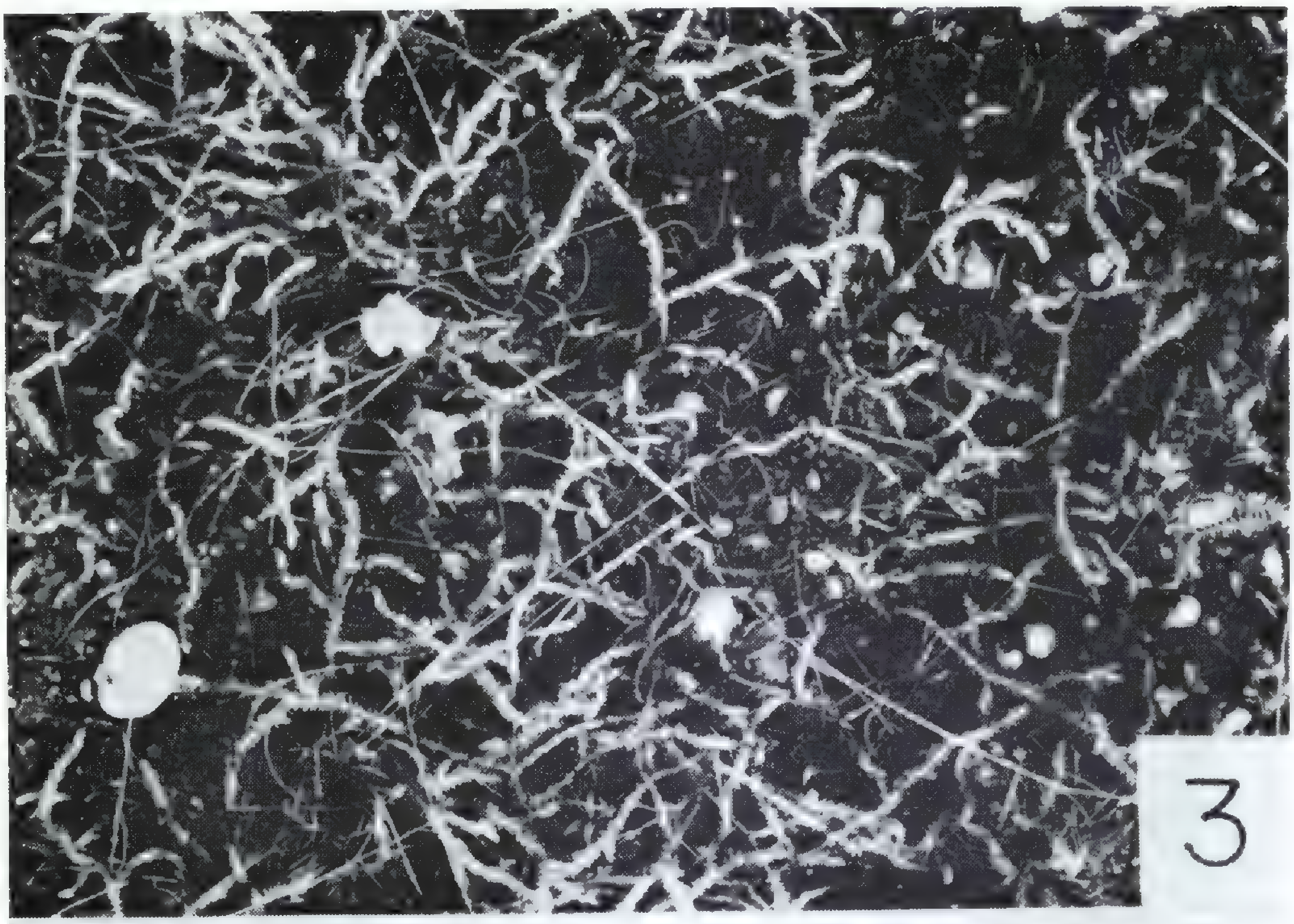

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Figure 3. Vertical view of dense mat of mature sporophytes (each branch less than one cm. thick).

Figure 4. Gametophyte bearing two young sporophytes (upper right dark area was green and minutely lobed, the remainder of the gametophyte was colorless).

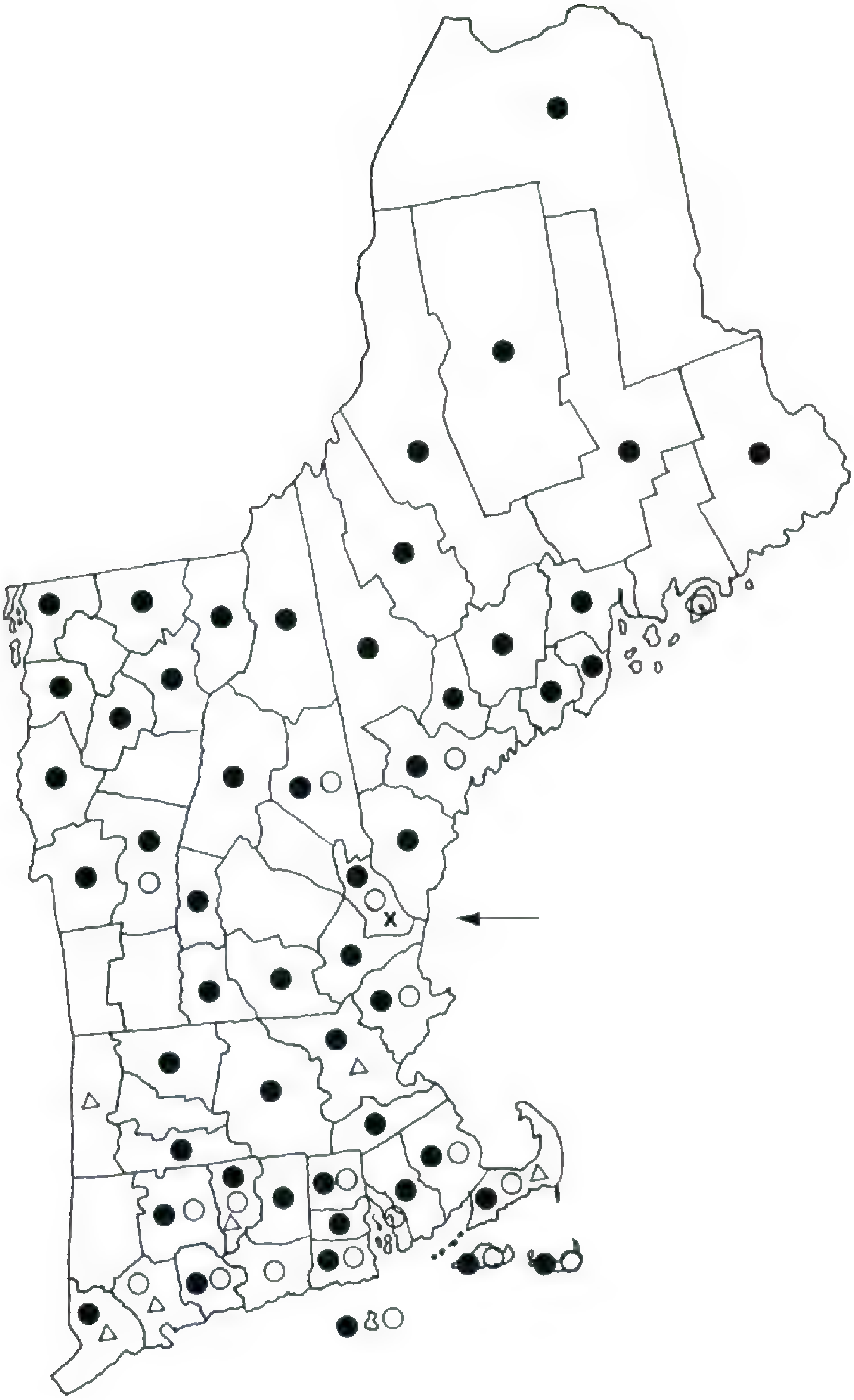

Figure 5. County distribution of *Lycopodium inundatum* varieties in New England (plotted from Seymour, 1969): var. *inundatum* (dots), var. *Bigelovii* Tuckerm. (circles), and var. *robustum* R. J. Eat. (triangles). Note site of gametophytes (x) discussed here.

NEW AND INTERESTING PLANTS FROM THE CENTRAL PLAINS STATES

LAWRENCE K. MAGRATH AND RONALD R. WEEDON

As a result of field and herbarium studies, a number of new or interesting records of plants have been found for Texas, Oklahoma, Kansas, and Nebraska. All specimens cited, unless indicated otherwise, are located at KANU.

Corallorhiza wisteriana Conrad. **Nebraska:** DAWES CO.: Chadron State Park, open ponderosa pine wooded hillside, pine needle litter, clay loam soil, two stems growing in ravine, in fruit, 14 July 1972, *Magrath & Weedon* 7620 (KANU). This collection represents an extension of the range of the coralroot southward from the Black Hills of South Dakota into the Pine Ridge of northwestern Nebraska.

Holosteum umbellatum L. **Texas:** COLLINGSWORTH CO.: 0.3 mi E of the Salt Fork of the Red River on T 203, growing in sandy soil in roadside ditch, scattered and uncommon, 10 April 1973, *Magrath & Richardson* 7936 (KANU). KENEDY CO.: 18.3 mi S of Armstrong on US 77, growing in railroad right-of-way, 20 March 1972, *Magrath, Rice & Johnston* 7225 (KANU, OKLA). This collection represents an extension of the range of the species westward from Oklahoma into the Texas Panhandle and southward from Oklahoma to the Gulf Coastal area of southern Texas.

Scleranthus annuus L. **Oklahoma:** GRADY CO.: Oklahoma College of Liberal Arts Campus (17th and Grand Avenue) in Chickasha; growing in flower bed on E side of Austin Hall; sandy soil; rare; associated with *Arenaria, Bromus* and *Holosteum,* flowers greenish-white, apetalous; 24 May 1973; *Magrath* 8032 (KANU). This collection represents an extension of the range of this species southwestward from Missouri and eastern Kansas.

Ranunculus testiculatus Crantz. **Nebraska:** DAWES CO.: Chadron State Park, 8 mi S of Chadron on Hwy #385, in campground in waste areas in shade of deciduous trees, weedy areas dominated by *Taraxacum officinale,* sandy soil, abundant, 6 June 1972, *Weedon & Gates* 7011 (KANU); *Doris Gates,* 29 April 1970. The range of this species is now known to be extended eastward into northwestern Nebraska. The above collection indicates the probable establishment of the species in abundance in this area.

Thlaspi perfoliatum L. **Oklahoma:** KAY CO.: rest area on I-35, 2.8 mi N of Blackwell-Medford Exit; clay loam soil, somewhat sandy; small area near moist drainage ditch; only one colony seen, apparently introduced; associated with *Bromus, Holosteum* and *Rumex;* 6 May 1973; *Magrath* 7969 (OKL). This collection represents an extension of the range of the species southwestward from Missouri and Kansas.

Eryngium prostratum Nutt. var. **prostratum. Kansas:** CHEROKEE CO.: 1.5 mi S of Galena on K 26, small cut-over and disturbed marshy area in Ozarkian oak-hickory woods, gravelly soil, associated with *Juncus* and sedges, apparently rare — only one plant found, prostrate vine rooting at the nodes, flowers bluish-purple, 22 October 1972, *Magrath* 7855 (KANU). This collection represents an extension of the range of the taxon westward from the eastern Ozarks of Missouri, and northward from southeastern Oklahoma.

Lactuca saligna L. f. **ruppiana** (Wallr.) G. Beck. **Oklahoma:** OKLAHOMA CO.: ca. 3 mi N of the Jct of I-44 and I-35 on I-35, a few scattered plants growing in road-cut, sandy loam soil, 5 August 1972, *Magrath* 7700 (KANU, OKL, OKLA). This collection represents an extension of the range of this taxon southwestward from Missouri and Kansas.

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A NEW DROSERA FROM VENEZUELA

J. A. STEYERMARK AND L. B. SMITH

Shortly after entering the Grand Savanna of Venezuela on the northern side we left the road to examine a sandy area with scattered small shrubs. On the patches of white sand between was a *Drosera* so small that it could easily be covered by a quarter and with so short a peduncle that the one or two flowers appeared practically sessile. This new species was such a happy augury for the Smiths' introduction to the Guayana Highland that we have christened it as follows:

Drosera felix Steyermark & Smith, sp. nov. Fig. 1.

Plantae solitariae; *caulibus* curtissimis; *foliis* dense rosulatis, patentibus; *stipulis* ad petiolum 1/3 adnatis, ad medium 3-laciniatis, membranaceis, 2.5-3 mm longis, basi vaginantibus, solidis, 1 mm latis, segmentis laciniatis anguste triangulari-lanceolatis, longe attenuatis, 1.7-2.2 mm longis, 0.2-0.3 mm latis, glabris; *petiolis* 5-5.5 mm longis, 0.7 mm crassis, supra minute papilloso-verruculosis et pilis patentibus paucicellularibus acicularibus laxissime vestitis, subtus pilis multis adpressis simplicibus acicularibus onustis; *laminis* suborbicularibus, apice late rotundatis, 3 mm longis, 2.5 mm latis, castaneo-purpureis, supra margine glandulis 2-4 stipitatis et centro glandulis subsessilibus vestitis, subtus pilis eis petioli similibus; *pedunculo* nullo vel haud ultra 2.5 mm longo, eglanduloso; *bractea* lineari-lanceolata, acuminata, 1.5 mm longa, 0.1 mm lata, ciliata; *floribus* 1-2; *pedicello* 1-5 mm longo, pilis adpresso-adscendentibus simplicibus et glandulis remotis sessilibus atropurpureis vestito; *hypanthio* cupulato-subcampanulato, 0.8 mm longo, 1.2 mm lato, pilis patentibus remotis vestito; *sepalis* 5, lanceolatis, 1.5-1.8 mm longis, sub medium 0.8 mm latis, e pilis laxis ascendentibus simplicibus paucicellularibus hirsutulis; *petalis* 5, patentibus, albis, obovatis, apice rotundatis, basi cuneatis, 2.5 mm longis, 1.5 mm latis; *stami-*

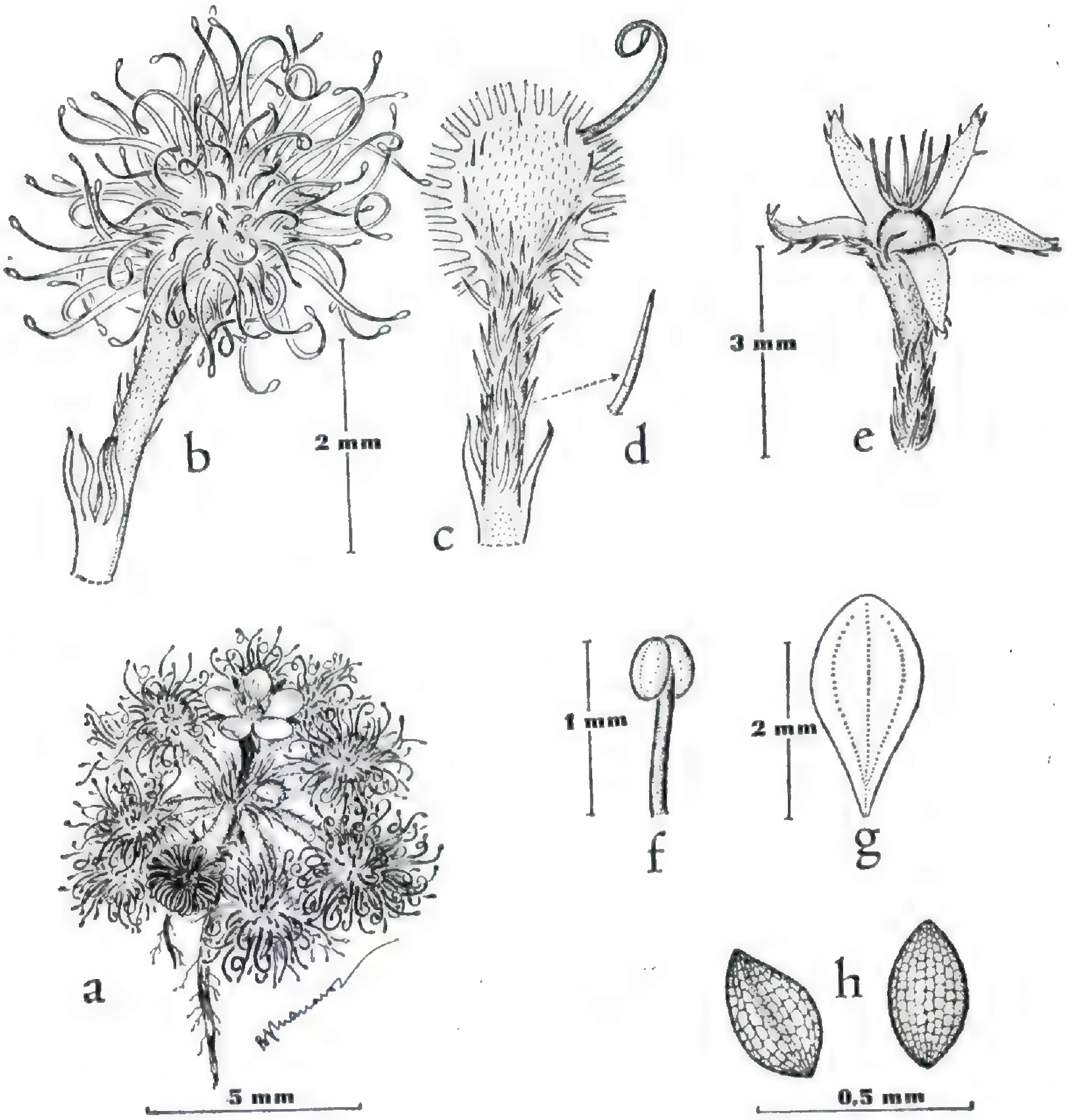

Fig. 1, a-h, *Drosera felix:* a, habit; b, single leaf (upper side); c, single leaf (lower side); d, hair detached from petiole; e, calyx and pistil with pedicel; f, stamen; g, petal; h, seed, ventral and dorsal views from left to right.

nibus 5, quam petalis brevioribus; *filamentis* 1 mm longis, glabris; *antheris* subhemisphaericis, 0.5 mm longis, 0.4-0.5 mm latis; *ovario* subgloboso, 1 mm longo, 1 mm lato, glabro; *stylis* 3, ad basim bipartitis, ramis 1.7 mm longis, glabris.

Venezuela: BOLÍVAR: Carretera El Dorado to Santa Elena de Uairen south of El Dorado, alt 1200-1400 m, 19 Feb 1972, *Julian A. Steyermark, Lyman & Ruth Smith, G. C. K. & E. Dunsterville* 105468 (holotype VEN, isotypes NY, US).

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PHENOLOGY AND PHYSIOGNOMY OF THE HYDROPHYTE COMMUNITY IN OTSEGO LAKE, N.Y.

WILLARD N. HARMAN

As part of a biological survey conducted in 1969, the species and distribution of aquatic macrophytes in Otsego Lake, Otsego Co., N.Y., were determined (Harman 1970). The 1969 information was compared with data collected by Muencher (1936) in 1935 (Harman & Doane 1970). Emergent plants were more abundant in 1969 than in 1935. The number of species present in the lake had decreased between 1935 and 1969 and an introduced species, *Potamogeton crispus* L., that was not present in 1935, was the most obvious plant in the lake in early summer of 1969. The reduction in species in this lake is similar, although not as pronounced, as changes observed over 50 years in Oneida Lake, N.Y. (Harman & Forney 1970) and over 70 years in Put-in-bay Harbor, Lake Erie, Ohio (Stuckey 1971).

During the summer of 1969 it was noted that the zoobenthos and zoo-meroplankton populations underwent drastic fluctuations that correlated with the phenology of the aquatic macrophytes and the seasonal changes in the physiognomy of the plant community. A study was initiated to more accurately determine the composition of the flora at various times during the year so that we could quantitatively ascertain its effects on the associated fauna. The purpose of this report is to describe the seasonal changes in the appearance of the littoral zone in Otsego Lake at Rat Cove, at the SUNY Oneonta Biological Field Station at Cooperstown, New York.

METHODS

In 1970, a transect about 500 m long was plotted from the end of our docks through the littoral zone, to the deeper water beyond. Plants growing along this line were measured by divers each week, from 1 June through 2 September, to determine the emergence time of the spring cohorts, greatest maximum heights attained, times of flowering, and times of death and decomposition of each species (Harman 1971). Because all growth represented even-aged stands, sufficient data were obtained by measuring the tallest individual plants of each species each week. It was impossible to measure the same individuals throughout their existence because the act of measurement disrupted, if not destroyed these fragile organisms. Also, movements along the transect disturbed the sediments so that by the end of September we had to move farther and farther away from the original line in order to measure plants in an undisturbed environment. Secchi transparency and surface water temperatures in Rat Cove were recorded from 15 June through 25 August.

In 1971 the same procedures were followed with these changes and additions. Samples were taken through the ice on 5 February. Weekly observations were initiated shortly after the ice breakup (22 April) and continued until 16 December after all plants had completed their seasonal growth. The transect was marked with an anchored hand line for divers to follow in order to alleviate the problems of getting lost in the often turbid water as had happened a few times in 1970. Secchi transparency and surface water temperatures in Rat Cove were recorded weekly from 10 May 71 until 3 January 72.

Samples of benthic organisms were taken near the transect at depths of 1-2 m, 3-5 m, and 6-8 m each week, to determine and correlate seasonal changes of the macrobenthos with those of the aquatic plants. Likewise, number 20 plankton nets were carried by divers through the macrophytes occurring at 1-2 m, 3-5 m, and 6-8 m depths each week, to correlate the successional changes in the zooplankton community associated with them. The data resulting from these observations will be reported in a manuscript now in preparation.

Surface temperatures were essentially the same for both 1970 and 1971 (high = 24°C; mean for June, July, and August = 21.0 and 21.2°C, respectively). Mean Secchi transparency for June, July, and August was 4.4 m in 1970 and 4.3 in 1971. One appreciable difference in transparency was noted in June, the time that many of the plants were growing most actively. In 1970 the mean Secchi transparency was 5.3 m, in 1971, 4.2 m (Harman 1972).

PHENOLOGY AND PHYSIOGNOMY

The zonation of hydrophytes according to water depth, i.e., emergents, floating leaved varieties, and submergents (e.g., Sculthorpe 1967), is common knowledge. The components of the submergent macrophyte flora also occur in similar patterns, presumably because of the varying compensation points of each species relative to decreasing light intensity in deeper water, or to their growth in the shade of other species, and to the severe competition for space on eutrophic littoral substrates.

In any one area along the Rat Cove transect, between 50 cm and 550 cm in depth, several species of hydrophytes usually occur. This often results in a complex physiognomy exhibiting an overstory (usually of low density), a moderately dense intermediate stratum, and a low, very dense understory, although up to 7 distinct strata may be present. Vertical stratification of the community is continually changing during the growing season as the various species of macrophytes emerge from the substrate, attain maximum height and density, and then decompose.

The shallowest waters along the transect are barren because of the action of the waves on the shore. *Nuphar variegatum* Engelm., the yellow water lily, grows in scattered clones in water from 20 to 60 cm in depth in association with *Elodea canadensis* Michx. and *Megalodonta Beckii* (Torr.) Greene. Water from 50 cm to 500 cm in depth maintains all the remaining macrophytes studied except for *Nitella flexilis* (L.) C. A. Agardh and *Potamogeton crispus* which occur in water from 500 to 700 cm in depth.

The growth of macrophytes in 1971 was similar to that observed in 1970 with the following exceptions: *Potamogeton crispus, P. Richardsonii* (Ar. Benn.) Rydb., and *P. illinoensis* Morong reached heights of approximately 300 cm in 1970, but attained less than 250 cm in 1971 before decomposition began. In 1969 and 1970 *Potamogeton crispus* reached the surface in some areas of the lake forming dense beds that hindered navigation, but did not reach the surface anywhere in 1971. After the spring cohort of the pond weeds mentioned died back in 1970, comparatively few scattered plants were observed during the rest of the summer. In 1971, after the first cohort decomposed, many individuals resumed growth and died back sporadically until October.

The following are descriptions of the phenology and physiognomy of the plants at 4 sites (0.5 m, 2.0 m, 4.0 m, and 5.5 m in depth) along the transect (Fig. 1).

WATER DEPTH 0.5 M: *Nuphar variegatum* emerged from the substrate the first week in May; by 15 June, 1971 the leaves had reached the surface. They remained there until decomposed in early September. *Elodea canadensis* and *Megalodonta Beckii* started their seasonal growth in late April and the middle of May respectively. They maintained a maximum height of about 30 cm beneath the *Nuphar* during August. By 15 September *M. Beckii* had collapsed to the bottom and was decomposing. At the same time, *E. canadensis* started to decompose from the base and the entire plants became very brittle. By 15 November the

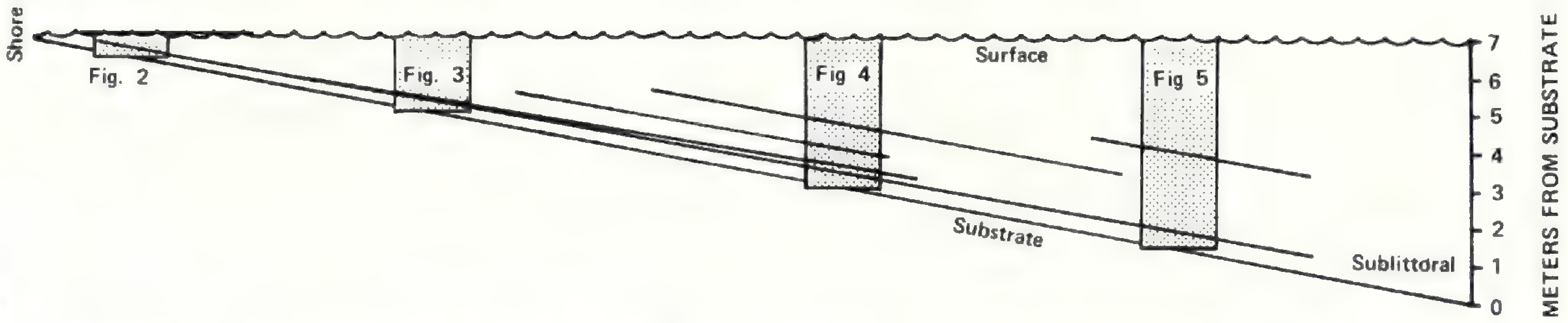

Figure 1. Diagrammatic profile of Rat Cove transect showing locations of figures 2-5. Horizontal lines indicate heights of dominant vegetation on July 15, 1971.

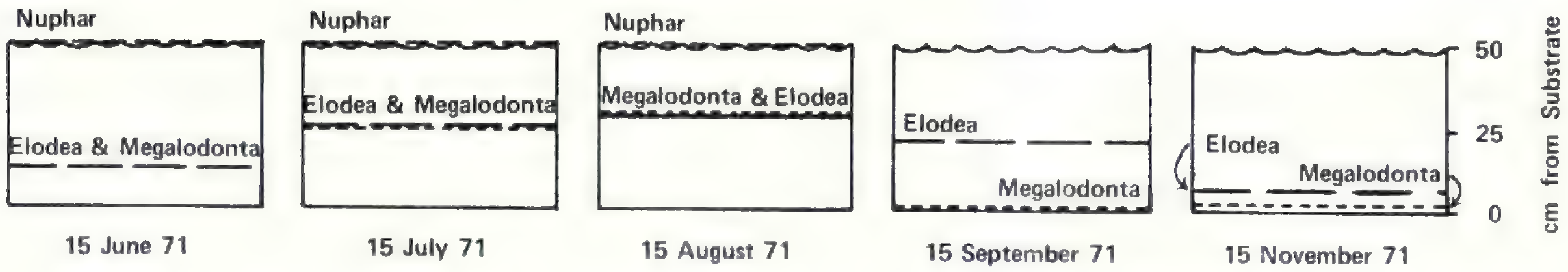

Figure 2. Water column 0.5 m in depth in Rat Cove, Otsego Lake, showing heights of abundant hydrophytes at selected dates. – – – = diffuse canopy: ——— = dense canopy.

winter condition was reached. *Megalodonta Beckii* and *E. canadensis* were prone on the bottom with winter buds 1 to 2 cm long developing at the nodes.

During July and August, two obvious layers of vegetation were present, *Nuphar variegatum* at the water's surface and *Elodea canadensis* and *Megalodonta Beckii* below. From autumn into the winter there were no actively growing macrophytes at this site. Figure 2 illustrates these changes at five selected dates during the year.

WATER DEPTH 2.0 M: This site was always dominated by dense stands of *Chara vulgaris* L. Only in June was *Megalodonta Beckii* able to emerge above this species. *Elodea canadensis* occurred only slightly higher than the *Chara* in June, July, and August before dying in the fall. In late August and early September *Najas flexilis* (Willd.) Rostk. & Schmidt was present, but never grew higher than the *Chara*. During August and September there were two definite vegetational strata present. A diffuse overstory of *Vallisneria americana* Michx. and *Myriophyllum exalbescens* Fern. occurred above *C. vulgaris*. With the decomposition of *V. americana* and *M. exalbescens* in November, only *Chara* remained.

The first week in May dense stands of *Chara vulgaris* were at their lowest height of the entire year. *Chara* grew steadily until the middle of November, when the plants started to decrease in size, presumably from basal decomposition, since the apices remained healthy all winter. *Megalodonta Beckii* and *Elodea canadensis* started growth at the same time as in the shallower water but attained somewhat greater heights. *Megalodonta Beckii* reached approximately 35 cm in height in August, decomposing in September. *Elodea canadensis* attained about 75 cm in height in early September and then began decomposing. *Myriophyllum exalbescens* appeared in early May, grew steadily until September and then fell to the bottom with new shoots appearing at the nodes. *Vallisneria americana* emerged from the substrate the middle of June, grew more rapidly

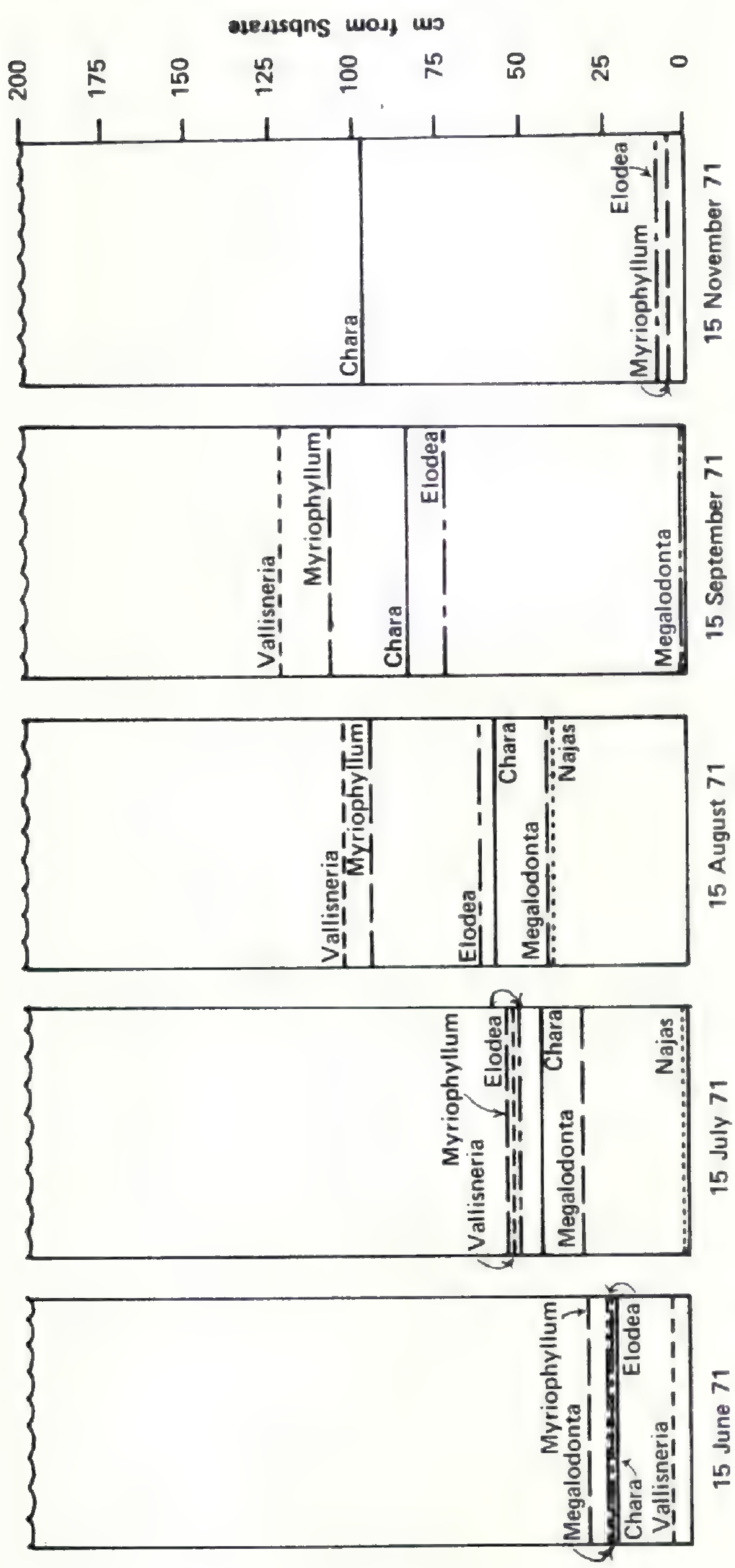

Figure 3. Water column 2.0 m in depth in Rat Cove, Otsego Lake, showing heights of abundant hydrophytes at selected dates. - - - = diffuse canopy: ——— = dense canopy.

than its competitors, attaining its maximum height of about 125 cm in September, and then rapidly decomposed. *Najas flexilis* emerged from the substrate in the middle of July, grew rapidly to about 60 cm high in early September and disappeared. Figure 3 shows the strata in 2.0 m of water at various times during 1971.

WATER DEPTH 4.0 M: As at the 2 m site *Chara vulgaris* grew in dense beds at a consistent rate throughout the summer. *Elodea canadensis* was present until August as before. Early in May *Potamogeton pusillus* L., *P. zosteriformis* Fern., *P. Richardsonii,* and *P. illinoensis* emerged from the substrate. By 15 July *P. Richardsonii* and *P. illinoensis* attained about 200 cm in height while *P. pusillus* and *P. zosteriformis* reached only about 100 cm heights. All of the species of *Potamogeton* were decomposing by August, although a second cohort of *P. Richardsonii* remained until early September. In late May, *Heteranthera dubia* (Jacq.) MacM. emerged from the substrate and maintained steady growth until late September when it collapsed to the substrate.

In June the morphology of the plant community was very complex with 7 species of actively growing hydrophytes all at different heights in the water column. By July 3 obvious strata were present: a diffuse overstory composed of *Potamogeton Richardsonii* and *P. illinoensis,* a discontinuous stratum of intermediate height composed of *P. pusillus* and *P. zosteriformis,* and a dense understory of *Chara, Elodea* and *Heteranthera.* In September this same area was entirely different in appearance with 2 major strata present. There was a rather dense overstory of *Heteranthera dubia* underlain by *Chara vulgaris.* By November the *Chara* was all that remained. Figure 4 illustrates the physiognomy at this depth at several selected dates.

WATER DEPTH 5.5M: In these deeper waters *Nitella flexilis* replaced *Chara vulgaris.* Dense beds attaining 95 cm occurred in this area. The only macrophyte associated with this alga was *Potamogeton crispus,* which ap-

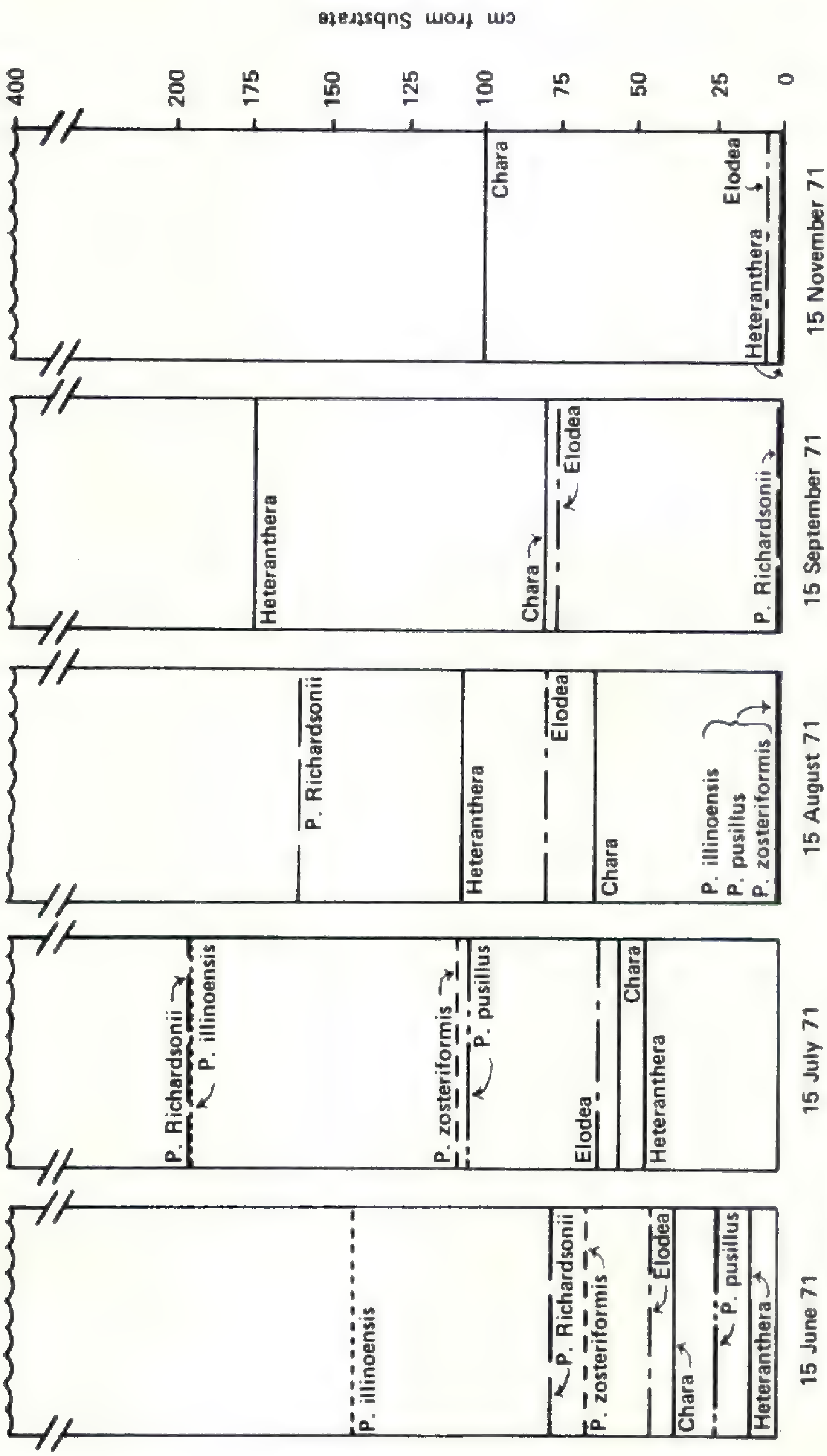

Figure 4. Water column 4.0 m in depth in Rat Cove, Otsego Lake, showing heights of abundant hydrophytes at selected dates. - - - = diffuse canopy: ——— = dense canopy.

peared from the substrate the first week in May. The latter species grew extremely rapidly, attaining about 250 cm in height by the middle of July. It then collapsed to the substrate and decomposed.

In June and July two definite layers of vegetation were present at these depths. *Potamogeton crispus* formed a diffuse overstory while *Nitella flexilis* composed a dense understory. From August on into the winter *N. flexilis* was the only species present at the site (Fig. 5).

The macrophytes studied can be separated into four groups according to their morphology during the winter season. These characterize the appearance of the substrate during this period and provide food and cover for the local benthos. Group 1. *Chara vulgaris, Nitella flexilis.* Once maturity is reached the oldest parts of these algae are continually decomposing. During the winter period entire stands decrease in height as the rate of decomposition greatly exceeds the rate of growth. The apical meristems remain in a healthy condition throughout the year. In early spring much new growth is added from germinating oospores that cannot be distinguished from the older plants remaining during the same time periods. Group 2. *Myriophyllum exalbescens, Elodea canadensis.* When these organisms decompose (late September and late August, respectively), the old growth lays on the substrate and winter buds, 2-3 cm in height, appear at once from the nodes. These grow extremely slowly over the winter reaching 4-6 cm by early May. At that time the roots have become established, internodal tissues from the parent plants have rotted away and the new plants grow rapidly until the fall when the process is repeated. Group 3. *Heteranthera dubia.* Like the organisms in Group 2, this plant collapses to the bottom in a living condition (in mid-October) but the new shoots do not appear at the nodes until late May or early June of the next year. They grow rapidly until fall and the cycle begins again. The parent stems remain intact throughout much of the growing season. Group 4. *Potamogeton crispus, P. Richardsonii, P. illinoensis, P. zosteriformis, P.*

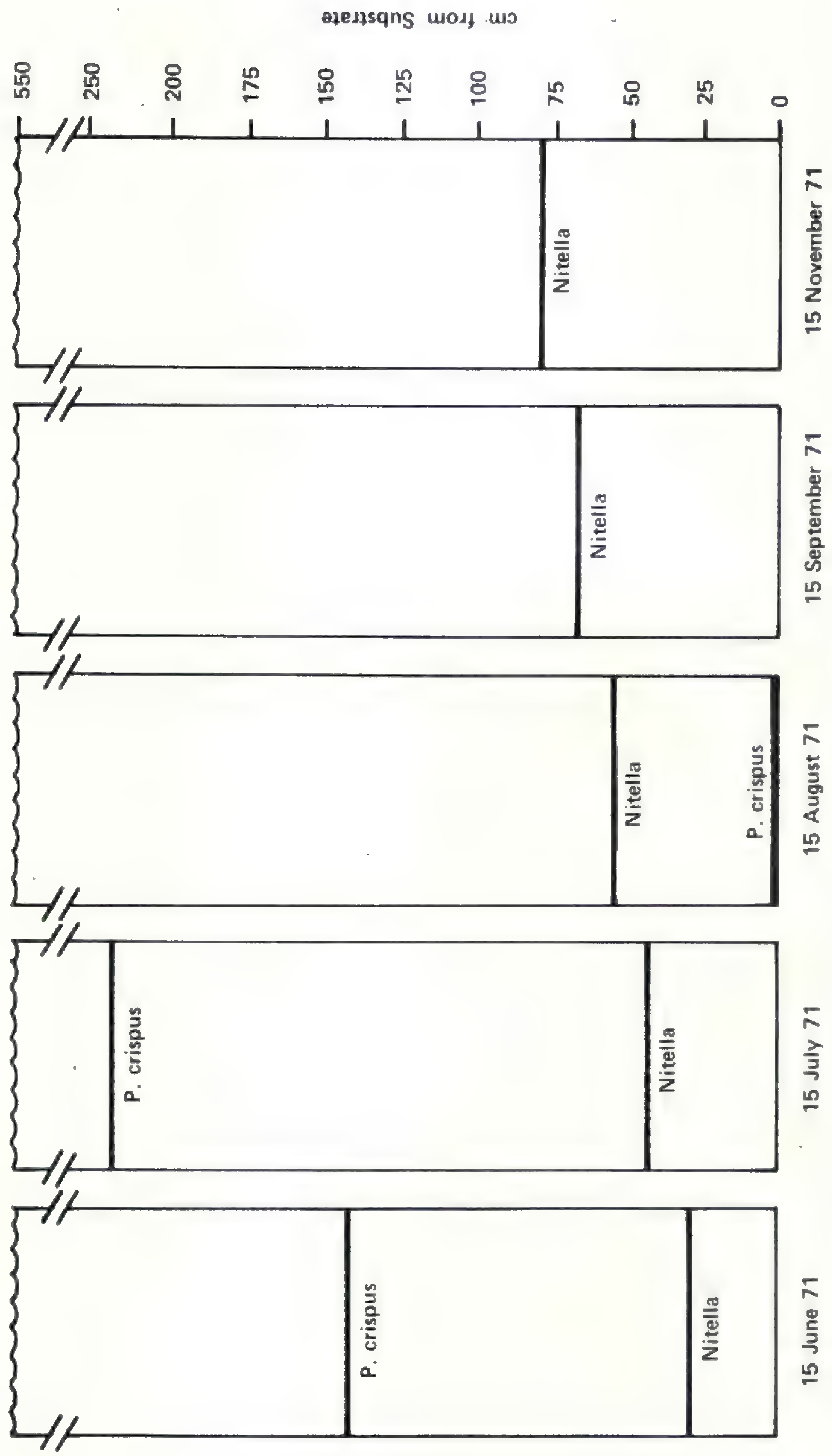

Figure 5. Water column 5.5 m in depth in Rat Cove, Otsego Lake, showing heights of abundant hydrophytes at selected dates. - - - = diffuse canopy: —— = dense canopy.

pusillus, Vallisneria americana, Najas flexilis, Megalodonta Beckii, Nuphar variegatum. This group contains all the remaining plants studied. These macrophytes grow rapidly from buried winter buds or underground stems or rootstocks and then decompose, shoots not appearing above the substrate until the next growing season.

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PANICUM ENSIFOLIUM BALDW.— NEW FOR MEXICO

MELVIN L. CONRAD

During the summer of 1972 a survey of grasses (Conrad, *et al.*, 1972) was conducted for the Food Agriculture Organization of the United Nations at the Instituto Tecnológico y de Estudios Superiores de Monterrey which is developing a range management experiment station near Tempoal, Veracruz. On July 19th the group of investigators accompanied the coordinators of the program, Dr. Donald Huss and Ing. Edmundo L. Aguirre, on an excursion south of Tempoal toward Molango, Hidalgo, to observe the cloud forest vegetation (Leopold, 1950) near the crest of the Sierra Madre Oriental. At a point 95.2 km. from Tempoal, before reaching Molango, the caravan of two automobiles stopped at a small parking area on the steep mountain slope to turn around due to heavy fog, rain, and an increasing number of fallen boulders on the highway. In the parking area I was observing a tree fern (*Cyathea* sp.) that grew beside the bluff from nearly 10 meters below; and after a moment, I realized that I was standing in a shallow wet depression about 5 meters in diameter that was filled with a *Panicum* different from several species that had been collected at lower elevations. Collections were taken.

In the laboratory the grass from the parking area on the mountain was identified as *Panicum ensifolium* Baldw. Intermixed with it was *P. cordovense* Fourn., (Hitchcock and Chase, 1910). Other species associated with these were *Juncus dudleyi* Wieg., *Carex festucacea* Schkuhr, *Agrostis perennans* (Walt.) Tuckerm., and *Sporobolus poirettii* (Roem. & Schult.) Hitchc.

It was first hypothesized that this population of *P. ensifolium* had been introduced, due to the considerable distance separating this station from its previously reported range in the southeastern United States, (Hitchcock, 1950). However, it is likely to be native, since reports by Sharp (1946) of disjunction in other taxa indicate similar affinities between the floras of these two regions.

The assistance of Dr. A. A. Beetle at the University of Wyoming for verification of the identification, and the confirmation by both Dr. Beetle and Dr. Arturo Gómez-Pompa at the Instituto de Biologia in Mexico City that *P. ensifolium* is new for Mexico is hereby acknowledged with deep appreciation. Thanks are also due Dr. David B. Dunn for the use of the herbarium at the University of Missouri.

Voucher specimens of *P. ensifolium* Baldw. (No. FAO Z-101) are deposited in herbaria at the Departamento Zootécnia, I.T.E.S.M., in Monterrey, México, Northeast Missouri State University, University of Missouri at Columbia (UMO), and The University of Wyoming (RM).

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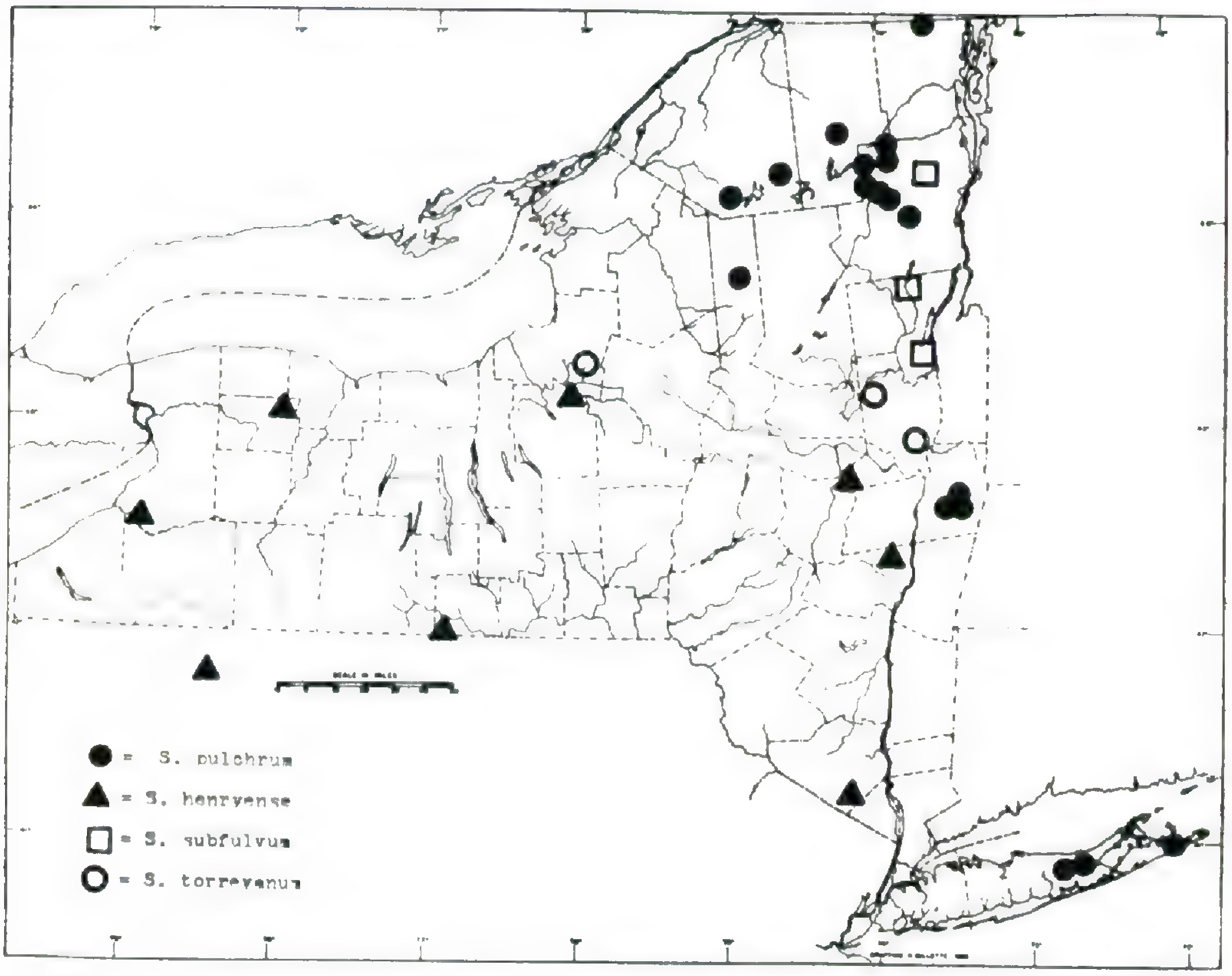
SIGNIFICANT NEW DISTRIBUTIONAL RECORDS FOR THE GENUS SPHAGNUM IN THE NORTHEASTERN UNITED STATES

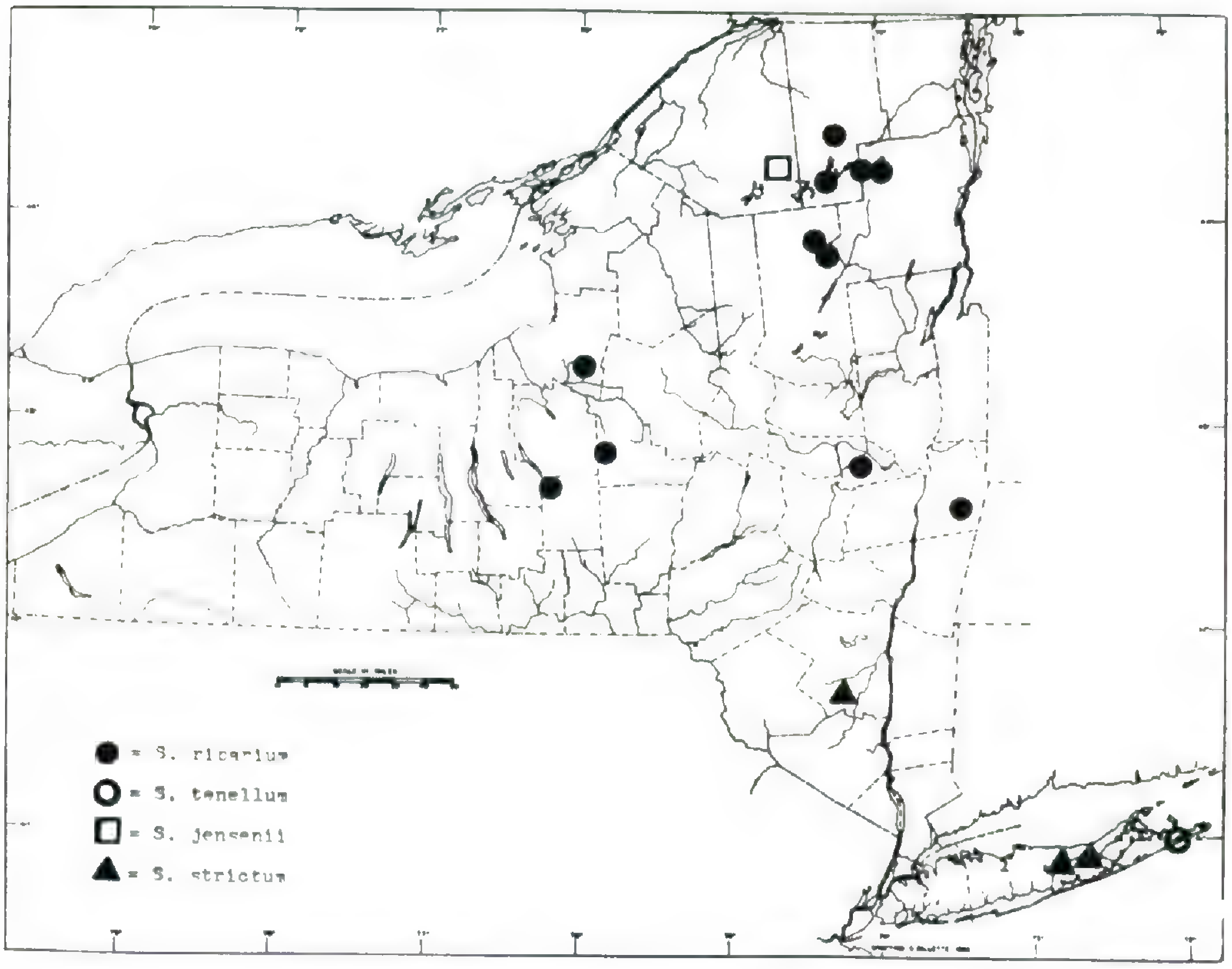
RICHARD E. ANDRUS

Recent collecting and herbarium studies reveal interesting new distributional records for several species of *Sphagnum* in the northeastern United States. Most of the records are from New York, and these are presented on the accompanying maps. Collection numbers, unless otherwise indicated, are those of the author. Duplicates for most stations collected by the author are at NYS, and many are also at NY and SU-CF (=S.U.N.Y. College of Environmental Science and Forestry).

Sphagnum henryense Warnst. A more difficult taxon than the literature would indicate, *S. henryense* has frequently been mistaken for *S. palustre* L., *S. papillosum* Lindb., or *S. imbricatum* Russow. Forms of *S. henryense* lacking the characteristic worm-like ridges on the hyaline cell walls where they overlie chlorophyll cells are especially difficult to identify. Such forms can usually be separated from the very similar *S. palustre* by the pore characteristics of the convex surface of the branch leaf. In *S. henryense*, the hyaline cells have numerous small round pores along the commissures, often 10 to 20 per cell, and usually lack large membrane gaps near the leaf apex. *S. palustre*, on the other hand, has hyaline cells with fewer and more elliptic pores as well as membrane gaps near the leaf apex. Macroscopically, well developed forms of *S. henryense* may be recognized by their reddish-brown pigmentation (often visible in the capitulum) and a flattened capitulum with small pointed head branches. In contrast, *S. palustre* is browner and typically has a rounded capitulum with the head branches blunter and more obese.

Sphagnum henryense is fairly widespread near the coast from Long Island, N.Y. (Ketchledge 1957) south to Florida


● = S. pulchrum
▲ = S. henryense
□ = S. subfulvum
○ = S. torreyanum


● = S. riparium
○ = S. tenellum
□ = S. jensenii
▲ = S. strictum

and westward to Texas. The Massachusetts station reported here represents a northward extension of this coastal range.

The inland stations extending into western New York and Pennsylvania are more surprising, however, but can be considered, perhaps, as analogous to similar vascular plant distributions noted by Fernald (1937). On this basis, one might expect to find *Sphagnum henryense* in other Great Lakes states such as Ohio and Michigan as well as southern Ontario.

In comparing *Sphagnum henryense* and *S. palustre* from inland stations, one particularly interesting pattern emerges. Where it is found, *S. henryense* is normally an obvious and abundant member of its plant community. *S. palustre,* on the other hand, although found at many more inland locations, typically occurs as a minor vegetational element, usually as a few scattered hummocks. Limited observations on Long Island indicate the same pattern may also hold in coastal areas. The factors responsible for this difference are unknown.

New York: ERIE CO.: Collins, *Glowny* 10850, 10848 (NYS). GENESEE CO.: Bergen Swamp, *Durand* 3642, 3624 (CU), *Winne* 1590 (CU), *S. J. Smith* 47742, 47982 (NYS). CHEMUNG CO.: Winter Bog, 1594, 2168, 2170, *Winne* 2094, 2083 (NYS). ONONDAGA CO.: Cicero Swamp, 2852. SCHENECTADY CO.: Featherstonhaugh Lake, 2142, 2146. GREENE CO.: Grapeville, *S. J. Smith* 48750 (NYS). ORANGE CO.: Sterling Forest, *G. L. Smith* 2666 (NY). CATTARAUGUS CO.: St. Bonaventure Campus, *Boehner,* Aug. 1, 1940 (St. Bonaventure Coll.). **Massachusetts:** SUFFOLK CO.: Milton, *Eaton & Faxon,* Sphagna Boreali-Americana #159. **Pennsylvania:** MCKEAN CO.: Smethport, *Glowny* 12007.

Sphagnum portoricense Sull. The previously known northern limit for *S. portoricense* was on Long Island, N.Y. (Mapes 1962). The northern range extreme is now extended to Mt. Desert Island, Maine, where a collection was made at a site strikingly different from those at the stations formerly thought to be the most northerly. On Long Island and in New Jersey (Andrews 1912) *S. portoricense* is aquatic in nature, being confined to shallow sandy-bottomed ponds. On Mt. Desert Island it was clearly non-aquatic, with the plants being found at the margin of Big Heath, a large open bog, where they formed a carpet well above the water table along a small water course in the shade of black spruce. One possible explanation may lie in the high humidity characteristic of Big Heath, which is situated very near the coast and often shrouded in fog. *S. portoricense* also forms non-aquatic carpets in the very humid environment of the high-elevation cloud forests of Puerto Rico.

Maine: Mt. Desert Island, Big Heath, 2030.

Sphagnum strictum Sull. The discovery of *S. strictum* in New York was not unexpected because of its occurrence northward and southward along the Atlantic coast (Maass 1966). The record from the Shawangunk Mountains of upstate New York is, however, unusual in view of the close affinity for the coastline that *S. strictum* exhibits in the northern part of its range (Maass 1966).

Sphagnum strictum, like the closely related *S. compactum* DC., is a pioneer species. It is found on more organic and shaded substrates than the latter species.

New York: ULSTER CO.: Lake Minnewaska, *S. J. Smith* 48953 (NYS). SUFFOLK CO.: Riverhead, Third Pond, *Latham* 34419 (CU, NYS); Sandy Pond, 2251, 2205, 2193, *Mapes* 1435 (NYS); Swan Pond, *S. J. Smith* 48158 (NYS); Manorville, *Latham* 33936 (NYS, CU).

Sphagnum torreyanum Sull. (*S. cuspidatum* var. *torreyi* (Sull.) Braithw.). *Sphagnum torreyanum* is reported here for the first time from upstate New York. Like *S. henryense,* it was previously known only from coastal locations, in this case from Newfoundland to North Carolina (Andrews 1938).

In upstate New York, as on Long Island, it occurs as an aquatic in poor fens, often intermixed with *S. cuspidatum* Hoffm.

New York: OSWEGO CO.: Kibbe Lake, 1521, 1610. SARATOGA CO.: Mulleyville Pond, *S. J. Smith* 46881, 46882 (NYS); Luther's Woods, 2163.

Sphagnum riparium Ångstr. The range of *S. riparium*, previously reported southward to New Hampshire, Michigan, Wisconsin, and Washington (Andrus & Layser 1971), is now further extended into New York. A robust northern species, it typically grows in moderately minerotrophic sites near the margins of poor fens associated with such *Sphagnum* species as *S. angustifolium* (Russow) C. Jens., *S. fallax* (Klinggr.) Klinggr., and *S. fimbriatum* Wils. Present collecting data indicates that *S. riparium* is a very minor element in New York mire vegetation.

New York: ESSEX CO.: Raybrook Bog, 1661; Peninsula Nature Trails, 2152. FRANKLIN CO., Upper St. Regis Lake, 1707; 0.6 mi. E. of Corey's, 2816. HAMILTON CO.: 4 mi. S. of Long Lake, 1969; Johnny Mack Bk. fen, 2846. OSWEGO CO.: Kibbe Lake, 1528, 1529. CORTLAND CO.: Little York Lake, 2795. MADISON CO.: Nelson Swamp, 2778. SCHENECTADY CO.: Featherstonhaugh Lake 2134. RENSSELAER CO.: Round Pond outlet, 1884; ¼ mi. NE. of Round Lake, 1914.

Sphagnum pulchrum (Braithw.) Warnst. A suboceanically distributed species, in eastern North America *S. pulchrum* is known from the arctic (Persson & Sjörs 1960) south along the coast to New Jersey (Andrews 1938) and inland around the Great Lakes to Michigan (Crum & Miller 1969) and Wisconsin (Andrews 1938). The only previous New York report (Ketchledge 1957) is from Big Moose Station, Herkimer Co. (Peck #45, NYS). The numerous New York records are not unexpected and fill in the known distributional pattern.

Sphagnum pulchrum is a characteristic poor fen species and occurs in both mire wide and mire edge vegetation, often in abundance. Typical associated *Sphagnum* species include *S. papillosum, S. majus, S. fallax, S. angustifolium* and *S. rubellum.*

New York: CLINTON CO.: Cannon Flatrock, 1997a. FRANKLIN CO.: Upper St. Regis Lake, 1808, 1811, 1346, 1725. ST. LAWRENCE CO.: Sevey Pond, 1978; Wanakena, 1481; Grass River Flow, 1990; 1 mi. E. of Sevey Corners, 1967, 1968. ESSEX CO.: Algonquin Peak, 1245, 1246, 1247, 1248, 1249; Raybrook Bog, 1283, 1288, 1671, 1282, 1821; Lower Cherry Patch Pond, 1389; Whiteface Mt., 1215; Lake Tear, 1333; between Scott and Wallface Ponds, 1351; near Scott Pond, 2425; Elk Lake, *Phelps* 100 (NYS). HERKIMER CO.: Big Moose Sta., *Peck* 45 (NYS). RENSSELAER CO.: Sand Lake, *Peck* 43 (CU, NYS); 1.5 mi. E. of Taborton, 2175, 2176, 2177, 2178; Bucks Corners, 1922. SUFFOLK CO.: Napeague Beach, 2357; 1 mi. E. of Manorville, 2867; Cedar Pond, *N. G. Miller* 6865 (NCH).

Sphagnum jensenii H. Lindb. (*S. annulatum* var. *porosum* (Schlieph. & Warnst.) Maass & Isov.). A far northern species, *S. jensenii* is noted for the first time for the U.S. east of Michigan (Maass 1967b). The collection site was at the margin of a large poor fen where it was growing in a shallow pool in the bog mat associated with *S. pulchrum*, *S. papillosum*, *S. subsecundum* Nees, *S. flexuosum* Dozy & Molk and *S. rubellum* Wils. Maass (1967b) gives an excellent account of the separation of *S. jensenii* from closely allied species.

New York: ST. LAWRENCE CO.: Sevey Pond, 2829, 2832, 2833.

Sphagnum tenellum (Brid.) Brid. *Sphagnum tenellum* was collected among sand dunes in a small bog pocket where *S. pulchrum* was also found. As in the case of *S. strictum*, this report fills a coastal distribution gap between Maine and New Jersey.

Wet hollows in ombrotrophic mires are the most frequent habitat of *Sphagnum tenellum*. Although such sites are found elsewhere on Long Island, they are devoid of the species. Lack of suitable habitat, therefore, is an unlikely explanation for its rarity on Long Island. Climatic factors are probably responsible, since on Long Island *S. tenellum* is very near the southern extreme of its eastern North American coastal distribution — this extreme being in New Jersey.

New York: SUFFOLK CO.: Napeague Beach, 2238.

Sphagnum subfulvum Sjörs. The single previous conterminous U.S. report for *S. subfulvum* is from Michigan (Crum & Miller 1969). It undoubtedly reaches its southern range limit in New York. The only other published records for North America (Maass 1967a) give a range of "Greenland to Bay of Fundy and N. Ontario and from Alaska into western Yukon."

The collection sites were medium to rich fens, uncommon mire types in New York, and this may account for its extreme rarity in the state. A plant that typically forms low to medium hummocks, *Sphagnum subfulvum* was found associated with *S. warnstorfii* Russow, *S. contortum* K. F. Schultz, *S. centrale* C. Jens., *Scorpidium scorpioides* (Hedw.) Limpr., *Calliergonella cuspidata* (Hedw.) Loeske and *Campylium stellatum* (Hedw.) C. Jens. — all common rich mire species.

Sjörs' (1944) original species description contains an excellent discussion on the distinction of *Sphagnum subfulvum* from the similar *S. subnitens* Russow & Warnst. and *S. flavicomans* (Card.) Warnst.

New York: ESSEX CO.: Lost Pond, 1475. WARREN CO.: Rush Pond, 1860, 1865; Glen Lake, 1854, 1885, 1889, 1886, 1890; Jenck's Swamp, 2815.

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ENVIRONMENTAL CONTROL OF NEEDLE CHARACTERISTICS IN SUBALPINE BLACK SPRUCE

BRIAN F. CHABOT[1,2]

Two distinct forms of *Picea mariana,* one upright and the other more or less prostrate, exist in the vicinity of treeline on several New England mountains. Characters distinguishing the two types were discussed by Teeri (1969) in establishing the varietal status of *Picea mariana* (Mill.) BSP. var. *semiprostrata* (Peck) Teeri. Individuals of this taxon are recognized by their prostrate growth form, lack of a dominant upright axis, and short, glaucous needles that are slightly adaxially curved. The most prominent character other than the growth form is the needle length. Needles average 4 mm. (2.2 to 5.5 mm.) in length in the prostrate form as compared with upright individuals that have needles averaging 7.5 to 8.5 mm. The study reported here indicates that needle characteristics and, perhaps, other features of the prostrate variety are subject to considerable modification by the environment.

Plants were collected during late August and September 1972 from Lion's Head (1450 m.) and Cape Horn (1280 m.) on Mt. Washington, N.H., and in Bear Swamp, Wolcott, Vt. (340 m.). Both upright and prostrate forms were collected at the treeline sites on Mt. Washington. Only the typical form was obtained from Wolcott. Individual plants from all populations were transferred to a commercial potting mixture (Jiffy Mix) and grown in a cool greenhouse (10 to 20°C). All individuals were watered daily and fertilized weekly with a 20-20-20 nutrient solution (Universal Chem-

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ical Co.). Buds expanded during April, and both the new needles and the previous year's needles produced under natural conditions were analyzed in early July. Fifty needles were selected from each indicated age class on three separate individuals from each of the populations studied. The samples were pooled according to age class and source population. A final sample of 100 needles was taken from each pooled sample for actual measurement. Length measurements were taken to the nearest 0.1 mm. Photographs of sample individuals were also taken.

New growth needles of the short needle var. *semiprostrata* contrasted dramatically in length compared with growth which had occurred under natural conditions (Fig. 1). The new growth needles were not only longer by about 5 mm. (Table 1), but they were darker green in color and had no pronounced curvature. New needles of the other populations of *Picea mariana* also had a healthier appearance than the naturally produced needles, but, otherwise, differences in needle length were not at all pronounced (Fig. 1, Table 1).

Average needle lengths along with standard deviations are presented in Table 1. Tests for significance were applied using the analysis of variance technique. The natural needle length (short form) of var. *semiprostrata* was significantly different (5% level) from the other sample lengths including the needles produced in this variety under cultivation. The needle lengths resulting from cultivation of all three populations were not significantly different.

Table 1. Average needle length and standard deviation for three populations of *Picea mariana*.

Source Elevation (m.)	Needle Length (mm.)	
	Natural	Cultivated
A) 1450 (var. *semiprostrata*)	4.5 ± 0.54	9.4 ± 1.2
B) 1450 and 1280 (var. *mariana*)	8.5 ± 0.97	8.1 ± 1.2
C) 340 (var. *mariana*)	6.4 ± 0.73	8.5 ± 1.3

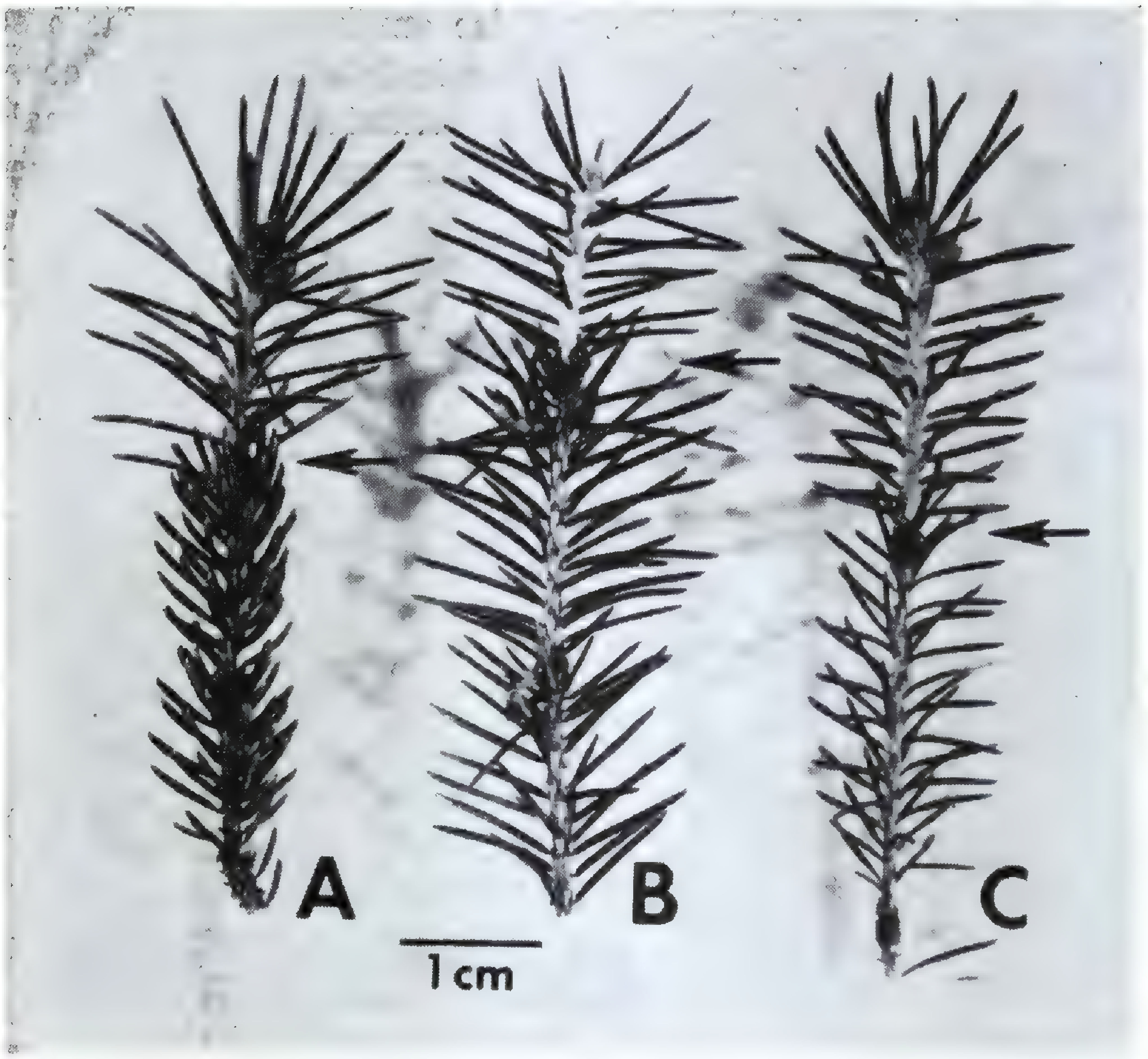

Figure 1. Branches of *Picea mariana* with needles produced naturally (below arrow) and under cultivation (above arrow). Sources of the original populations are: A) 1450 m., Mt. Washington, var. *semiprostrata*; B) 1450 m., Mt. Washington, long-needle form; and C) 340 m., Bear Swamp.

The results indicate that needle length in var. *semiprostrata* is under some degree of environmental control. Needle curvature is also capable of being modified. Curvature appears to be related to needle length in that the shorter needles (less than 5 mm.) of all populations had varying degrees of adaxial bending, while the longest needles were most frequently straight. Modified needle growth in black spruce under cultivation has previously been observed, but not fully reported (Kozlowski, 1971;

R. Pike, pers. comm.). The precise environmental factors which operate here have not been isolated, but they certainly include both the improved nutrient and thermal regimes of the greenhouse. The nutrient regime may be particularly important in that the bog population, from an environment which has been characterized as having low nutrient availability (Small, 1972), also tended to have shorter needles.

Additional information regarding the genetic structure of var. *semiprostrata* can be obtained from observations concerning the prostrate form itself and the fact that both short- and long-needle types exist in close proximity to each other at treeline (Teeri, 1969). The latter observation may be taken as presumptive evidence of genetic distinctiveness assuming that the forms are not actually distributed in different microenvironments. The environmental situation must be studied carefully as personal observation and the studies of Tiffney (1972) indicate that slight differences in microtopography, slope, and degree of exposure can make considerable difference in the success of individual plants at treeline.

The genetic nature of the prostrate growth habit is difficult to demonstrate experimentally because of the long period of time necessary to develop this form. There is a tendency for new twigs on the uppermost branches to occur vertically. Frequently the preceding year's needles on these protruding branches have been removed on the windward side. Thus we may be witnessing an example of wind trimming as has been observed in other climates (Thomas, 1973). Additionally, the work of Jaffe (1973) suggests that the stunting of individuals could be an aspect of thigmomorphogenesis resulting from the mechanical action of wind.

The contiguous natural distribution of characteristic forms of both varieties as well as character variation which is essentially clinal in nature (Teeri, 1968) perhaps has resulted from disruptive selection similar to processes described by Antonovics and Bradshaw (1970) and Snaydon (1970). Phenotypic variation which has little importance in other parts of the range of *Picea mariana* may assume considerable significance at alpine treeline. Several morphological features of var. *semiprostrata* make it particularly well adapted to the alpine environment (Teeri, 1969). Additionally, it has frequently been observed that growth rates, such as needle elongation, and cold-hardiness are inversely related (Alden and Hermann, 1971). Thus, at the distributional limit for a species, a uniquely adapted genotype could exist sympatrically with the more common genotype even in a homogeneous environment. Some degree of reproductive isolation exists between the varieties due to the infrequency of cone production at treeline (Teeri, 1968).

It is not the intention of this study to reorganize the taxonomy of black spruce. The variety *semiprostrata* as defined from natural specimens is sufficiently unique to merit distinction. However, it should be recognized that the genetic basis for this taxon lies not in a narrowly specified phenotype, but in its plasticity and the sensitivity of the genotype to interaction with the environment.

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LINDERA MELISSAEFOLIUM IN ARKANSAS. An excellent description of *Lindera melissaefolium* (Walter) Blume (Lauraceae) and a detailed account of its known distribution in 1949 were given by Steyermark (Rhodora 51:153-162). He suggested that the shrub might some day be found in Arkansas because of its occurrence in adjacent Ripley County, Missouri. The discovery of an Arkansas locality in 1972 is not unexpected, therefore, but is here recorded in view of the extreme rarity of the species.

Several colonies representing hundreds of plants are now known from the northern part of Clay County, Arkansas. The area is a part of the Mississippi Embayment region and is characterized locally by a series of low woods in which swampy depressions are surrounded by sandy knolls. The shrub occurs in the water of these depressions, where it forms dense stands which average 2-4 feet in height. Some of the colonies occurring at the woods margins grow in close association with the rare and interesting Corkwood, *Leitneria floridana* Chapman.

Specific collection data for specimens from the Arkansas locality are as follows: CLAY COUNTY: Low woods having depressions with standing water surrounded by sandy knolls, Sect. 2, T21N, R4E, 10 June 1972 (with R. Davis), *Tucker* 9642 (UARK, NCU, APC).

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SPIRANTHES CASEI, A NEW SPECIES FROM NORTHEASTERN NORTH AMERICA

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In 1923 Henry Mousley made a collection of *Spiranthes* orchids from the vicinity of Hatley (45° 11′ N., 71° 56′ W.), Stanstead Co., Quebec. He reported these plants in 1924, under the name of *Spiranthes cernua* (L.) Rich. var. *ochroleuca* (Rydberg) Ames (Can. Field-Nat. 38: 61-63, 86-88, p. 88). About 17 years later he sent these collections to Dr. D. S. Correll at Harvard University, who was then engaged in a study of the genus. Correll reported back to Mousley that the plants from Hatley represented a mixed collection of *S. cernua* (L.) Rich. var. *odorata* (Nutt.) Correll and *S. vernalis* Engelm. & Gray. This was reported by Mousley in 1941 (Can. Field-Nat. 55: 79-80, *pl. 1-2*), and by Correll in 1950 (p. 227). Another station of *S. vernalis* was discovered by Mousley during 1941 near Ste. Dorothée (45° 32′ N., 73° 39′ W.), Quebec, and described in some detail by him in 1942 (Can. Field-Nat. 56: 1-2, *pl. 1-2*). Gleason and Cronquist (1963) reported southeastern Quebec to be within the range of *S. vernalis*, a decision probably based on the report of Correll (1950). In recent floristic work concerning eastern Canada (e.g. Marie-Victorin, 1964; Roland & Smith, 1963-64; Boivin, 1967) no further mention has been made of *S. vernalis*, and surprisingly the reports of Mousley and Correll have not been repeated. However, Case (1964) discussed the occurrence of plants referable to *S. vernalis* in the western Great Lakes region, and Voss (1972, p. 461) has mapped the distribution of *S. vernalis* in Michigan, although both of these authors assigned their plants to *S. vernalis* with some hesitation.

Over the past three years a species of *Spiranthes* that compared favorably with Mousley's specimens from Quebec was found to be frequent and locally abundant in some parts of the Canadian Shield region of southern Ontario, and it was listed for the province as *S. vernalis* by Whiting and Catling (1971). A survey of herbarium collections in eastern North America revealed many new localities for this "northern *S. vernalis*" in Ontario, several new stations in Quebec, Michigan, and New England, and two localities in Nova Scotia where it was previously unknown.

As specimens were examined over this wide range, it became clear that the northern plants were quite distinct and easily separated from *Spiranthes vernalis* as it occurs in the southeastern states. A series of specimens from the Coastal Plain and the gulf states, including the type of *S. vernalis* Engelm. and Gray (AMES 82967), differed consistently from the northern plants in exhibiting a light-colored and frequently more dense, non-glandular pubescence on the rachis, and a denser, less robust spike with a larger number of narrower and slightly longer flowers. Plants collected from Massachusetts, including the types of *Spiranthes* × *intermedia* Ames (AMES 2246) and *Spiranthes neglecta* Ames (AMES 2518) and the justifying specimens for *Spiranthes cernua* × *gracilis* Ames (AMES 17391), are comparable with the "southern *S. vernalis*." In his enumeration of North American orchids, Ames (1924) included *S.* × *intermedia*, *S. neglecta* and *S. cernua* × *gracilis* in synonymy with his × *S. vernalis*. A general northern limit for the "southern *vernalis*" is approximated by a line joining Massachusetts, Kentucky, and northern Missouri. The northern plants referred to *vernalis* are distributed in a broad band from Michigan to northern New England and the Canadian maritime provinces. As these northern plants are quite distinct and different from the southern plants (including the type of *S. vernalis*), and as they appear to have a discrete distribution pattern we are herewith describing them as a new species.

Spiranthes casei Catling et Cruise sp. nov.

Differt a *S. vernalis* pubescentia septata et rubri-glandulosa in inflorescentia, spica robustiore et minus densa, floribus paucioribus, latioribus, brevioribus.

Spiranthes vernalis Engelm. and Gray

Ont.
Simcoe
Moist edge of aspen woods.

Lot 4, conc. X,
Innisfil tp.

30 Aug. 1970 T. Reznicek 470

[redacted] 470 T. Reznicek

There was a colony of about 40 of these
overlooked orchids in this area.

Figure 1. A typical herbarium specimen of *Spiranthes casei.* The elongate spike with flowers loosely arranged in a single spiral, the erect oblanceolate leaves, and the robust nature of the plant are characteristic. (*T. Reznicek 470,* Simcoe County Museum).

Figure 2. Part of a spike of *Spiranthes casei* from Dorset, Ontario. (Photograph by Dr. Erich Haber).

Plantae (13-) 27-33 (-43) cm. altae sub anthesi. *Folia* omnia laevia, saepe glauca, usque ad tertiam caulis partem assurgentia; infima ad anthesin non permanentia, ovato-lanceolata, 1-2 cm. lata, 7 cm. longa; superiora ad et nonnumquam per anthesin permanentia, oblanceolata vel lineari-lanceolata, usque ad 15 vel 20 cm. longa, plerumque minus quam 1 cm. lata, brevia, sub inflorescentia ad vaginas sine laminis reducta. *Caulis* basaliter glaber, in rachidi pilis septatis rubri-glandulosis 0.10-0.30 mm. longis pubescens. *Spica* plerumque 6-10 cm. interdum ad 15 cm. longa, floribus laxe et saepe in spiram unicam dispositis. *Bracteae florales* ovatae vel ovato-lanceolatae, longi-acuminatae, 7-12 mm. longae, basaliter plus minusve pubescentes. *Flores* cremei. *Ovarium* sub anthesi 4-6 mm. longum, supra oblique tumidum. *Pubescentia* in ovarii, sepali dorsalis, sepalorum lateralium superficie pubescentiae rachidis similis. *Sepala* lateralia 5-7 mm. longa; sepalum petalaque dorsalia sursum vix curvata, 5-7 mm. longa; *petala* dorsalia pagina externa papillosa. *Labellum* florum inferiorum 6-6.5 mm., superiorum 5-6 mm. longum; calli basales crassi, 0.8-1.0 mm. longi, incurvi; labelli inferior superiorque centralis pagina et callorum regio brevi-pubescens vel papillosa.

Different from *S. vernalis* in its septate, reddish-glandular pubescence in the inflorescence, and its less dense, more robust spike with fewer, wider and shorter flowers.

Plants (13-)27-33(-43) cm. tall at anthesis. Leaves glabrous, often glaucous, ascending up to 1/3 the length of the stem; lowest leaves, not persisting until anthesis, ovate-lanceolate, 1-2 cm. wide, 7 cm. long; upper leaves, persisting until and sometimes throughout flowering, oblanceolate or linear-lanceolate, to 15 or 20 cm. long, and usually less than 1 cm. wide, reduced to bladeless sheaths below the inflorescence. Stem glabrous basally, becoming pubescent in the rachis with septate, reddish-glandular hairs 0.10-0.30 mm. long. Spike usually 6-10 cm. long, occasionally to 15 cm. long, with the cream-colored flowers arranged loosely and often in a single spiral. Floral bracts ovate or ovate-lanceolate, long-acuminate, 7-12 mm. long, more or less pubescent basally. Ovary 4-6 mm. long at anthesis, obliquely swollen on the upper side. Pubescence on the surface of the ovary, dorsal sepal, and lateral sepals, similar to that of the rachis. Lateral sepals 5-7 mm. long. Dorsal sepal and petals barely upcurved, 5-7 mm. long, the dorsal petals papillose on the outer surface. The lip 6-6.5 mm. long in the lower flowers, 5-6 mm. long in the upper flowers. Basal calli of the lip stout, 0.8-1.0 mm. long, incurved. The lower surface and central upper surface of the lip, and region of the calli short pubescent or papillose.

TYPE: CANADA: **Ontario:** MUSKOKA DISTRICT: ca. 6 mi. w. of Bracebridge along highway 118 in Monck township, (45° 02′ N., 79° 29′ W.), on dry hillside in full sun, *Catling & Whiting* (TRT 169205).

REPRESENTATIVE SPECIMENS

CANADA: **Nova Scotia:** SHELBURNE CO.: Hope's Lot Barrens, Clyde River, 7 Sept. 1921, *M. L. Fernald & B. Long* (AMES 85418). **Ontario:** FRONTENAC CO.: Salmon Lake, Frontenac Park, Bedford Tp., 23 Aug. 1968, *R. Hainault & I. MacDonald* (QK 97607). SIMCOE CO.: lot 4, conc. 10, Innisfill Tp., 30 Aug. 1970, *T. A. Reznicek* (Simcoe Co. Museum 470) **Quebec:** STANSTEAD CO.: Hatley, 11 Sept. 1924, *Mousley* (QFA 42012, AMES 63699). UNITED STATES: **Michigan:** MARQUETTE CO.: summit of Huron Mountain, 1-9 Sept. 1916, *C. K. Dodge* (MICH). **New Hampshire:** COOS CO.: Colebrook, 21 Aug. 1942, *A. S. Pease* 29802 (NEBC). **Vermont:** ORLEANS CO.: Sutton Rd., Willoughby, 13 Sept. 1899 (*Mrs. Bruche*) (NEBC).

We dedicate this species to Mr. Frederick W. Case II, whose book on orchids of the western Great Lakes region has been enjoyed and admired by amateurs and professionals alike. Mr. Case has indicated that the northern plants placed with *Spiranthes vernalis* differed from the southern plants, and he repeated Ames' suggestion of a hybrid origin for the northern plants (*Spiranthes lacera* × *Spiranthes cernua*) here described as *S. casei.*

While such a hybrid origin is quite possible, several characteristics of this plant suggest that it is worthy of specific status. All plants in populations studied have been found to be fertile, and many maintain themselves in the absence of one or both putative parents. There is no evidence of back-cross-swamping of the distinctness of *Spiranthes casei.* Although *S. casei* is intermediate between *S. cernua* and *S. lacera* in many characters, certain other characters are hard to rationalize in a hybrid; for example, the flowers of *S. casei* are creamy-colored but white in both *S. cernua* and *S. lacera.*

Spiranthes casei (Figs. 1 and 2) has been much confused with other species of *Spiranthes* growing within its range, particularly with *S. cernua* (L.) Rich. and *S. lacera* (Raf.) Raf., but also with *S. romanzoffiana* Cham.

Spiranthes romanzoffiana, which also has creamy or pale yellowish-green flowers, is readily distinguished by the pandurate lip that is sharply constricted beyond the middle (distally), and also by the connivent nature of the sepals and petals which form the hood. Further, the flowers of *S. romanzoffiana* are usually larger (perianth 8-10 mm. long) and arranged in two or more rows in a compact spike. Where *S. casei* and *S. romanzoffiana* occur sympatrically, the latter reaches its peak of flowering in late July and early August, while the former is in full flower in late August and early September.

Spiranthes lacera has a singly-spiralled elongate spike like that of *S. casei,* but it differs in being less robust, in its large, oval, widely spreading leaves in a basal rosette, and its smaller flowers (perianth usually ca. 4-5 mm. long) with green colouration in the lip. *S. lacera* reaches its peak of flowering in Ontario in late July and early August. We have noticed that some plants of *S. lacera* have gone to seed by late August when the first flowers of *S. casei* are opening. *Spiranthes lacera* frequently occupies the same habitats as *S. casei,* and both species grow in close proximity.

Spiranthes cernua may be distinguished from *S. casei* by its shorter stature (20-30 cm.), usually short and compact spike (ca. 5-7 cm. long), and its larger, pure white flowers (perianth usually 9-11 mm. long). In early September we have encountered *S. casei* growing on dry sandy roadside banks only a few feet removed from moist ditches with abundant plants of *S. cernua.* On several occasions the plants of *S. casei* were noted to be more advanced in flowering, with all of the flowers open and the lower flowers fading. The nearby plants of *S. cernua* were less advanced with the lower flowers fresh and many of the upper flowers still in bud. Although this may be a result of microclimate, it has nevertheless been a consistent observation.

Spiranthes casei shares some characteristics with *S. cernua* (L.) Rich. var. *ochroleuca* (Rydb.) Ames, particularly the cream-coloured flowers and a preference for an upland habitat. The var. *ochroleuca* is stated to differ from the typical form principally in yellowish-white flower colour, longer floral bracts, monoembryonic seeds, and preference for an upland habitat. Ames (1921, p. 78) has indicated that the only reliable means of distinguishing var. *ochroleuca* is through microscopic examination of the seeds. Apparently in other respects it is very close to typical *S. cernua,* as is obvious from the plate provided by Ames (*loc. cit. pl. 127,* Figs. 12-13), which was subsequently used in "The Orchids of North America" (Correll, 1950, *pl. 70,* 12-13). Clearly, this drawing does not illustrate *S. casei,* and the distinctive features of each make the separation of *S. casei* from either variety of *S. cernua* relatively simple.

DISTRIBUTION AND ECOLOGY

The range of *Spiranthes casei* extends from Michigan through Ontario and southern Quebec to the New England states and Canadian maritime provinces (Fig. 3). It is fairly frequent in the Muskoka-Haliburton region of Ontario, where there are 34 stations (and probably many more) separated from one another by distances of at least one mile. Here it is usually found in dry, open locations growing in coarse sandy soil in areas that have been disturbed but are not continually disturbed. Associated plants in such habitats include *Danthonia spicata* (L.) Beauv., *Pteridium aquilinum* (L.) Kuhn., and *Polytrichum* spp. The barren tops of ridges (Fig. 4) are the only naturally occurring habitats in which this orchid has been frequently encountered.

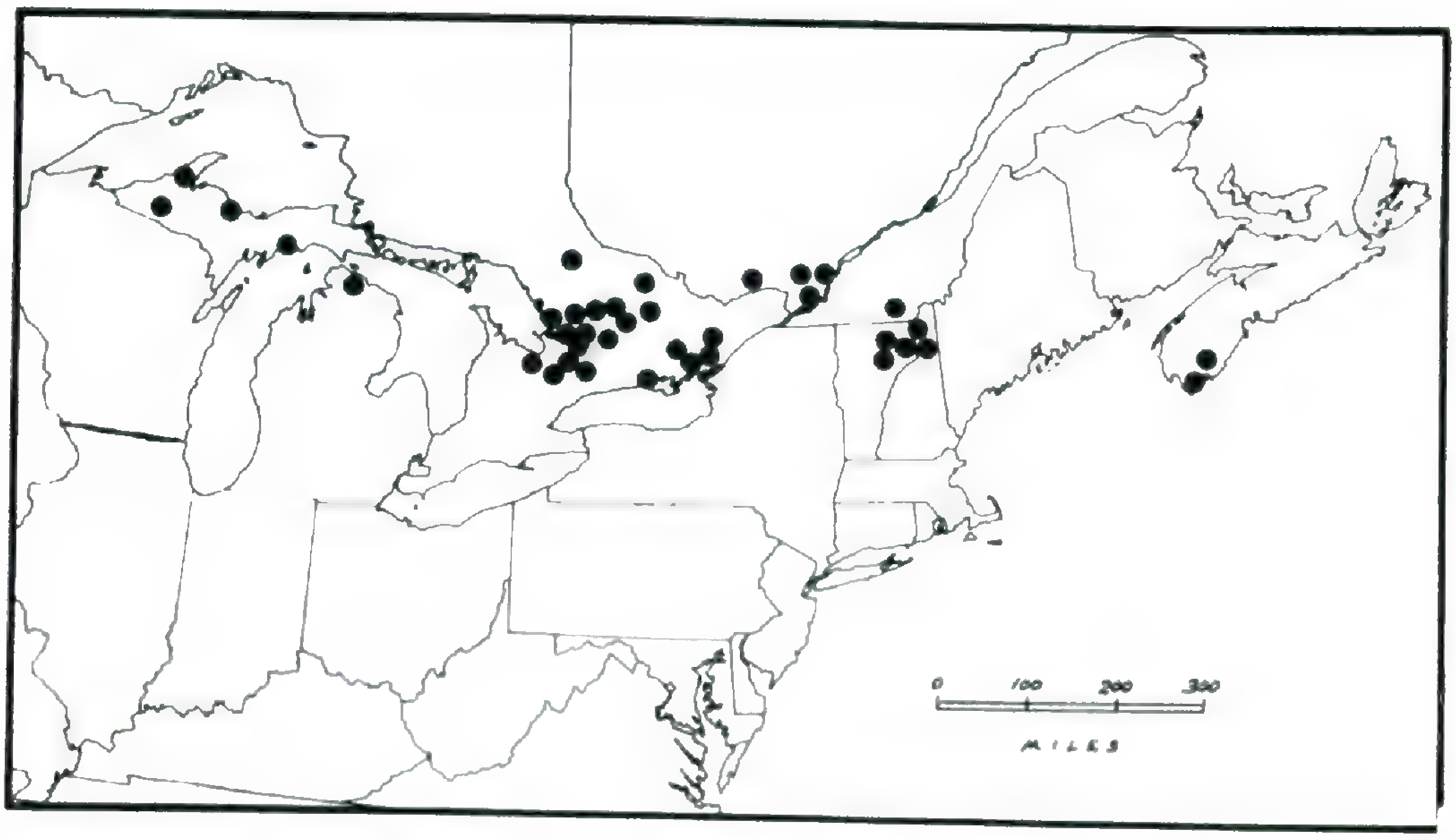

Figure 3. Distribution of *Spiranthes casei* based on specimens examined in the following herbaria: ACAD, AMES, CAN, DAO, HAM, LKHD, MICH, MTMG, NBM, NEBC, NFLD, OAC, QFA, QK, TRT, UWO.

Figure 4. Barren ridge-top on the Precambrian Shield in Matchedash Township, Simcoe County, Ontario. *Spiranthes casei* was quite frequent on this ridge, growing in coarse shallow soil in open locations.

The earliest collection of *Spiranthes casei* from Ontario was made in 1904. Prior to 1965 it had been collected only eight times in the province. However, during the period from 1965-1972 more than 25 specimens have been added to local herbaria. It is true that some of this represents our own field work, but we cannot overlook the possibility that this orchid has become more abundant in Ontario due to human activity, such as land-clearing and road-building. Of 14 collections made since 1970, 10 were from formerly disturbed habitats such as roadsides, sand pits, abandoned fields, and hydro-line transects. *Spiranthes casei* becomes apparent in these sites several years after the initial disturbance.

As with many other plants that quickly colonize habitats created by human activity, *Spiranthes casei* has proved to be at least partially apomictic. Seeds obtained from flowers, from which pollinators were excluded with cloth bags demonstrated 10-25% germination.

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INVESTIGATIONS OF NEW ENGLAND MARINE ALGAE VI: DISTRIBUTION OF MARINE ALGAE NEAR CAPE COD, MASSACHUSETTS[1]

DOUGLAS C. COLEMAN AND ARTHUR C. MATHIESON

Cape Cod is a major phytogeographic boundary on the northeast coast of North America, delineating a distinctive northern and southern marine flora (Chapman, 1964; Humm, 1969; Setchell, 1922; Stephenson & Stephenson, 1949). Harvey (1852-1858) and Farlow (1870, 1882) first recognized its importance as a phytogeographic boundary. Additional information regarding the uniqueness of the Cape Cod flora was contributed by Collins (1900), Davis (1913a, b) and Taylor (1937, 1957).

Although the marine flora of Cape Cod has received considerable attention since the time of Harvey, no one has ever conducted simultaneous year round studies of the algae on both sides of the Cape. In addition, nothing is known about the seasonal changes that occur in the Canal, which joins Cape Cod Bay and Buzzards Bay. Conover (1958) and Sears (1971) conducted seasonal studies of the algae in southern Cape Cod, but they gave no consideration to the Canal. The purpose of the present investigation was to study the horizontal and vertical distribution of seaweeds at seven locations from Scituate to Woods Hole, Massachusetts, and reproduction including the Cape Cod Canal. The seasonal occurrence of seaweeds at the same sites will be discussed in another paper.

Monthly collections of all the conspicuous algae at seven stations (Fig. 1) were made from January to December, 1969. Severe winter conditions (heavy ice and surf) existed from December to March, and they restricted some

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collections. Specimens were collected on foot in the intertidal zone and by SCUBA diving to a depth of 60 feet in the subtidal zone. Diving in the Canal was done at slack water (Anon. 1969a). The collections were brought to the University of New Hampshire for identification and processing.

Taylor (1937, 1957, 1960) was the primary source of identification and nomenclature. A number of additional references were consulted for the identification of species and the determination of recent geographical records along the Atlantic Coast of North America subsequent to Taylor's (1960) summary. These include: Adey, 1964, 1965, 1966; Bell & McFarlane, 1933a,b; Blomquist & Humm, 1946; Cardinal, 1964, 1965, 1966, 1967a,b,c, 1968; Collins, 1909; Edelstein, *et al.*, 1967, 1969, 1970; Edelstein & McLachlan 1966, 1967a,b, 1968a,b, 1969; Fritsch, 1935, 1945; Hoek, 1964; Hoyt, 1920; Lamb & Zimmermann, 1964; Lee, 1968, 1969; Lewis, 1914; MacFarlane & Bell, 1933; McFarlane & Milligan, 1965; Mathieson & Fuller, 1969; Mathieson, Dawes & Humm, 1969; Rhodes, 1970; South & Cardinal, 1970; Stone, *et al.,* 1970; Wilce, 1959, 1965; Williams, 1948, 1949; Wulf, *et al.,* 1968; Zaneveld & Barnes, 1965; Zaneveld, 1965, 1966a,b, 1972. The nomenclature of Parke & Dixon (1968) was applied in most cases.

Surface water temperature and salinity information was recorded when each station was investigated. Temperature was determined with a laboratory grade mercury thermometer; salinity was measured with a set of hydrometers (G. M. Mfg., Co.). In addition, hourly and daily surface water temperature data were obtained for each end of the Canal from thermographs monitored by the Fisheries Division of the State of Massachusetts. Additional (daily) temperature and salinity information was supplied by the Woods Hole Oceanographic Institute, Falmouth, Massachusetts (personal communication with Dean Bumpus and Joseph Chase).

Figure 1 illustrates the location of the seven study sites. One station (Scituate) was located north of the east end of the Canal, four were in the Canal proper and two (Woods

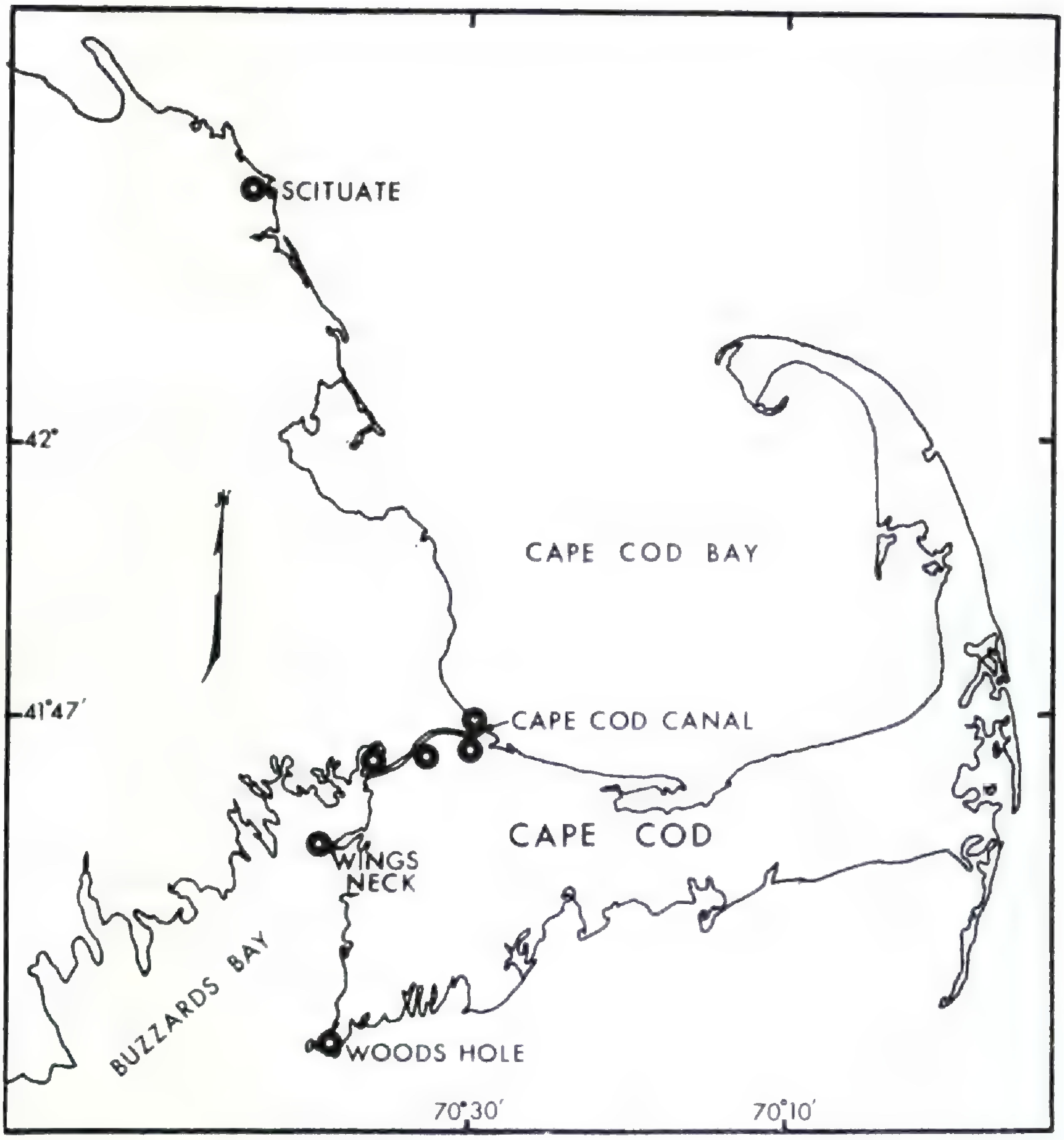

Figure 1. Map of Cape Cod, Massachusetts, showing the seven stations.

Hole and Wings Neck) were located south of the west end of the Canal. The land-cut of the Canal cuts across the Cape in an east-west direction from the town of Buzzards Bay (approximately 41°44′ N Latitude, 70°37′ W Longitude) to Sandwich (approximately 41°46′ N Latitude, 70°30′ W Longitude). It is seven miles in length, with an additional seven miles of approach channels.

Several differences are obvious between the two sides of the Cape. To the north, the substrate consists of granite outcrops, boulders and cobbles, while to the south the sub-

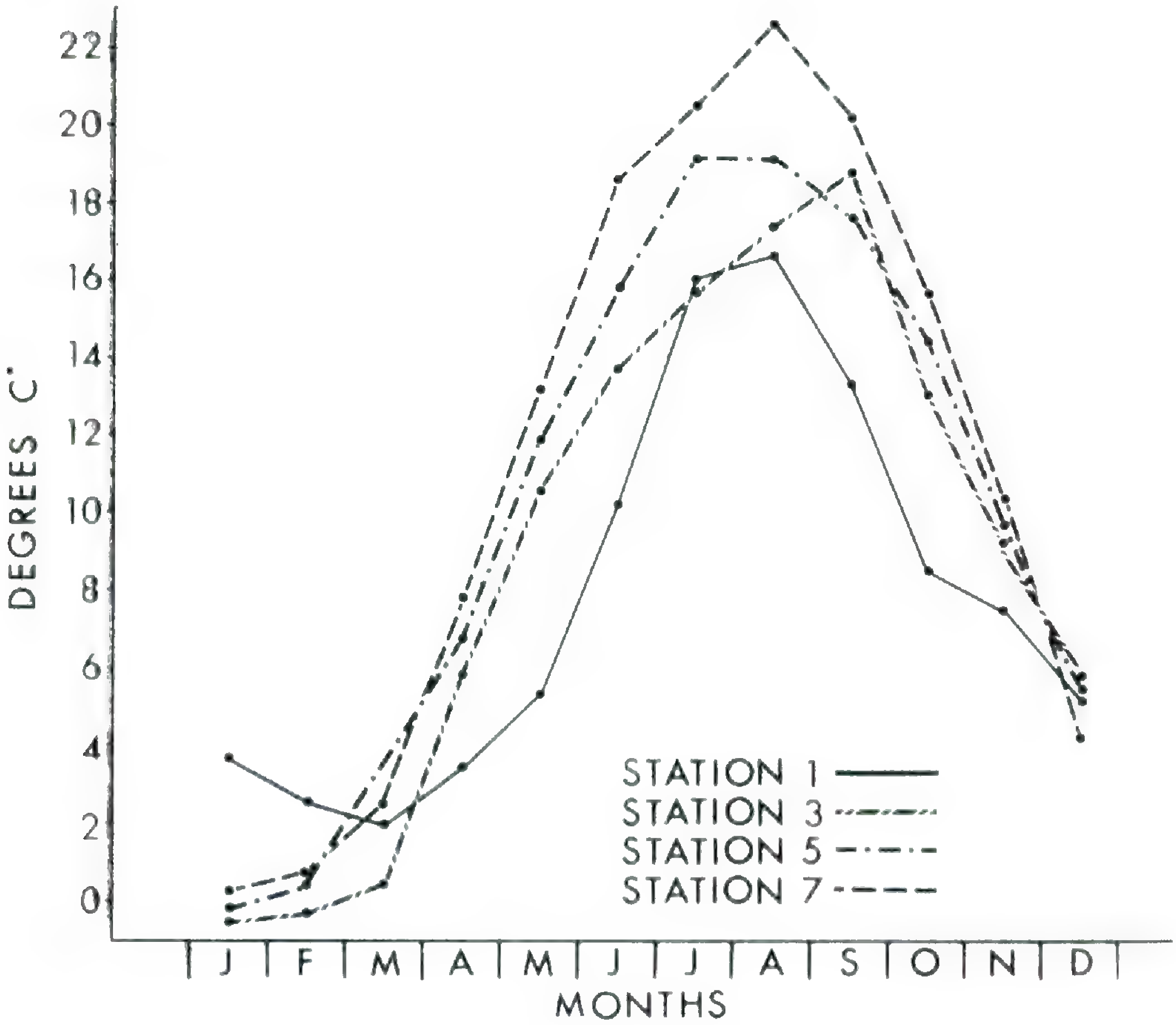

Figure 2. Mean monthly variation of surface water temperatures at stations 1, 3, 5 and 7 during 1969.

strate is largely sand and mud with fewer boulders. The Cape is also the dividing line between the Labrador Current to the north and the Gulf Stream to the south. Thus, a marked difference in water temperatures occurs during the summer. The yearly temperature range south of the Cape was approximately 22°C., while that to the north was about 17°C. (Fig. 2). The salinity ranges south of the Cape were usually higher than those to the north, particularly during spring and summer (Fig. 3). The tidal amplitude is much greater on the north than the south side. Thus, a three foot tidal amplitude exists in Buzzards Bay, while it is approximately ten feet at Scituate (Anon. 1969a). The waters of Cape Cod Bay are over 100 feet deep while those in Buzzards Bay are shallower.

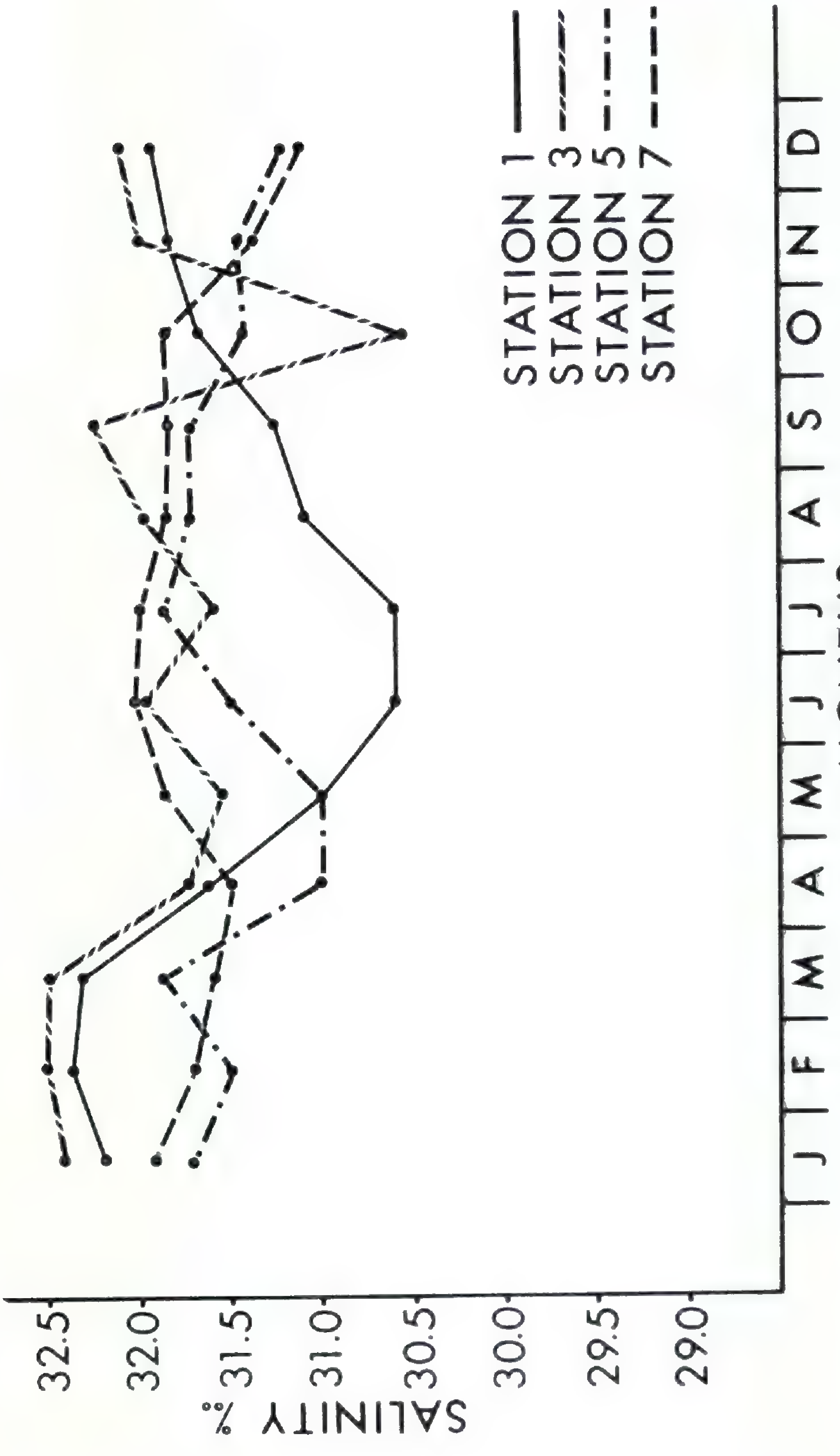

Figure 3. Mean monthly variation of surface water salinity at stations 1, 3, 5 and 7 during 1969.

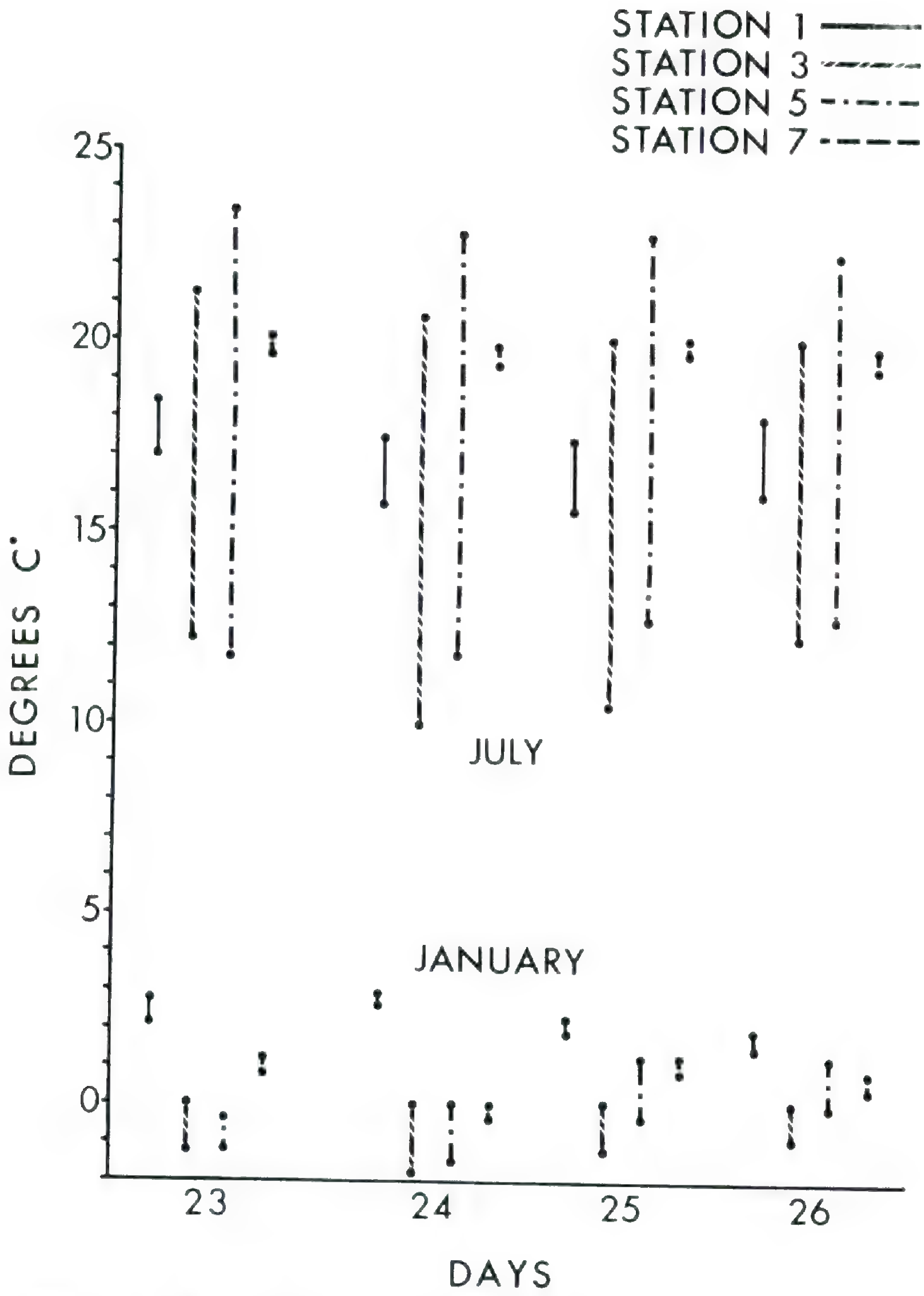

Figure 4. Mean daily variation of surface water temperatures at stations 1, 3, 5 and 7 during January and July, 1969.

The Canal has a limited amount of solid substrate, no wave action and a reduced intertidal zone. The seasonal temperature ranges are intermediate between the north and south sides of the Cape, but daily fluctuations during the summer are greater than on either side of the Cape (Fig. 4). The summer temperatures in the Canal are somewhat lower in the east than the west end (Fig.2). Seasonal and spatial variations of salinity are minimal (Fig. 3). The tidal amplitude in the Canal ranges from four feet in the west end to ten feet in the east end (Anon. 1969b). There is a difference of about two hours between the tides at the two ends (Anon. 1969b). The current reaches a peak of about six knots, three hours after slack water. Slack water occurs uniformly throughout the Canal, and it does not coincide with either high or low water (Anon. 1969b). The substrate at each site in the Canal grades vertically from granitic boulders to sand-silt. In addition, there is a general decrease in stable substrate towards the east end.

The Canal is maintained by the Army Corps of Engineers. A private access road along the banks was used to reach the stations. Telephone poles are located at 100 foot intervals along the Canal; they are numbered beginning at the east end. Stations 2-5 were located in the Canal and correspond to poles 10, 45, 245 and 385 respectively. Station 3 (pole 45) is located in front of the Cape Cod Canal Power Plant. A detailed description of the Canal stations, plus the Scituate, Wings Neck and Woods Hole sites is summarized in the Appendix.

SPECIES COMPOSITION

A total of 106 taxa was collected at the seven stations, including 52 Rhodophyta, 35 Phaeophyta and 19 Chlorophyta. Table I summarizes the species composition at each station. Scituate and Woods Hole showed the greatest diversity of species, while stations 2-6 showed lower numbers. No subtidal collections were made at station 2. It is of interest to note that the relative percentages of Rhodophyta, Phaeophyta and Chlorophyta were about the same at each station.

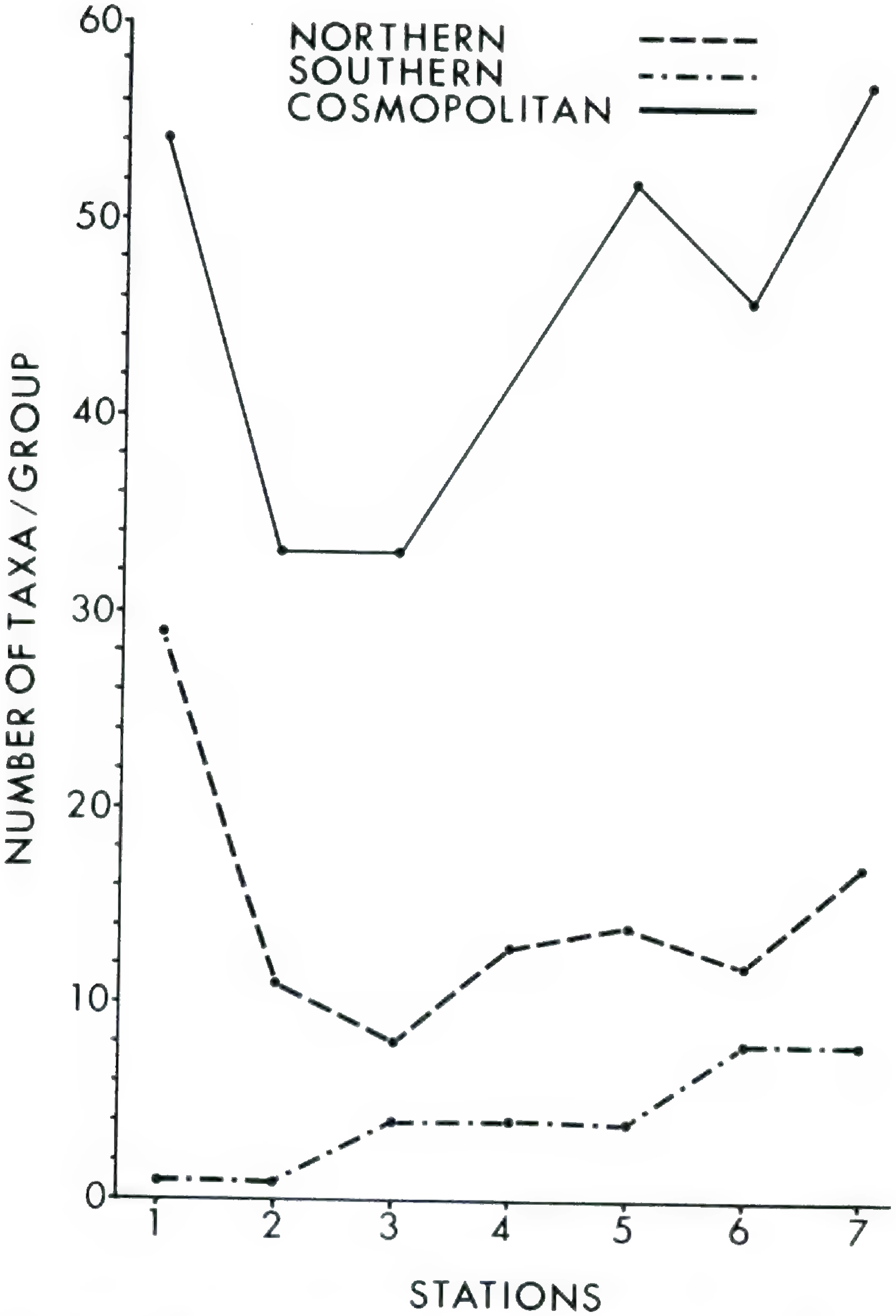

Figure 5. Number of northern, southern and cosmopolitan species at each station.

A listing of the known geographical distribution of each taxon along the Atlantic Coast of North America is also designated numerically in Table I. The species can be grouped into three components (i.e., northern, southern and cosmopolitan) according to their major centers of distribution. The northern species are found most commonly north of the Cape, and they include groups 1, 2, 3, 4 and 15. The southern species are more common south of the Cape; they include groups 7, 11, 12 and 13. Cosmopolitan species are found on each side of the Cape, and they include groups 5, 6, 8, 9, 10, 14 and 16.

Figure 5 summarizes the number of northern, southern and cosmopolitan species at each station. Most of the species were cosmopolitan. The northern component declined towards the south, while the southern component increased towards the south, reaching a maximum at Wings Neck and Woods Hole. Cosmopolitan species included *Chaetomorpha melagonium, Rhizoclonium tortuosum, Ulva lactuca, Ascophyllum nodosum, Petalonia fascia, Ahnfeltia plicata* and *Ceramium rubrum,* while conspicuous northern components included *Codiolum petrocelidis, Monostroma* spp., *Chorda filum, Fucus spiralis, Laminaria digitata, Choreocolax polysiphoniae,* and *Porphyra umbilicalis.* Representative species more common to the south of the Cape included *Codium fragile* subsp. *tomentosoides, Sargassum filipendula, Agardhiella tenera, Champia parvula* and *Hypnea musciformis.*

Scituate had a species composition typical of northern New England, while Wings Neck and Woods Hole were more typical of warmer water locations. Thus, *Laminaria* spp., *Gigartina stellata, Ralfsia fungiformis, Chaetomorpha atrovirens, Urospora collabens,* and *Fucus vesiculosus* were common at the former station, while *Sargassum filipendula, Agardhiella tenera, Callithamnion baileyi,* and *Codium fragile* subsp. *tomentosoides* were common at the latter stations. The Canal stations, 3-5, included representatives from both sides of the Cape (e.g. *Laminaria saccharina, Chondrus crispus, Rhodymenia palmata, Agardhiella tenera, Codium fragile* subsp. *tomentosoides* and *Sargassum filipendula.*

VERTICAL DISTRIBUTION

Figure 6 summarizes the vertical distribution of the conspicuous species at each station. The distributions were recorded as follows: 1) species restricted to the intertidal zone; 2) species restricted to the subtidal zone; 3) species found in both the intertidal and subtidal zones. Most of the plants at Scituate were collected from the intertidal and subtidal zones, including tide pools. Species that were common to both zones included *Chondrus crispus, Chorda* spp., *Ectocarpus siliculosus, Petalonia fascia, Ceramium rubrum, Corallina officinalis, Dumontia incrassata,* and *Chaetomorpha linum.* Few species (e.g. *Chaetomorpha atrovirens, Cladophora flexuosa, Polyides rotundus, Asperococcus echinatus,* and *Laminaria* spp.) were restricted to the subtidal zone or intertidal zone (e.g. *Codiolum* spp., *Enteromorpha intestinalis, Rhizoclonium tortuosum, Ulothrix flacca, Choreocolax polysiphoniae,* and *Fucus spiralis*). Subtidal substrate was lacking at station 2, and the lowest number of species was found here.

The Canal stations (2-5) had the highest subtidal component. Species restricted to the subtidal zone in the Canal were also found in the intertidal zone at other stations. The most common subtidal species in the Canal included *Laminaria* spp., *Chondrus crispus, Agardhiella tenera, Chorda* spp., *Chordaria flagelliformis, Ulva lactuca, Petalonia fascia,* and *Scytosiphon lomentarius.* Species restricted to the intertidal zone included *Urospora penicilliformis, Ascophyllum nodosum, Fucus spiralis,* and *Choreocolax polysiphoniae;* those common to both zones included *Ectocarpus siliculosus, Fucus vesiculosus,* and *Sphacelaria cirrosa.*

The majority of species collected at Wings Neck and Woods Hole was found in the subtidal zone and the intertidal-subtidal zones. Few species were restricted to the intertidal zone. Species restricted to the subtidal zone included *Agardhiella tenera, Sargassum filipendula, Callithamnion roseum, Dasya pedicellata, Seirospora griffithsiana, Leathesia difformis, Chordaria flagelliformis,* and *Clado-*

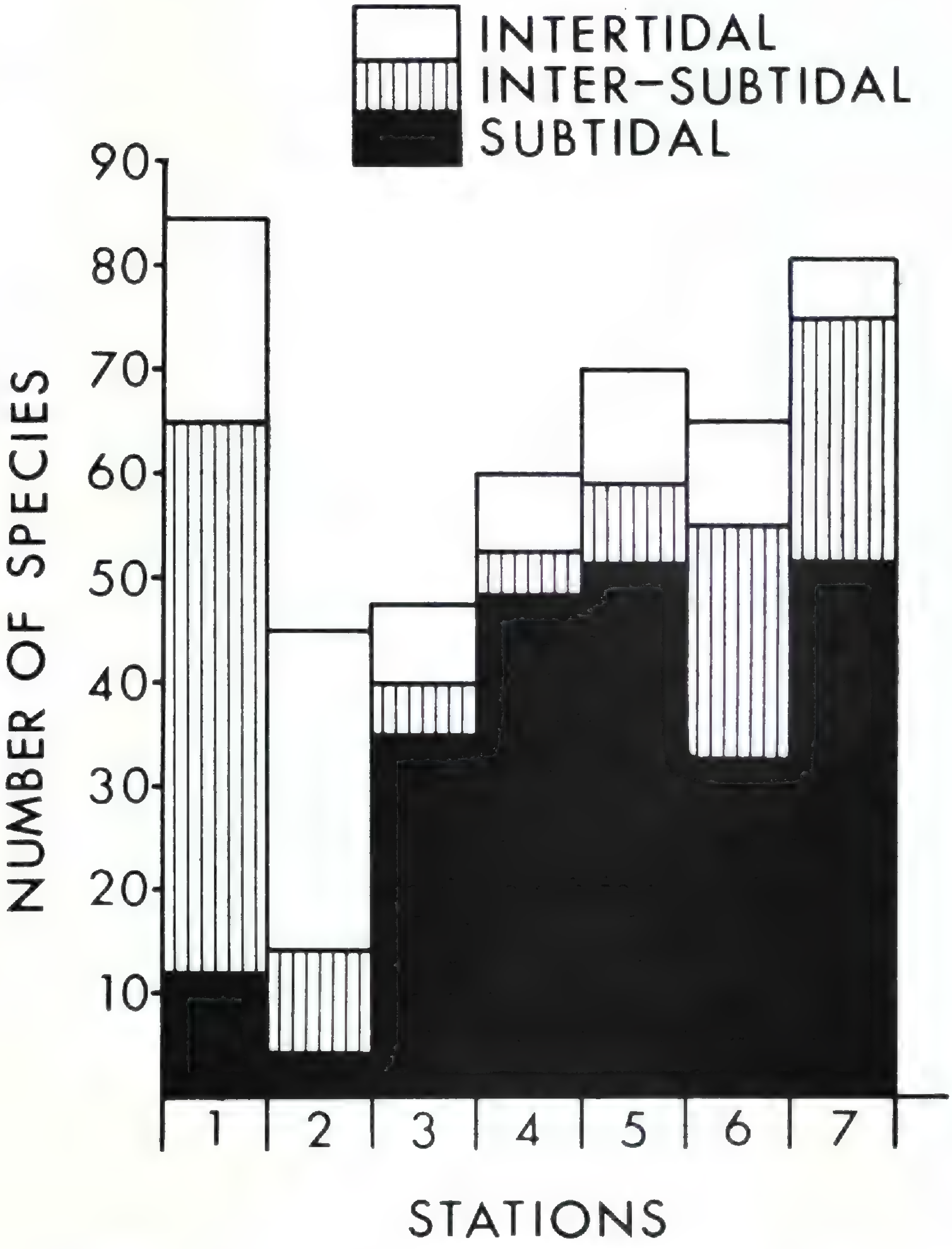

Figure 6. Vertical distribution of species at each station.

phora spp. Species found in both zones included *Chondrus crispus, Melobesia lejolisii, Ectocarpus siliculosus, Fucus vesiculosus* var. *spaerocarpus,* and *Chaetomorpha linum,* while those restricted to the intertidal zone included *Bangia fuscopurpurea, Porphyra umbilicalis, Fucus spiralis,* and *Ulothrix flacca.*

DISCUSSION

Setchell (1917) was one of the first workers to emphasize the role of temperature in determining the geographical distribution of seaweeds. He divided the oceans into 5°C. intervals or isotherms, according to the maximum summer water temperatures. Hutchins (1947) also confirmed that 5°C. intervals either favored or inhibited growth and repopulation of marine organisms. Williams (1948), Parr (1933), Well and Gray (1960), and Humm (1969) have reported a similar relationship between temperature and species composition. As suggested by Setchell (1917) Cape Cod is a dividing line between the 15° and 20°C. maximum summer isotherms. Hence, it is not surprising that it is a major phytogeographic boundary, with distinct floras occurring north and south of the Cape.

Several factors are responsible for the marked difference in summer temperatures between the north and south side of Cape Cod. A southern extension of the Labrador Current carries cold water as far south as the Cape, where it remains throughout the year. In addition, the deep waters of Cape Cod Bay warm up slowly during the summer. Davis (1913a, b) described Cape Cod Bay as a "holding pocket" of cold water. He further described the islands of Martha's Vineyard and Nantucket as barriers protecting Buzzards Bay from the intrusion of cold waters off Gay Head. The high surface water temperatures in Buzzards Bay result from a northern extension of the Gulf Stream into the shallow confines of Buzzards Bay. During the winter, cold air lowers the temperature on both sides of the Cape and the sharp differential of temperature disappears. Winter temperatures in Buzzards Bay, however, may be somewhat lower than in Cape Cod Bay, because of the shallowness of the water of the former location.

The transitional nature of the Cape Cod Canal is documented by its species composition. The Canal is dominated by cosmopolitan species; northern species increase toward the east end of the Canal, while southern components increase toward the west end. Setchell (1922) also recognized a cosmopolitan group of plants common to both sides of the Cape — in contrast to more northern and southern elements. The completion of the Canal in 1914 presumably provided a direct route for spores to pass from one side to the other. Stephenson (1944) has shown a similar transition of flora and fauna near the Cape of Good Hope in Africa; on the west coast the waters are relatively cold, while on the east coast the shore is bathed by the warm waters of the Indian Ocean. Seven major components are evident near the Cape of Good Hope; the major components are the cosmopolitan, warm- and cold-water elements.

Physical factors, such as tidal amplitude, wave action and availability of solid substrate, determine the local distribution of species at the seven sites. Salinity was not considered a major factor in the areas studied because of the small range recorded. Scituate had the highest number of species; it is the most exposed site having ample substrate. The lack of wave action, lower tidal amplitude, and reduced substrate in the Canal were probably responsible for the low number of species at stations 2-5. Woods Hole had the second highest number of species, even though tidal amplitude, wave action, and substrate were reduced south of the Cape. The abrasive action of sand at Wings Neck resulted in low species numbers.

A variety of physical factors, such as temperature, salinity, light intensity, substrate and exposure, determine the vertical distribution of seaweeds (Stephenson & Stephenson, 1949; Chapman, 1964). Most algae at Scituate were collected from the intertidal and subtidal zones, while in the Canal and south of the Cape the majority of species was restricted to the subtidal zone. The former location (Scituate) is characterized by greater tidal amplitude and wave action, both of which are necessary for the development of an extensive intertidal flora — assuming substrate is not limiting. The vertical position of species varied from station to station. Species found in the intertidal and subtidal zones at Scituate were often restricted to the subtidal zone in the Canal or south of the Canal.

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APPENDIX

DESCRIPTION OF STATIONS

Scituate (station 1) is located about 30 miles north of the east end of the Canal at approximately 42°12′ N latitude and 70°43′ W longitude (Fig. 1). It is a semi-exposed site, consisting of massive granite outcroppings. There are several tide pools and a well developed intertidal zone. The substrate in the subtidal zone consists of large outcroppings, boulders, cobbles and sand. The surface water temperatures ranged from approximately 2-16°C. The highest temperatures occurred in August, while the lowest occurred in March. The daily temperature range was about 2°C. during the summer and 3°C. during the winter. The average monthly summer temperatures at Scituate were the lowest of all the stations. Salinity values remained relatively constant throughout the year, ranging from a low of $30.6^{0}/_{00}$ in the summer to a high of $32.5^{0}/_{00}$ during the winter.

Station 2 is located at the east end of the Canal at the Scusset Breakwater (Fig. 2). Collections were restricted to the intertidal zone because of the lack of subtidal substrate. An extensive intertidal zone is present. The water temperatures ranged from 12°C. to 19°C. The tidal amplitude is 10 feet (Anon. 1969a).

Station 3 is located at the power plant (Fig. 2). Rip-rap extends to about 6 feet below M.L.W., while a shelf extends out 30-40 feet and to a depth of 15 feet. During operation, the power plant discharges water of over 23.9°C. Substrate is limited and a small intertidal zone is present. The tidal amplitude is approximately 10 feet.

Station 4 is approximately 2.5 miles east of the west end of the Canal proper (Fig. 2). The study site was on the south bank of the Canal. The substrate grades from rocks (boulders) in the upper shore to sand-silt in the lower subtidal zone. The tidal amplitude is about 6 feet (Anon. 1969a). A limited intertidal zone is exposed during low tide.

Station 5 is located at the Engineer's station at the west end of the Canal. Collections were made in the vicinity of the pier. Rip-rap extends to about 12 feet below M.L.W., while a shelf extends out to about 75 feet and slopes to about 20 feet below M.L.W. The tidal amplitude is about 4 feet (Anon. 1969a).

Wings Neck (station 6) is located at approximately 41°31′ N latitude and 70°40′ W longitude in the town of Bourne, Massachusetts (Fig. 1). It is a semi-exposed area subject to southwest winds during the summer. A limited intertidal zone is present; it is composed of small cobbles and a few large boulders. A few shallow tide pools are evident. The tidal amplitude is about 4 feet (Anon. 1969a). The range of water temperatures was 0.2-22.1°C. The mean monthly winter temperature (2.2°C.) was lowest in January. At that time the temperature was lower than at Scituate, the northernmost station. The area is subject to severe ice scouring during the winter. The salinity remained relatively constant throughout the year, with a range of about 0.9‰ (Fig. 4).

Woods Hole (station 7) is located at approximately 41°31′ N latitude and 70°40′ W longitude in the town of Falmouth, Massachusetts (Fig. 1). Collections were made at the jetty behind the U. S. Fisheries Building. The bottom is approximately 20 feet below M.L.W., at the deepest point, and the bottom substrate is composed of sand and silt. Some small rocks were present at one side of the jetty. The tidal amplitude is about 2 feet (Anon. 1969a). The temperature ranged from a low of 0.2°C. in January to 22.5°C. in August (Fig. 3). Daily temperature ranges were small during the year (Fig. 5). The salinity remained relatively constant throughout the year with a range of only 0.8‰ (Fig 4).

Footnotes to Table I

[1] Geographical distribution zones relating to Table I, right hand column.

1. Northern Massachusetts to Newfoundland and north.
2. Northern Massachusetts to Nova Scotia.
3. Southern New England-Long Island Sound to Gaspé and Labrador.
4. Southern New England-Long Island to Newfoundland and north.
5. New Jersey-Maryland to Newfoundland and north.
6. New Jersey-Maryland to Gaspé and Labrador.
7. New Jersey-Maryland to Cape Cod.
8. North Carolina to Newfoundland and north.
9. North Carolina to Gaspé.
10. South Carolina to Newfoundland and north.
11. South Carolina to northern Massachusetts.
12. Tropics to southern New England-Cape Cod.
13. Tropics to northern Massachusetts.
14. Tropics to Newfoundland and north.
15. Southern New England-Long Island Sound to northern New England-Nova Scotia.
16. Tropics to northern New England-Nova Scotia.

[2] = *Neoagardhiella baileyi* (Harvey *ex* Kützing) Wynne *et* Taylor. (Wynne and Taylor, 1937).

[3] = *Phyllophora truncata* (Pallas) Newroth *et* Taylor. (Newroth and Taylor, 1971).

[4] = *Phyllophora pseudoceranoides* (Gmelin) Newroth *et* Taylor. (Newroth and Taylor, 1971).

TABLE I. DISTRIBUTION OF SPECIES

Chlorophyta	Distribution							
	Station							[1]Geo-
Taxon	1	2	3	4	5	6	7	graphical
Chaetomorpha atrovirens Taylor	X							4
Chaetomorpha linum (Müller) Kützing	X	X	X	X	X	X	X	14
Chaetomorpha melagonium (Weber *et* Mohr) Kützing	X	X		X	X		X	5
Cladophora flexuosa (Müller) Harvey	X			X	X	X	X	14
Cladophora gracilis (Griffiths *ex* Harvey) Kützing	X					X	X	14
Codiolum gregarium A. Braun	X	X						3
Codiolum petrocelidis Kuckuck	X							2
Codium fragile (Sur.) Hariot subsp. *tomentosoides* (van Goor) Silva			X	X	X	X	X	7
Enteromorpha intestinalis (L.) Link	X	X	X	X	X	X	X	14
Enteromorpha linza (L.) J. Agardh	X	X			X		X	14
Monostroma grevillei (Thuret) Whittrock	X	X				X	X	4
Monostroma pulchrum Farlow	X	X				X	X	4
Rhizoclonium tortuosum Kützing	X	X						8
Spongomorpha arcta (Dillwyn) Kützing	X	X			X	X	X	5
Spongomorpha spinescens Kützing	X	X						1
Ulothrix flacca (Dillwyn) Thuret	X	X				X	X	8
Ulva lactuca L.	X	X	X	X	X	X	X	12
Urospora collabens (C. Agardth) Homes *et* Batters	X							1
Urospora penicilliformis (Roth) Areschoug	X	X			X	X	X	4
Subtotal	18	13	4	6	9	11	13	

TABLE I cont.

	Distribution							
	Station							[1]Geo-
Phaeophyta Taxon	1	2	3	4	5	6	7	graphical
Ascophyllum nodosum (L.) Le Jolis	X	X	X	X	X	X	X	8
Asperococcus echinatus (Mertens) Greville	X		X	X	X	X	X	4
Chorda filum (L.) Stackhouse	X	X	X	X	X	X	X	5
Chorda tomentosa Lyngbye	X	X	X	X	X	X	X	3
Chordaria flagelliformis (Müller) C. Agardh	X	X	X	X	X	X	X	5
Desmarestia aculeata (L.) Lamouroux	X	X	X	X	X			5
Desmarestia viridis (Müller) Lamouroux	X		X	X	X	X	X	5
Desmotrichum balticum Kützing	X		X				X	3
Desmotrichum undulatum (J. Agardh) Reinke						X	X	9
Dictyosiphon foeniculaceus (Hudson) Greville	X					X	X	5
Ectocarpus siliculosus (Dillwyn) Lyngbye	X	X	X	X	X	X	X	14
Elachista fucicola (Velley) Areschoug	X	X	X		X	X	X	5
Fucus distichus L. emend. subsp. *distichus* (C. Agardh) Powell	X							1
Fucus distichus L. emend. subsp. *endentatus* (C. Agardh) Powell	X	X			X			5
Fucus distichus L. emend. subsp. *evanescens* (C. Agardh) Powell	X	X	X	X	X			4
Fucus spiralis L.	X	X	X	X	X	X	X	4
Fucus vesiculosus L.		X	X	X	X			8

TABLE I — Phaeophyta cont.

	Distribution							
	Station							[1]Geo-
Taxon	1	2	3	4	5	6	7	graphical
Fucus vesiculosos var. *sphaerocarpus* J. Agardh					X	X	X	3
Fucus vesiculosus var. *spiralis* Farlow	X						X	6
Giffordia granulosa (Smith) Hamel				X	X		X	5
Giffordia secunda (Kützing) Batters							X	15
Laminaria digitata (Hudson) Lamouroux	X			X				4
Laminaria saccharina (L.) Lamouroux	X	X	X	X	X		X	5
Leathesia difformis (L.) Areschoug	X		X	X	X	X	X	8
Myrionema strangulans Greville	X		X	X	X	X	X	14
Petalonia fascia (Müller) Kuntze	X	X	X	X	X	X	X	14
Pilayella littoralis (L.) Kjellman	X	X	X	X	X	X	X	5
Punctaria latifolia Greville			X		X	X	X	5
Punctaria plantaginea (Roth) Greville						X	X	5
Ralfsia fungiformis (Gunner) Setchell *et* Gardner	X					X	X	1
Ralfsia verrucosa (Areschoug) J. Agardh	X	X	X	X	X	X	X	5
Sargassum filipendula C. Agardh		X	X		X	X	X	12
Scytosiphon lomentarius (Lyngbye) Link	X	X	X	X	X	X	X	14
Sphacelaria cirrosa (Roth) C. Agardh	X	X	X	X	X	X	X	4
Sphaerotricia divaricata (C. Agardh) Kylin					X	X	X	5
Subtotal	26	18	23	21	26	24	29	

TABLE I cont.

Rhodophyta	Distribution							
	Station							[1]Geo-
Taxon	1	2	3	4	5	6	7	graphical
Agardhiella tenera (J. Agardh) Schmitz[2]	X		X	X	X	X	X	12
Ahnfeltia plicata (Hudson) Fries	X	X	X	X	X	X	X	5
Antithamnion americanum (Harvey) Farlow							X	5
Bangia fuscopurpurea (Dillwyn) Lyngbye	X	X			X	X	X	14
Bonnemaisonia hamifera Hariot				X				15
Callithamnion baileyi Harvey	X					X	X	5
Callithamnion roseum (Roth) Lyngbye				X	X	X	X	16
Ceramium rubrum (Hudson) C. Agardh	X	X	X	X	X	X	X	14
Ceramium strictum Harvey	X			X		X	X	16
Champia parvula (C. Agardh) Harvey				X		X	X	13
Chondria sedifolia Harvey						X	X	12
Chondrus crispus Stackhouse	X	X	X	X	X	X	X	5
Choreocolax polysiphoniae Reinsch	X	X	X	X	X			4
Clathromorphum circumscriptum (Strømfelt) Foslie	X							1
Corallina officinalis L.	X		X	X	X	X	X	14
Cystoclonium purpureum (Hudson) Batters var. *cirrhosum* Harvey	X		X	X	X	X	X	15
Dasya pedicellata (C. Agardh) C. Agardh			X		X	X	X	11
Dermatolithon pustulatum (Lamouroux) Foslie	X					X	X	15
Dumontia incrassata (Müller) Lamouroux	X	X	X	X	X	X		3

TABLE I — Rhodophyta cont.

Taxon	Distribution							
	Station							[1]Geographical
	1	2	3	4	5	6	7	
Gigartina stellata (Stackhouse) Batters	X							4
Gloiosiphonia capillaris (Hudson) Carmichael *ex* Berkeley	X				X		X	4
Goniotrichum alsidii (Zanardini) Howe				X	X	X	X	4
Griffithsia tenuis C. Agardh				X				11
Grinnellia americana (C. Agardh) Harvey			X	X	X	X	X	11
Hildenbrandia prototypus Nardo	X	X			X	X	X	14
Hypnea musciformis (Wulfen) Lamouroux						X	X	12
Lithophyllum corallinae (Crouan) Heydrich	X							15
Lithothamnium glaciale Kjellman	X							1
Lomentaria baileyana (Harvey) Farlow	X				X	X	X	16
Lomentaria orcadensis (Harvey) Collins *ex* Taylor				X	X			15
Melobesia lejolisii Rosanoff				X		X	X	16
Petrocelis middendorfii (Ruprecht) Kjellman	X							15
Phyllophora brodiaei (Turner) Endlick[3]	X			X	X		X	5
Phyllophora membranifolia (Goodenough *ex* Woodward) J. Agardh[4]	X		X	X	X	X	X	5
Phymatolithon lenormandi (Areschoug) Adey	X							6
Plumaria elegans (Bonnemaison) Schmitz	X	X						5

TABLE I — Rhodophyta cont.

Taxon	Distribution: Station 1	2	3	4	5	6	7	[1]Geographical
Polyides rotundus (Hudson) Greville	X		X	X	X	X	X	4
Polysiphonia denudata (Dillwyn) Greville *ex* Harvey in Hooker	X		X	X	X		X	16
Polysiphonia elongata (Hudson) Sprengel			X	X	X			4
Polysiphonia harveyi Bailey	X	X		X		X	X	10
Polysiphonia lanosa (L.) Tandy	X	X	X	X	X	X	X	5
Polysiphonia nigrescens (Hudson) Greville	X	X	X	X	X	X	X	10
Polysiphonia novae-angliae Taylor	X			X	X		X	5
Polysiphonia urceolata (Lightfoot *ex* Dillwyn) Greville	X		X	X	X	X	X	5
Porphyra leucosticta Thuret				X		X	X	9
Porphyra miniata (C. Agardh) C. Agardh	X				X		X	1
Porphyra umbilicalis (L.) J. Agardh	X	X	X	X	X	X	X	10
Rhodochorton penicilliforme (Lightfoot) Rosenvinge	X	X						4
Rhodomela confervoides (Hudson) Silva	X		X	X	X		X	5
Rhodymenia palmata (L.) Greville	X	X	X	X	X		X	5
Seirospora griffithsiana (Harvey) Dixon							X	7
Trailliella intricata (J. Agardh) Batters	X			X	X	X	X	5
Subtotal	37	14	20	32	31	30	38	
TOTAL	81	45	47	59	66	65	80	

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A REVISION OF NORTH AMERICAN POTAMOGETON SUBSECTION PUSILLI (POTAMOGETONACEAE)[1]

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The importance of the aquatic environment is becoming more evident with our present ecological concerns. Many aquatic plants have been shown to be indicators of water quality and of changes in the aquatic environment (Volker & Smith, 1965; Lind & Cottam, 1969; Harman & Doane, 1970; Stuckey, 1971; Wentz & Stuckey, 1971). Certain species, e.g. *Najas minor, Potamogeton foliosus, P. pusillus,* and *Vallisneria americana,* are tolerant of polluted waters. Other species, e.g. *Najas flexilis, Potamogeton amplifolius, P. friesii,* and *P. strictifolius* are intolerant.

Early workers, e.g. Pond (1905) and Shelford (1918, 1937), considered aquatic vascular plants of little value in the food chain of aquatic animals. Later workers, e.g. Moore (1915), Moyle and Hotchkiss (1945), and Welch (1935, 1952), however, considered the aquatic vascular plants an important source of food for aquatic animals. In a survey of literature on the significance of aquatic vascular plants in the nutrition of animals, Gaevskaya (1966) considered the aquatic vascular plants as a primary source of food for animals of the aquatic environment.

According to Martin (1951), the pondweeds (*Potamogeton*) are probably more valuable to ducks than any other group of plants in the United States. Trautman (1957) indicates that the distribution in Ohio of certain species of fish is contingent upon that of associated pondweeds. Gaevskaya (1966) lists 124 species of animals (89 invertebrates and 35 vertebrates) that feed upon *Potamogeton.*

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The plants also serve as shelter for panfish and young fish of other species. Many aquatic insects have at least one stage of their life cycle, if not their entire life cycle, upon the vegetative structures of the pondweeds (Welch, 1952). These insects are, in turn, preyed upon by fish and some birds. Müller-Liebenau (1956) found 294 invertebrates in beds of five species of *Potamogeton* in the lakes of eastern Holstein. The pondweeds are, therefore, a major factor in the food cycle of the aquatic environment. In fact, among the submerged and floating-leaved species of aquatic vascular plants, Gaeyskaya (1966) states that as regards distribution, productivity, and trophic relations of aquatic animals, *Potamogeton* is the most important genus.

Potamogeton Linnaeus is a cosmopolitan genus with approximately 100 species of submerged and floating-leaved aquatic plants. The genus has been separated into two subgenera (Raunkiaer, 1896) and numerous sections and subsections (Graebner, 1907; Hagstrom, 1916). The North American representatives of one of the latter, *Potamogeton* subsection *Pusilli* Graebner (narrow-leaved pondweeds), are the subject of this paper. The *Pusilli* can be separated from the other taxa of the genus by their 3-7(-9)-nerved leaves that are 2-5 mm broad, by their stipules free from the blade, and by their small (to 4.0 mm long) fruits that normally are produced terminally.

Although the *Pusilli* have been included in at least four revisionary treatments (Morong, 1893; Ascherson, 1907; Hagstrom, 1916; Fernald, 1932), uncertainty still exists as to the number of taxa to be included in the group and at which rank these taxa should be recognized. Taylor (1909), for example, accepted only six taxa; Ogden (1957) divided the group into 18 taxa; Muenscher (1944) recognized only 12 taxa; Fernald (1932) acknowledged 21 taxa.

The *Pusilli* have been considered difficult taxonomically for many years (Fassett, 1940) and, in fact, many of the recently collected specimens from North America have been extremely difficult, if not impossible, to identify. The reasons for these difficulties may have been: 1) the *Pusilli* are morphologically small and, thus, the characters are difficult to observe; 2) vegetatively (the condition in which much of the material is encountered) the species superficially resemble each other; 3) ecological variability has not been fully understood; 4) the nomenclature has been confused. Many authors in the past have not recognized the vegetative variability of the species. As a result, more than 60 names have been proposed for the taxa of North American *Pusilli.*

Because of the apparent economic importance of the group, it is essential to understand the taxonomic relationships within the genus. As stated above, this understanding has not previously been accomplished. Therefore, I considered that the subsection *Pusilli* was in need of a thorough revision. It is understood that problems still exist within the *Pusilli,* but it is hoped this re-evaluation will clarify some of the confusion within the group.

TAXONOMIC HISTORY

Potamogeton was first described by Tournefort (1719) who recognized 13 species. Linnaeus (1753), basing his treatment upon that of Tournefort, accepted 12 species. Since that time, a proliferation of names has occurred, both at the generic and infra-generic levels, resulting in considerable chaos of the nomenclature. However, because of the nomenclatural confusion and the fact that I am treating only the *Pusilli,* a brief outline of the major events is presented rather than a detailed discussion of the history.

1788. Walter applied *Potamogeton* to two species of *Myriophyllum* (Haloragaceae).

1790. Loureiro named *Hydrogeton,* based on *P. heterophyllum.*

1819. *Peltopsis* was created by Rafinesque, based on *Potamogeton perfoliatus.*

1837. Koch divided the genus into five sections: *Chloephylli, Coleophylli, Enantiophylli, Heterophylla, Homophylla.*

1845. Reichenbach recognized five major groups, without giving these groups formal rank: *Antiphyllogeton, Chloegeton, Coleogeton, Heterophyllogeton, Homophyllogeton.*
1845. *Spirillus* was named by Gay, without any species having been listed.
1858. Irmish divided the *Homophylla* of Koch into two sections, naming the new one *Batrachoseris.*
1896. Raunkiaer placed all Danish species into two subgenera: *Coleogeton* and *Eupotamogeton.*
1903. Raunkiaer divided the genus into 16 groups, which were not given any formal taxonomic rank.
1907. Graebner (in Ascherson & Graebner) gave formal rank to most of Raunkiaer's groups (mostly at the subsectional level) and named several other subsections.
1913. Nieuwland transferred 20 species of *Potamogeton* to *Spirillus.*
1916. Hagstrom named several new sections and numerous subsections.

Potamogeton subsection *Pusilli* was first recognized as a natural unit by Raunkiaer (1903). He gave no formal name to the group, but referred to it as "*P. pusillus*-group." Graebner in Ascherson and Graebner (1907) combined two of Raunkiaer's groups — *P. pusillus*-group and *P. confervoides*-group — into the subsection *Pusilli.* Based upon characters of the stem anatomy, Hagstrom (1916) removed *P. confervoides* from the subsection. Hagstrom's concept of the group was the one followed by Fernald (1932; 1950) and accepted in the present work.

MORPHOLOGY

HABIT: The *Pusilli* are rooted linear-leaved obligate aquatic plants that grow totally submerged except for the spikes, which are usually extended above the surface of the water. When fruiting, the spikes are normally withdrawn below the surface so that the plant is again totally submerged. The mature plants, at least in the temperate regions, are mostly functionally annuals, which overwinter as seeds, winter buds, or turions. The winter buds are produced in such abundance that Fernald (1932) and Hagstrom (1916) were of the opinion that the plants rarely reproduced by seeds, but instead reproduced by winter buds. These conclusions were based upon a high percentage of plants having been collected with the winter buds still attached. Muenscher (1938), however, has shown that for *Potamogeton pusillus* [var. *tenuissimus*], at least, and possibly for other *Pusilli,* the young seedlings are very similar to a winter bud and these could easily be mistaken for old winter buds.

STEM: The stems of the *Pusilli* are erect to decumbent or prostrate, depending upon the water depth and rate of water flow, and are round to compressed in cross section. Ogden (1972) has suggested that no species of the *Pusilli* from New York possess a rhizome. This statement implies that the stem arises from a winter bud or a similar structure formed from the seedling as illustrated by Muenscher (1936). This situation probably represents the majority of the cases. However, some taxa, such as *Potamogeton hillii,* may produce a rhizome if the stem becomes decumbent and subsequently becomes covered by debris. Rooting at the nodes may then occur, and a rhizome-like structure several centimeters in length would be formed. Ogden (1966), in fact, illustrated a rhizome of *P. foliosus* from Texas.

Slight variation in the shape of the stem in cross-section and in the number and sizes of ridges along the stem has been observed. Certain species, e.g. *Potamogeton foliosus* and *P. friesii,* may have compressed stems, whereas other species, e.g. *P. pusillus* and *P. clystocarpus,* usually have terete stems. However, at certain times the stem of all species may be slightly compressed. Therefore, stem characters used for identification are helpful only as supplemental evidence.

Raunkiaer (1903), Hagstrom (1916), and Ogden (1943) have utilized stem anatomy for distinguishing certain species of other sections of *Potamogeton.* However, the stem anatomy of the various species of the *Pusilli* is so similar that this character is of little or no use to separate the species.

At the nodes of some species, a pair of translucent oil glands may be present; in other species, they are extremely uncommon. The glands range in color from white, cream, gold, brown, or green, and in diameter from 0.1-1.0 mm. When present, by variations in color and size, the glands can be useful supplemental evidence. As with the lacunae, their presence (or absence) should not be relied upon absolutely, as they are apparently a physiological response to unknown ecological factors.

LEAF BLADES: The blades of the *Pusilli* are rufescent, green, pellucid, to nearly black, setaceous to linear, non-lunate, sessile, stipulate, and acute to obtuse or apiculate. Venation is parallel with 1-9 veins (nerves). The lateral nerves join the midrib at or just below the apex. In some species, one to several rows of lacunae parallel the midrib. To my knowledge, no one has studied the development or structure of the lacunae of *Potamogeton.* Singh (1964) studied the vegetative structures of various species of Potamogetonaceae, including *P. berchtoldii* [*P. pusillus* var. *tenuissimus*], which is characterized by having lacunae bordering the midrib. If Singh noticed any lacunae, he made no mention of them. Fernald (1932) suggested they are rows of nearly empty and colorless cells, presumably giving buoyance to the leaves. To my knowledge, the origin and functions of the lacunae are not known. However, regardless of their origin, the lacunae appear as light lines on each side of the midrib. The individual rows can be observed with 10× magnification, which would indicate that each row is several cells in width, rather than one cell wide. The lacunae are useful for identification, as some taxa rarely possess them, whereas others commonly have 1-

several rows on each side of the midrib. This character usually serves as good supplemental evidence when used in conjunction with other features, preferably reproductive ones.

Recognition of many taxa of *Potamogeton*, especially of the *Pusilli*, has been based upon slight morphological differences in the leaves (Hagstrom, 1916; Fernald, 1932). Dandy and Taylor (1940) suggested that, due to different ecological conditions, the vegetative variability of the species is too great to be useful as the only criterion for naming a new taxon. During the present study I have observed that several populations undergo a seasonal dimorphism, e.g., producing two morphologically dissimilar sets of leaves in one growing season. Often, plants of *Potamogeton pusillus* var. *tenuissimus* produce in the early summer a set of obtuse leaves that are near the limits of width for the species and which possess four to five rows of lacunae on each side of the midrib. Later in the growing season, these leaves die and a new set is formed. The leaves of this second set are usually acute, quite narrow, and possess only one to three rows of lacunae. If one were to follow Fernald's (1932) taxonomy of this group, one could correctly identify the plant as one variety in the early summer and another variety in the fall. The cause of this seasonal variation is unknown. Since the same genotype may produce two sets of leaves, each morphologically distinct, these vegetative characters should be considered with caution when attempting to distinguish taxa.

STIPULE: Associated with each leaf blade and surrounding the stem of the *Pusilli* is a tubular or convolute stipule. The stipules are free from the leaf blades and vary in color from white to brown to green. The number and coarseness of the veins varies from one species group to another. This vein character, along with the stipule color, can be useful for identification of species. In some taxa, e.g. *Potamogeton friesii*, the stipules are white with many coarse veins. With age the interveinal tissue near the apex decays leaving the coarse veins extending as fibers past the remaining interveinal tissue. In other species, e.g. *P. pusillus,* the stipules are usually brown to green with only a few veins, these being quite delicate. With age, the vein tissue decays along with the interveinal tissue.

Hagstrom (1916) considered the tubular versus convolute condition of the stipules to be of great evolutionary significance. He, in fact, divided the *Pusilli* into two series — *Pusilli Convoluti* and *Pusilli Connati* — based on no characters other than the connation of the stipules. Later workers, Dandy and Taylor (1938), Ogden (1966), and Voss (1972) have accepted this character as important for determining species but have not accepted its use in separating the subsection into two series. For one of the species complexes in which the stipule character is considered most useful, according to Hagstrom and Fernald, — that being *P. pusillus* and *P. panormitanus* [*P. pusillus* var. *tenuissimus* and var. *pusillus,* respectively], I have compared the character with other vegetative and reproductive characters considered important by these workers. The data obtained from this comparison indicate only about a 70-80% correlation of this character with the other characters. In my opinion, when the situation is either the presence or absence of a character, for that character to be given such high value in a classification system, there should be little variability of that character within a taxon.

WINTER BUDS: The winter buds (turions) are vegetative reproductive structures that function as agents for multiplication of the individuals and as perennating organs during the unfavorable season. Yeo (1966) planted one winter bud of *Potamogeton crispus* on 1 Apr. 1963. At the end of the growing season, 23,520 winter buds had been produced. This is obviously a very effective method of propagule production. In some species, the winter buds are produced early in the growing season and may, therefore, germinate to produce new plants that year. In other species they are produced only at the end of the season, and do not germinate until the following year.

The winter buds consist of a short stem apex with shortened internodes. The leaves of the structures can be divided into two types: outer and inner. The outer leaves usually resemble the vegetative leaves, but the inner leaves may not. The inner leaves may be numerous, shortened, and oriented in a plane perpendicular to that of the outer leaves, thus giving a fan-shaped appearance, as in *P. friesii.* On the other hand, the winter buds may be few to several, compacted, and rolled into a hardened structure, thus appearing fusiform, as in *P. pusillus.* Finally, they may be various in number and similar to the vegetative leaves, as in *P. obtusifolius.*

As indicated above the winter buds may be useful as characters for the identification of the *Pusilli.* Hagstrom (1916) and Fernald (1932) have placed emphasis upon the location on the plant of the structures. I consider the location of the structure too variable to be of taxonomic value. Instead, the size of the structure and the modification of the inner leaves are of significant taxonomic value.

INFLORESCENCE: The inflorescence of the *Pusilli* is either a capitate or cylindric spike consisting of from one to five whorls of four flowers each. Some authors have considered this structure to consist of a reduced compound spike (see comments under discussion of the flower). The inflorescence is a very good character for distinguishing species of the *Pusilli.* Important features are the length, shape, and number and separation of the whorls of the inflorescence. In some taxa, e.g. *Potamogeton pusillus* var. *pusillus,* with an inflorescence of more than three whorls, the whorls will usually be separated; however, in other taxa, e.g. *P. foliosus,* the whorls are rarely separated.

PEDUNCLES: The peduncles of the *Pusilli* are either terminal on the stem or axillary to vegetative leaves. Often, axillary peduncles are reflexed, whereas the terminal ones usually are erect. In longitudinal section, the peduncles either have parallel sides or are clavate. In cross sections, they range from nearly terete to so compressed that they are three to four times as broad as high.

The peduncle is often a very good character for distinguishing taxa of the narrow-leaved pondweeds. In *Potamogeton foliosus* for example, the peduncle is short, clavate, usually reflexed, and axillary. In *P. pusillus* var. *pusillus,* on the other hand, the peduncle is elongate, parallel-sided, erect, and usually terminal.

FLOWER: The flowering structures of *Potamogeton* have been interpreted variously. First, Eames (1961) interpreted each perianth segment as a sepaloid bract subtending and adnate to the corresponding stamen. He, therefore, regarded the flower of *Potamogeton* as an inflorescence comprising four staminate flowers, each of a single stamen and its adnate bract, and four apetalous carpellate flowers, each of a single carpel with one campylotropus ovule. By this interpretation, the spike represents a reduced compound inflorescence. Second, based upon vascular anatomy and floral morphology of seven species of *Potamogeton,* Singh (1965) chose to consider the flower of *Potamogeton* as a normal flower with four perianth segments. Finally, Sattler (1965) considered it impossible to classify the structure as a true flower or as an inflorescence, because it displayed characters of both. He questioned the classical use of flower and inflorescence as two separate categories and emphasized the need for more developmental work in the "Helobiales" (an order that is now considered to be the Alismatidae). For the sake of convenience, Singh's concepts are followed in this revision.

Controversy has also existed as to the real nature of the perianth-like structures that are adnate to the stamens. Ascherson (1889) and Rendle (1930) considered the structures to be outgrowths of the stamens. They then called the structures stamen connectives. Sattler (1965) and Singh (1965) have reached a different conclusion. Sattler, for example, demonstrated in *Potamogeton richardsonii* that these structures are initiated on the floral apex prior to stamen initiation. Thus, they cannot be outgrowths of the stamens. He instead considered them to be perianth segments. After inception of the stamen primordia, growth occurs between the perianth primordia and that of the stamen. Thereby, the base of the developing stamen and perianth become united. The perianth is usually light green to greenish brown in color and consists of two parts — a claw and an expanded upper portion — each of approximately equal length.

The gynoecium consists of four separate, superior, uniovulate carpels with parietal placentation. The androecium consists of four bithecate stamens. Anthesis usually is approximately at the time of embryo sac maturity (Lawrence, 1951).

Among the various taxa of the *Pusilli*, only slight morphological variation exists in the flowers. These structures, therefore, are of little value for distinguishing species. However, the size of the structures often is quite useful for separating various subsections of the genus.

FRUITS: The fruits of the pondweeds have been variously classified — e.g., as a drupe (Reichenbach, 1845), as a drupelet or drupaceous (Morong, 1893; Fryer and Bennett, 1915), as a drupe or an achene (Clapham et al., 1962) and as a druplet or nutlet (Lawrence, 1951). The use of such an array of terms suggests that no one term could adequately describe the fruits. Although the fruits resemble an achene in size and by having a thin, often leathery mesocarp, they do not conform with the definition of an achene in that the seed coat is not adnate to the pericarp, and under natural conditions the fruits are rarely ever dry. Muenscher (1936), in fact, has shown that when the fruits are subjected to drying, a very high rate of mortality occurs. The fact that the fruits rarely dry also rules out the possibility of their being a nut or nutlet. According to Aalto (1970) the fruits are histologically drupes since the pericarp is differentiated into an exocarp, mesocarp, and stony endocarp. The fruit is, however, unlike a drupe because the dorsal area of the pericarp wall appears to open and then be covered by a lid (Aalto, 1970). At the junction of the lateral walls and the lid, a ridge is formed. This ridge, in many species, is pronounced into two lateral wings (one on each side of the fruit). The lid can be removed exposing the seed coat. Because of the histological similarity, Aalto chose to call the fruits of the Fennoscandian species drupes. Until a better term is proposed, I am considering the fruits drupe-like.

The fruits are the single most important character for distinguishing the taxa of the *Pusilli*. Several fruit characters are useful for identification: 1) color — usually brown or green; 2) size; 3) shape — whether widest above the middle, at the middle, or below the middle; 4) presence of dorsal or lateral wings or ridges — one species, *P. foliosus*, has a dorsal wing, three others two lateral and one dorsal ridge, others have no ridges; 5) amount of depression on the sides; 6) length and position of the style (or beak).

Aalto (1970) has demonstrated that for some species of *Potamogeton* the endocarp can be useful for identification. The majority of his work was done with subfossil endocarps. He also exposed recent endocarps by boiling the fruits in 5% potassium hydroxide solution for 10 to 15 minutes. The exocarp and mesocarp disintegrate leaving the endocarp exposed. These were examined for shape and size of the cells and for shape, size, and appendages of the endocarp.

VEGETATIVE DIMORPHISM

Vegetative morphology has been used as a basis for separation of certain taxa of *Potamogeton*. In Fernald's study (1932), *P. pusillus* was divided into six varieties based on shape of the leaf apex and number of lacunae bordering the leaf midrib. The species was divided into two informal groups using the shape of the leaf apex. These groups then were further divided into the varieties with the number of lacunae being the only character used for separation. During the summer of 1878, E. S. Miller made two collections of *P. pusillus* from presumably the same locality of the Wading River, Suffolk County, New York: 1) sterile plants on 25 May 1878, and 2) fertile plants on 12 Jul. 1878. A sterile and fertile plant together were mounted on a herbarium sheet and these sheets were distributed. I have seen six such sheets and on every one the sterile plant had leaves with obtuse apices and two to three rows of lacunae each side of the midribs. Leaves of the fertile specimens, on the other hand, were acute and lacked lacunae. Fernald examined some of the specimens and consistently identified the sterile plants as *P. pusillus* var. *mucronatus* and the fertile plants as *P. pusillus* var. *tenuissimus*. This situation led me to consider the hypothesis that the taxonomic character of the leaf apex and lacunae were environmentally controlled. I, therefore, began visiting populations several times throughout one year and, often, in subsequent years to see if any morphological changes occurred. Data gathered from these field studies indicate that *P. pusillus* and, also, *P. friesii* may undergo a dimorphism in which two morphologically dissimilar phenotypes may be observed in the same population.

During the summer of 1969, I made a collection of *Potamogeton pusillus* (*Haynes* 3251) from Pelee Island, Ontario. These specimens had obtuse leaves with five to six rows of lacunae on each side of the midrib (Fig. 1). The population was visited separately by Dr. Ronald L. Stuckey and Mr. Marvin L. Roberts, both of The Ohio State University, several times during the next two years. In late August 1971, the population was found in fruit (*Roberts* 1562). The leaves from this collection were acute and had at most two rows of lacunae each side of the midrib (Fig. 1). Therefore, plants of this one population could be correctly identified, according to Fernald (1932), as var. *mucronatus* when sterile and var. *tenuissimus* when fertile. I also have observed this phenomenon in a population from New York (*Haynes* 3326). Here both types of leaves were found on the same plant. The obtuse, lacunate leaves were black and appeared dead at the time of collection and the acute, non-lacunate leaves were green and alive at the time of collection. During the course of herbarium work, I have examined many specimens in which both types of leaves were present on one plant, usually with the obtuse, lacunate ones appearing to have been dead at the time of collection. These data appear to indicate that plants with obtuse lacunate leaves are always sterile. This is not the case. Some are fertile; however, as compared with the number of fertile plants with non-lacunate, acute leaves, the former are few in number.

A similar situation can be observed in *Potamogeton friesii.* However, rather than two distinct sets of leaves being produced by one plant, apparently only one set of leaves is produced a year, but these leaves undergo a morphological change during the growing season. According to Voss (1972), *P. friesii* tends to have leaves without revolute margins, whereas *P. strictifolius* normally has ones with revolute margins. Data gathered during my field work indicate that in the early summer *P. friesii* does have leaves without revolute margins (Fig. 1). A population in Emmet County, Michigan, visited by me on 15 Jun. 1971 (*Haynes* 3694) had such leaves. However, on 30 Jul. 1971, I again visited the same population and found most plants with leaves having revolute margins (*Haynes* 3747). Thus, one population may produce both phenotypic expressions in one year.

The two examples of vegetative dimorphism outlined above illustrate the vegetative plasticity of *Potamogeton* explained by Dandy and Taylor (1940). These data indicate that within the *Pusilli,* and probably other groups of aquatic plants, the effects of differing environmental conditions upon the vegetative characters should be understood before one uses these characters in a classification.

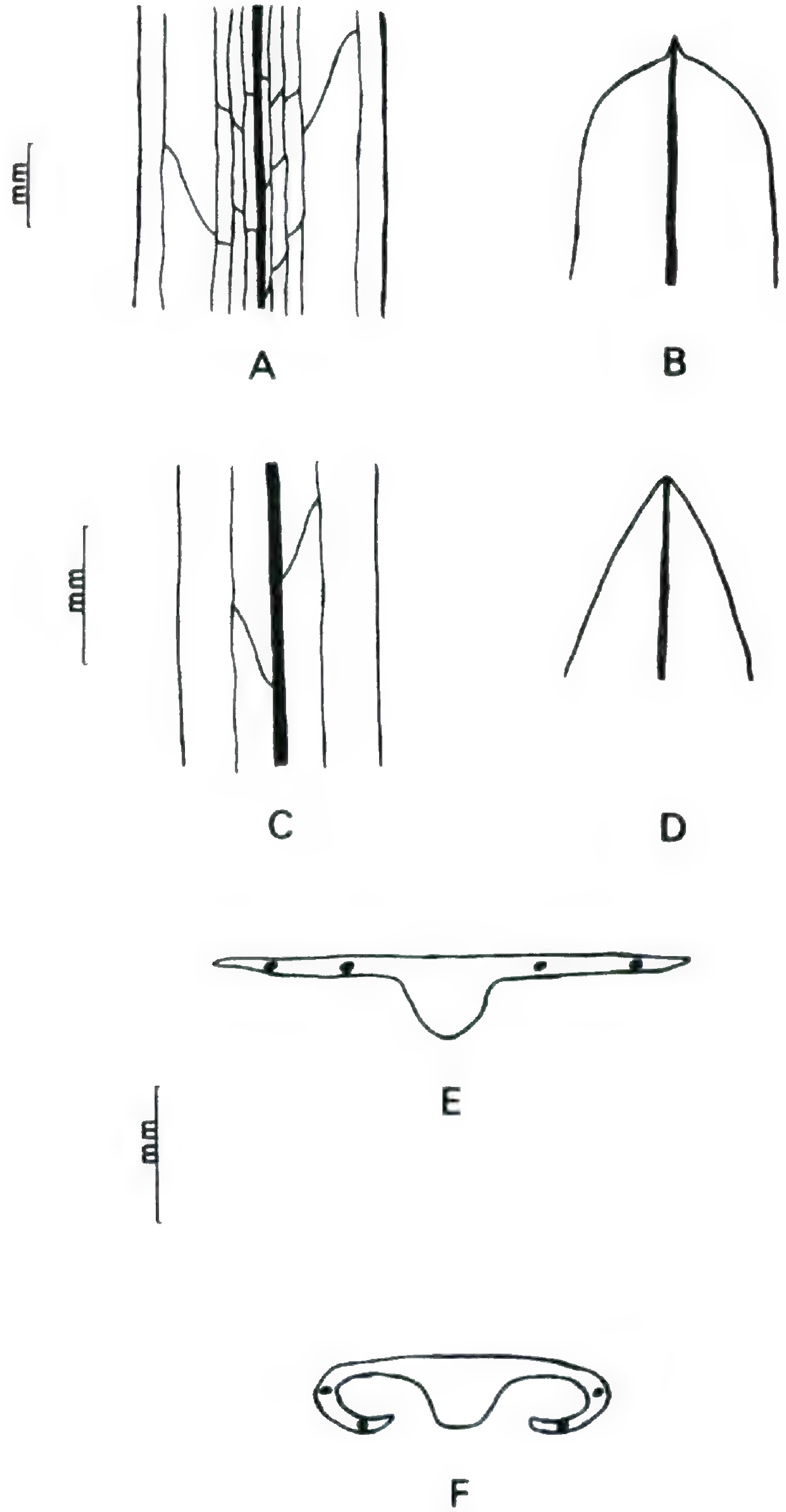

Fig. 1. *Potamogeton pusillus* leaf (A-D). A. Midsection, early summer. B. Apex, early summer. C. Midsection, late summer. D. Apex, late summer. Cross-section of *Potamogeton friesii* leaf (E-F). E. Early summer. F. Late summer.

REPRODUCTIVE ECOLOGY

REPRODUCTION: The reproductive ecology of *Potamogeton* is poorly known. According to Sculthorpe (1967) certain species of *Potamogeton* reproduce by rhizome fragments, tubers, and winter buds or turions. Also, Moore (1915) studied seed germination of *Potamogeton* and concluded that once a seed germinates and develops into a mature plant, several periods of vegetative reproduction must occur before the plant will produce flowers and fruits. In the *Pusilli,* Hagstrom (1916) and Fernald (1932) were of the opinion that the plants rarely reproduced by seeds, but instead, reproduced mostly by winter buds. For the species in which winter buds are rare or unknown, this idea of reproduction by winter buds may not be valid. However, for the species which prolifically produce winter buds, reproduction by these structures is probably the most common type, since fruiting plants often are found with winter buds attached to the underground parts.

POLLINATION: According to Sculthorpe (1967) and to Cronquist (1968), the pollination trend in the Alismatidae is from insect to wind, and ultimately, to water pollination. Members of the genus *Potamogeton* including the *Pusilli* are, for the most part, wind pollinated (Sculthorpe, 1967). However, according to Voss (1972) and data based on personal field experience, many inflorescences of the *Pusilli* never become emergent. In such instances, if pollination does occur, the medium for the transport of the pollen must be the water. However, the mature, viable fruits might be formed as a result of apomixis.

GERMINATION: As shown by Muenscher (1936), the germination rate of *Potamogeton* fruits is greatly reduced when the fruits are subjected to drying. Many species, according to Muenscher, require near-freezing temperatures for a period of one to three months. However, as shown by Sullivan (1967) for many of the broad-leaved species of *Potamogeton,* the fruits can be induced to germinate without a previous cold treatment if the exocarp and mesocarp are split, thus exposing the endocarp.

As stated earlier, the fruits of the pondweeds are among the most common foods of waterfowl. Often only the exocarp and mesocarp are digested, leaving the endocarp with the intact seed to be passed from the digestive system. Lohammar (1954) has shown that a high percentage of germination may occur after the fruits have passed through the digestive system of the waterfowl.

CYTOLOGY

Several workers, e.g. Palmgren (1939), Harada (1942; 1956), Löve (1954), Löve and Löve (1961), and Stern (1961), have studied *Potamogeton* cytologically. However, according to Bolkhovskikh *et al.* (1969), these studies have produced chromosome counts for only 50 of the approximately 100 species of the genus. Stern (personal communication) indicates that the pondweeds are difficult to collect for meiotic material since the plants undergo meiosis quite rapidly in very early bud stage. The above-mentioned factor added to the fact that the aquatic environment is a difficult one for field work probably are the major reasons that few cytological studies have been undertaken on the pondweeds. During the summers of 1970, 1971, and 1972, I collected flower buds with the intention of obtaining chromosome counts from meiotic material. The buds were preserved in the usual manner with a 3:1 solution of ethyl alcohol and acetic acid. In some instances, the buds were examined within two or three days of collection; in others, the buds were examined after several months. In all instances I failed to have success in obtaining countable meiotic configurations. Therefore, all counts included in this paper are based upon previous reports in the literature.

According to Stern (1961), the base number for *Potamogeton* is $x = 13$ or 14. The majority of the chromosome numbers reported for the floating-leaved species are multiples of these figures; e.g. *P. amplifolius* Tuckerm., $n = 26$; *P. gramineus* L., $n = 26$; *P. illinoensis* Morong, $n = 52$

(Stern, 1961). On the other hand, most reports for the submersed-species indicate an n number of 13 or 14. A summary of the reported chromosome numbers for the *Pusilli* is included in Table 1.

These reports of chromosome numbers in *Potamogeton* should be considered with caution, as the nomenclature has been considerably confused and most workers, excluding Stern (1961) and Taylor and Mulligan (1968), did not cite voucher specimens from which the counts were taken.

TABLE 1

Published chromosome numbers for *Potamogeton* subsection *Pusilli.*

Taxon	Chromosome number
P. berchtoldii Fieber	$n = 13$ (Taylor & Mulligan, 1968)
[*P. pusillus* var. *tenuissimus*]	$2n = 26$ (Taylor & Mulligan, 1968)
P. foliosus Raf.	$2n = 28$ (Stern, 1961)
P. groenlandicus Hagstrom	$2n = 26$ (Jørgensen, *et al.*, 1958)
P. mucronatus Schr. [*P. friesii*]	$2n = 26$ (Palmgren, 1939)
P. obtusifolius M. & K.	$2n = 26$ (Palmgren, 1939)
P. panormitanus Biv. [P. *pusillus* var. *pusillus*]	$2n = 26$ (Palmgren, 1939)
P. strictifolius Ar. Benn.	$2n = 52$ (Löve, 1954)

PHYLETIC RELATIONSHIPS

GENERIC RELATIONSHIPS: According to Cronquist (1968), *Potamogeton* is classified in the Class Liliatae (monocots), Subclass Alismatidae, Order Najadales, and family Potamogetonaceae. He considers the Alismatidae to be "a near-basal sidebranch, a relictual group which has retained a number of primitive characters." The group is, therefore, not considered to be in the main line of evolution of the monocots.

In studying the relationships of the Potamogetonaceae with other families of the "Helobiae," Chrysler (1907) came to the conclusion that *Potamogeton* was the most primitive genus of the group and that *Potamogeton*-like organisms gave rise to most of the other genera. He considered the floating-leaved species, especially *P. pulcher* with its submersed leaves very similar to its floating leaves, to be more primitive than the submersed-leaved species. The submersed species were assumed to have been derived from the floating-leaved species as "a stage in the assumption of the aquatic life by the genus." One would conclude that Chrysler considered the Helobiae (Alismatidae) to have been derived from terrestrial species.

Cronquist (1968), on the other hand, considered the primitive monocots to have been derived from a Nymphaeales-like dicot, thus aquatic in origin. He considered the typical parallel-veined leaf of the monocot to be a modified, bladeless petiole. From this modified, flattened petiole, the expanded blade of, say *Sagittaria,* could have been derived by the spreading of the veins farther apart near the tip of the petiole. By applying this concept to *Potamogeton,* one could infer that the floating leaves might have been derived from the submersed leaves by an increase in the amount of tissue between the veins near the tip of the petiole. This would imply that possibly the floating-leaved species were derived from some ancestral stock of submersed-leaved plants.

Published cytological data (cf. cytological section) support this interpretation. The submerged-leaved species are, for the most part, diploid, whereas the floating-leaved species are, for the most part, tetraploid. Although Raven and Thompson (1964), DeWet (1965), and Anderson (1972) have demonstrated instances of polyhaploidy, based upon our present interpretation of cytological data as evidence for evolutionary relationships, the published chromosome numbers indicate that the primitive condition probably was that of total vegetative submergence.

As stated earlier, pollination in the Alismatidae is of three types — insect, wind, and water. According to Cronquist (1968), the reduction of the perianth in the Najadales reflects the abandonment of insect pollination, with water pollination, as in *Najas* and *Zostera*, being the most specialized type. One would suspect, therefore, the primitive species of *Potamogeton* to be wind-pollinated. The water-pollinated species, then, would have been derived from some wind-pollinated ancestral stock. Again, this interpretation is supported by cytological data. Chromosome number reports for the *P. filiformis* subsection are the highest of all *Potamogeton*. This group is the only one thought to be totally water-pollinated. Palmgren (1939) reports numbers of $2n =$ ca. 66 for *P. filiformis* Pers. and $2n =$ ca. 88 for *P. vaginatus* Turcz.

Based upon the scanty cytological, pollination, and morphological evidence, I here propose that the primitive species of *Potamogeton* were similar to *P. zosterifolius* in that they possessed narrow submersed leaves with many fine nerves and that they were wind pollinated. From the *Potamogeton zosterifolius*-like ancestor, several lines of differentiation probably occurred. One of these, featuring a reduction in vein number and retaining the wind pollination, eventually gave rise to the *Pusilli*. As the scope of this paper is only the *Pusilli*, I will not postulate on the systematic relationships of the entire genus. Instead, my further comments on this subject will be restricted to the *Pusilli*.

SUBSECTIONAL RELATIONSHIPS: *Potamogeton* subsection *Pusilli* is treated here to consist of 15 species. The species morphologically most similar to *P. zosterifolius* is *P. friesii*. The latter species, as does *P. strictifolius*, resembles *P. zosterifolius* in fruits, peduncles, inflorescence, leaves, and stipules. *Potamogeton friesii*, therefore, is probably the most primitive species of the *Pusilli*. *Potamogeton* *strictifolius*, being a tetraploid, probably was derived from a *P. friesii*-like ancestor by polyploidy. One can postulate two main lines having developed from the ancestral *Pusilli* (Fig. 2): 1) dorsal and lateral keels absent; 2) dorsal and/or lateral keels present.

The first line is represented by *Potamogeton pusillus* and *P. groenlandicus*. *Potamogeton pusillus* is widespread throughout the world, whereas *P. groenlandicus* is restricted to the coastal areas of Greenland. The latter species probably represents a population of *P. pusillus* that was isolated on Greenland and has differentiated from those of *P. pusillus*.

The second line is represented by *Potamogeton obtusifolius*, *P. hillii*, *P. clystocarpus*, and *P. foliosus*. *Potamogeton foliosus*, having a chromosome number of $2n = 28$, probably represents a population which was separated from a *P. obtusifolius*-like ancestor by aneuploidy and has become widespread. In fact, it is so widely distributed in North America that it is difficult to draw any relationships as to its possible place of origin. However, other species of the line as well as *P. strictifolius* and *P. friesii* have very distinct distributions. These ranges will be discussed and used as supplemental evidence for the phyletic relationships. *Potamogeton obtusifolius*, *P. strictifolius*, and *P. friesii*, have distributions limited almost entirely to geographical areas that were covered with ice during Pleistocene glaciation. These species probably survived glaciation elsewhere and migrated into the once glaciated areas following the retreat of the ice. Apparently, species or varieties could have evolved in a matter of 10,000 years. One need only examine a few of the Great Lakes endemics, e.g. *Iris lacustris* (Guire & Voss, 1963), *Cirsium pitcheri* (Johnson & Iltis, 1963), and *Calamovilfa longifolia* var. *magna* (Thieret, 1960). However, in comparison to these sand dunes endemics, most of the *Pusilli* are wide ranging circumboreal species. If these *Pusilli* were to have evolved recently, then rapid circumpolar dispersal also would have had to occur.

Hultén (1937) proposed that there were two main refugia in North America — the Rocky Mountains and the continental shelf outside eastern America — where plants survived during continental glaciation. From these refugia, he stated, the plants probably spread in an easterly and westerly direction, respectively, toward the center of the continent. Some taxa probably survived in only one area, while other taxa possibly survived in both areas. Some of the taxa which survived in both refugia migrated until their ranges overlapped; thus, they now have a continuous range across North America. For others, however, migration ceased before the ranges overlapped. Hultén conceded that species surviving in other areas south of the glacial boundary did migrate north to some extent into the once glaciated lands. However, he suggested that a much smaller proportion of the species now found in the glaciated areas survived in the vast areas south of maximum glaciation than in the two other refugia.

Iltis (1965) and Stuckey (1972) have suggested that certain species of *Gentianopsis* and *Rorippa,* respectively, survived glaciation in the Rockies and migrated eastward following the retreat of the Wisconsin Ice sheet. The distributions of the taxa discussed by these two workers are similar to that of *Potamogeton obtusifolius, P. strictifolius,* and *P. friesii* in that all have a more or less continuous range across northern North America and are mostly known from south of the glacial boundary only in the Rockies. Marie-Victorin (1938) proposed an explanation of the eastward migration of such species by suggesting that "the unforested belt that must have existed along a receding icefront [served] as a kind of sidewalk extending from the Rockies to the Gulf of St. Lawrence." He cited no pondweeds which demonstrated such distributions, but Stuckey (1972) indicated that *P. friesii* and *P. strictifolius* have ranges similar to a distribution pattern that Marie-Victorin probably had in mind when proposing this idea.

At the time of Hultén's article (1937) *Potamogeton obtusifolius* from western America was represented by few collections, all from localities in glaciated areas. This exiguous number of specimens from western America led Hultén to regard the taxon as a circumpolar species which survived in the eastern refugium. However, recent collections indicate that the taxon is widespread, although uncommon, throughout this geographical area, including the Rocky Mountains. Therefore, I include *P. obtusifolius* as a taxon which survived continental glaciation in the western refugium and then migrated eastward.

Potamogeton hillii, on the other hand, survived continental glaciation in eastern America just south of the glacial boundary, in the area of Pennsylvania, and migrated north and west with the retreat of the ice. In fact, the morphological similarity of the species with *P. obtusifolius* would indicate that prior to glaciation, the two currently recognized taxa were perhaps represented by one large heterogeneous population. Glaciation would have separated this large population into two smaller allopatric ones, one to the east and one to the west. During glaciation, the two populations differentiated, resulting in each population evolving into a different species. Once the period of glaciation was complete and the distributions overlapped, the reproductive barriers that had been established during glaciation, evidently now prevents gene flow from one population to the other. Iltis (1965) indicated that *Gentianopsis procera* and *G. crinita* possibly had a similar history. Similarly, *P. clystocarpus* is known from only one locality in Jeff Davis County, Texas. This species probably represents a population of *P. obtusifolius* in the southern mountains which was isolated and has differentiated from the parental population.

TAXONOMY

Of the more than 60 names that have been proposed for the North American *Potamogeton* subsection *Pusilli,* most of these are based on differences in venation, texture, color, lacunae number, and apex shape of the leaves. Dandy (1937), Dandy and Taylor (1940), and Clapham *et al.*

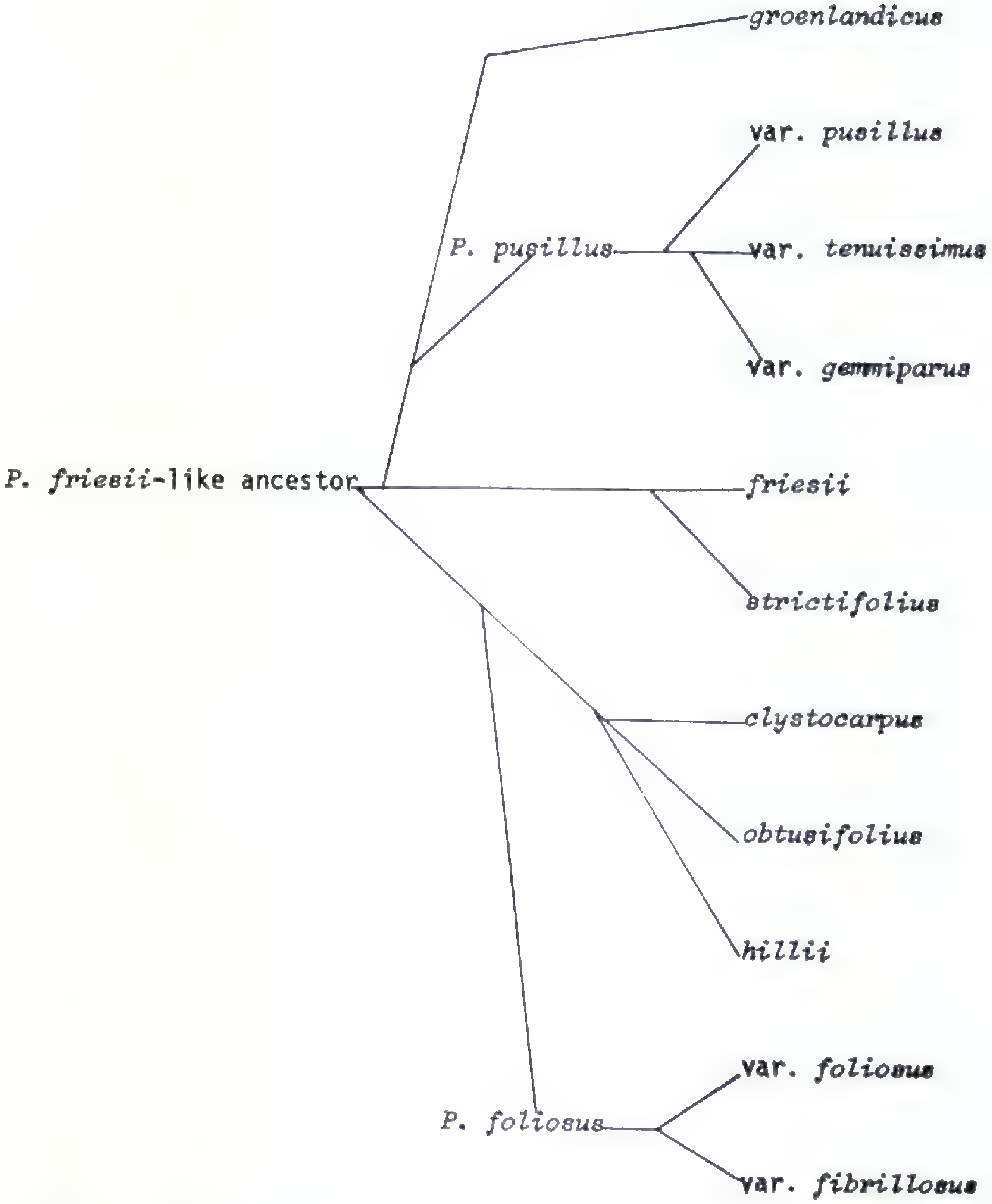

Fig. 2. Hypothetical phylogenetic relationships of North American *Pusilli*.

(1962) have shown that the leaf form and anatomy of *Potamogeton* may vary widely with age, water depth, current speed, nutrient supply, light intensity, and perhaps other factors. Data from classical and experimental studies of other genera of aquatic vascular plants indicate that this heterophyllous condition is common among the submerged species. Fassett (1951) illustrated no fewer than ten quite distinct individuals of *Callitriche heterophylla* and drew attention to the close morphological similarities of ecological forms which actually belong to different species. Bostrack and Millington (1962) found in *Ranunculus flabellaris* that the shape of the leaf may be affected by temperatures, photoperiod, light intensity, and submergence acting directly upon the distribution and frequency of cell division in the primordium so that the inherent zones of growth initiated on the primordium are modified in their development. Cook (1966), in fact, after recognizing 20 taxa of *Ranunculus* subgenus *Batrachium* listed 302 names which applied to these taxa. Williams (1970) found that by transplanting individuals of *Nymphaea tuberosa* to localities where *N. odorata* occurred, the individual would lose its "*tuberosa*" characters and obtain those of *N. odorata*. For reasons just outlined, these workers have found it necessary to compile a classification based primarily on reproductive characters.

My approach to the systematics of *Potamogeton* subsection *Pusilli* has been primarily that of combined herbarium and field studies. The data presented are based on three summers field work in northern United States and southern Canada and an examination of over 8000 herbarium specimens from the following 22 herbaria (Acronyms from Lanjouw and Stafleu, 1964): C, CAN, CGE, DAO, F, GH, ILL, K, LAF, MICH, MO,MU, NY, NYS, OS, PH, S, UC, UMBS, UPS, US, W.

Evidence from the field work has indicated that the *Pusilli* are as morphologically plastic as *Callitriche* and *Ranunculus*. Just as workers in these other genera have resorted to fruiting characters as a basis of a classification, I think that a classification based for the most part upon the reproductive structures is the only one which would be workable. Therefore, one should always attempt to collect flowering or fruiting specimens (preferably fruiting)! Just as identification of a sterile *Aster* or *Solidago* is nearly impossible, it is difficult at best to identify a sterile pondweed (and then one can never be sure of his determination).

I have thus refrained from mapping any specimen in which the determination was questionable.

For one to completely adhere to the biological species concept, he should demonstrate, either experimentally or naturally, if hybridization between two taxa does occur. However, in genera such as *Potamogeton,* in which the flowers are so small as to render difficult the artificial crossing of individuals, one hardly can demonstrate whether two individuals are capable of crossing and producing fertile offspring. Ogden (1943) has suggested that the broad-leaved species of *Potamogeton* hybridize quite readily. He, however, did not demonstrate this phenomenon experimentally; rather he depended wholly upon the hybrid individuals possessing characters intermediate between those of the two putative parents. With the *Pusilli,* however, it is not so easy. Vegetatively, the condition one would expect to find a hybrid, the species of the *Pusilli* are quite similar; thus, intermediates would be difficult to detect. Therefore, the techniques used by Ogden are not applicable to the *Pusilli.*

Because of the difficulties outlined above with hybridization, I have chosen to stress a morphological species concept. I have followed the premise that species should be separated by discontinuities between the morphological ranges of the fruits, peduncles, inflorescence, and, to a lesser extent, the winter buds. Therefore, for the 60 names which have been applied to the North American *Pusilli,* I am accepting only eight species, with one of these, *Potamogeton foliosus,* being represented by two varieties and another, *P. pusillus,* being represented by three varieties. In an attempt for consistency, I have regarded varieties as morpho-geographic subdivisions of a species (Kapadia, 1964) that presumably reflect genetic differences. As will be noticed, I do not recognize subspecies or forms. It is my contention (as that of Raven, 1969) that only one infraspecific unit should be recognized. I have chosen to use variety over subspecies because of tradition in eastern North America.

In the treatment that follows, keys are based upon fruiting material. Dimensions of leaves are taken from the fully expanded, longest leaves of a specimen. Measurements of the width were taken approximately at the widest point of the leaf. Dimensions of the spike and peduncles are based upon both flowering and fruiting specimens. Descriptions of the fruits are taken strictly from mature structures.

POTAMOGETON Linnaeus, Species Plantarum 126. 1753

Hydrogeton Loureiro, Flora Cochinchinensis 244. 1790. Type Species: *Hydrogeton heterophyllum* = *Potamogeton octandrus* Poir.

Patamogeton Honckeny, Syn. Plan. Germ. 2: 110. 1793. (orthographic variant).

Potamogiton Rafinesque, Med. Repos. 5: 354. 1808. (orthographic variant).

Potamogetum Clairville, Man. d'Herb. Suisse & Valais 34. 1811. (orthographic variant).

Peltopsis Rafinesque, J. Phys. Chim. Hist. Nat. Arts 89: 102. 1819. Type Species: *Potamogeton perfoliatus.* L.

Spirillus J. Gay, Compt. Rend. Hebd. Seances Acad. Sci. 38: 703. 1854. (name without any listed species); emend. Nieuwland, Amer. Midl. Naturalist 3: 14. 1913. Type Species: (lectotype here designated) *Potamogeton diversifolius* Raf.

Plants herbaceous, aquatic, submerged in fresh or rarely brackish water, annual or perennial, propagated from seeds, winter buds, or rhizomes. Stems variable in length according to water depth, branched or unbranched, terete or compressed, rooting at the nodes. Leaves all submersed or both submersed and floating, alternate or subopposite; submersed leaves pellucid, sessile or petiolate, linear to orbicular, subulate to obtuse at the apex, the margins entire to serrate, rarely crimped, the nerves 1-35; floating leaves coriaceous, mostly petiolate, rarely subsessile, elliptic to ovate, acute to obtuse at apex, cuneate to rounded or cordate at base, the margins entire, the nerves 3-51. Stipules tubular, sheathing the stem and young inflorescences, connate or convolute, either free or adnate to the base of submersed leaves, free from base of floating leaves. Winter buds present or absent, with extremely shortened nodes, divided into inner and outer leaves; inner leaves few to numerous, either shortened and oriented at 90° angles with respect to outer leaves, rolled into a fusiform structure, or unmodified; outer leaves 1-5 per side, mostly similar to vegetative leaves, rarely corrugated near base. Inflorescence a capitate or cylindric spike with 1 to 20 whorls of flowers, compact or moniliform, with 2 to 4 flowers each whorl, mostly buoyed above surface of water. Flowers bisporangiate. Perianth of 4, free, rounded, short-clawed, greenish segments. Androecium of 4 stamens: filaments adnate to the perianth claw; anthers bithecate, extrorse. Pollen spherical monoaperturate. Gynoecium of 4, free, unilocular, uniovulate carpels; ovule campylotropus; placentation parietal. Fruit drupe-like; dorsally rounded or keeled; embryo coiled; cotyledon one, endosperm absent. Chromosome base number: $x = 13$ or 14 (Stern, 1961). (Name from the Greek *potamos,* a river and *geiton,* a neighbor.) Type Species: *Potamogeton natans* L. (*fide* Taylor, 1909).

POTAMOGETON Subsection **PUSILLI** Graebn. in Aschers. & Graebn. Das Pflanzenreich 4(11): 260. 1907.

Plants submersed in fresh water, annual or perennial. Stems branched or unbranched, terete or compressed. Leaves all submersed, pellucid, sessile, linear, subulate to obtuse at apex, entire, 1-9-nerved. Stipules connate or convolute, free from the base of the leaves. Winter buds present or absent. Inflorescence mostly emersed, a capitate or cylindric spike with 1-5 whorls of flowers, compact or moniliform, mostly with 4 flowers at each whorl. Fruit dorsally rounded or keeled, to 4.0 mm long. Chromosome base number $x = 13$ or 14. Type Species: *Potamogeton pusillus* L.

KEY TO THE TAXA OF NORTH AMERICA

1. Leaves 7-9-nerved *and* inner-leaves of winter buds unmodified; plants of Greenland. . . 8. *P. groenlandicus.*
1. Leaves with up to 9 nerves, but *if* 7-9-nerved, *then* with inner-leaves of winter buds modified; plants from areas other than Greenland. . . . . 2.
    2. Fruits with a dorsal keel or ridge to 0.4 mm high, often with 2 lateral keels. . . . . 3.
        3. Inflorescence cylindric, 8 mm or more long; basal glands usually present, mostly 0.5 mm or larger in diam; leaves obtuse or apiculate, rufescent. . . . . 3. *P. obtusifolius.*
        3. Inflorescence capitate or rarely cylindric, 7.5 mm or shorter; basal glands when present, mostly smaller than 0.5 mm diam; leaves acute, rarely obtuse, olive or green. 4.
            4. Peduncle cylindric, mostly terminal, erect; basal glands present; fruit with basal tubercles. . . . . 6. *P. clystocarpus.*
            4. Peduncles usually clavate, axillary, often recurved; basal glands uncommon; fruit without basal tubercles. 5.
                5. Fruits rounded on sides, 3-keeled, 3-4 mm long; dorsal keel ridge-like, to 0.2 mm high. . . . . 4. *P. hillii.*
                5. Fruits with concave sides, 1-keeled, to 2.7 mm long; dorsal keel wing-like and undulate, to 0.4 mm high. . . . . 6.
                    6. Spike rarely interrupted; fruit olive to green-brown, 1.5-2.7 mm long, 1.2-2.2 mm wide; keel mostly 0.2 mm high or higher; beak 0.2-0.6 mm long; stipular veins decaying with age; basal glands rare, to 0.3 mm diam. . . . . 5a. *P. foliosus* var. *foliosus.*

6. Spike mostly interrupted; fruit pale-green, 1.4-1.7 mm long, 1.1-1.2 mm wide; keel mostly less than 0.2 mm high; beak 0.2 mm long or less; stipular veins with age remaining as long fibers; basal glands common, to 0.5 mm diam. . . 5b. *P. foliosus* var. *fibrillosus.*

2. Fruits with dorsal surface rounded; lateral keels absent. . . . . 7.

7. Stipules more or less coarsely fibrous, whitish, the oldest tending to disintegrate into shreds; bases of winter-buds usually indurated and corrugated; peduncles mostly clavate. . . . . 8.

8. Leaf tips rounded to apiculate; leaves light green to rufescent, 5-7 (-9)-nerved, 1.2-3.2 mm wide; winter buds 1.5-4.0 mm wide, inner leaves modified into a fan-shaped structure, outer leaves corrugated at base; peduncles compressed; stem compressed. . 1. *P. friesii.*

8. Leaf tips acute, rarely obtuse, mostly deep green to olive, 3-5 (-7)-nerved, 0.6-2.0 mm wide; winter buds 0.8-2.2 mm wide; inner leaves modified into a fusiform structure, outer leaves rarely with corrugations at base; peduncles mostly terete; stem mostly terete. . . . . 2. *P. strictifolius.*

7. Stipules mostly delicate, whitish, green, or brownish, usually disintegrating with age; bases of winter-buds without corrugations; peduncles cylindric. . . . . 9.

9. Fruits 2.5-3.6 mm long, 1.7-2.4 mm wide; winter buds 3.5-7.8 cm long, 2.3-5.1 mm wide, inner leaves unmodified. . . 3. *P. obtusifolius.*

9. Fruits 1.5-2.2 mm long, 1.2-1.6 mm wide; winter buds 0.9-3.2 cm long, 0.3-1.8 mm wide, inner leaves modified into a fusiform structure. . . . . 10.

10. Leaves uninervate, subulate, 0.2-0.7 mm wide; plants of New England and southern Quebec. .... 7c. *P. pusillus* var. *gemmiparus*.

10. Leaves 1-5-nerved, acute to obtuse, 0.2-2.5 mm wide; widespread throughout North America. .... 11.

    11. *Mature* fruit widest above the middle, sides concave, beak central; peduncle filiform to cylindrical, usually 1-3 per plant; inflorescence usually of 2-4 distinct verticels; leaves with up to 2 rows of lacunae along midrib, apex acute, rarely apiculate; stipules mostly connate. .... 7a. *P. pusillus* var. *pusillus*.

    11. *Mature* fruit mostly widest at or below the middle, sides rounded, beak mostly forward, peduncles cylindrical, usually more than 3 per plant; inflorescence mostly of 1-2 adjacent verticels; leaves with 1-5 rows of lacunae along midrib, apex acute to obtuse; stipules mostly convolute. .... 7b. *P. pusillus* var. *tenuissimus*.

1. **Potamogeton friesii** Rupr. in Beitr. Pflanzenk. Russ. Reiches 4: 43. 1845. TYPE: (type not located), application of the name is from the illustration of *Potamogeton compressus auct. non* Linn.: *In* Reichenbach. Icones Florae Germanicae et Helveticae 7: *pl. 24*. 1845!

Spirillus friesii (Rupr.) Nieuwl. Amer. Midl. Naturalist 3: 17. 1913.

Potamogeton pusillus var. *major* Fries, Novitiae Florae Suecicae, ed. 2, 48. 1828. *P. mucronatus* Schr. ex Sonder, Flora Hamburgensis 99. 1851. *P. major* (Fries) Morong, Mem. Torrey Bot. Club 3: 41. 1893. TYPE: (type not located), application of the name is from the illustration of *Potamogeton compressum auct. non* L.: *In* Smith, English Bot. 2: *pl. 418.* 1797!

Potamogeton pusillus var. *latifolius* Meyer, Chloris Hanoverana, 525. 1836. *P. oederi* Meyer, Flora Hanoverana Excursoria 536. 1849. TYPE: (type not located), application of the name is from the illustration of *Potamogeton compressum auct. non* L.: *In* Oeder, Flora Danica 2: (4) *t. 203.* 1765!

Stem pale green to pale brown, simple to profusely branched near the apex, compressed, slightly ridged, 10-135 cm long, 0.3-1.1 mm diam. Leaves usually light green, rarely olive-green to rufescent, delicate to rigid, 5-7 (-9)-nerved, 2.3-6.5 cm long, 1.2-3.2 mm wide; apex acute to apiculate, glands green, greenish-brown, or gold, to 0.7 mm diam; lacunae absent or 1 narrow row each side of the midrib; lateral nerves joining the midrib 0.2-0.9 mm below the apex. Stipules white, fibrous, shredding at apex, 5.5-21.0 mm long, 0.7-2.5 mm diam. Winter buds common, terminal or lateral, 1.5-5.0 cm long, 1.5-4.0 mm wide; inner leaves reduced, arranged into a fan-shaped structure and oriented at right angles to the outer leaves; outer leaves 2-3 per side, apiculate to acute, corrugated at base. Peduncles usually slightly clavate, terminal or axillary, rarely recurved, 1.2-4.1 (-7.0) cm long, (0.1-) 0.5-1.2 mm diam. Spike cylindrical, 7.0-16.0 mm long, 2.6-8.0 mm diam; verticels 2-5, 1.5-5.0 mm apart. Perianth segment 1.2-1.5 mm long, 0.5-1.5 mm wide. Fruit olive-green to brown, without dorsal keel, 1.8-2.5 mm long, 1.2-2.0 mm wide; beak central, 0.3-0.7 mm long, 0.2-0.5 mm diam; sides rounded, rarely centrally depressed; wall texture smooth, rarely reticulate. Chromosome number, $2n = 26$ (Palmgren, 1939).

Distribution: Central Alaska to Newfoundland, south to northeastern Utah and southeastern Pennsylvania, Fig. 3. Fruiting from late June to September.

Illustrations: Fernald (1932, pl. 6; 29, fig. 3; 33, fig. 1; and 39, fig. 8).

Nomenclaturally, *Potamogeton friesii* has been poorly understood. The taxon was long referred to *P. compressum* L. (Smith, 1797; Oeder, 1765; Reichenbach, 1845). Fries (1828) regarded the taxon as a variety of *P. pusillus* and, therefore, proposed *P. pusillus* var. *major.* However, Mertens and Koch (1828) had made the same combination for a different taxon. Thus, Fries' name was a later homonym. The first combination at specific rank which apparently applied to this entity was *P. mucronatus* Schrader. However, to my knowledge, this name was never published by Schrader, but first appeared in Romer and Schultes (1818) as a *nomen nudum* — "Qid *P. mucronatus* Schrader." I have been unable to locate the name again until used by Reichenbach (1845), definitely placing the name in synon-

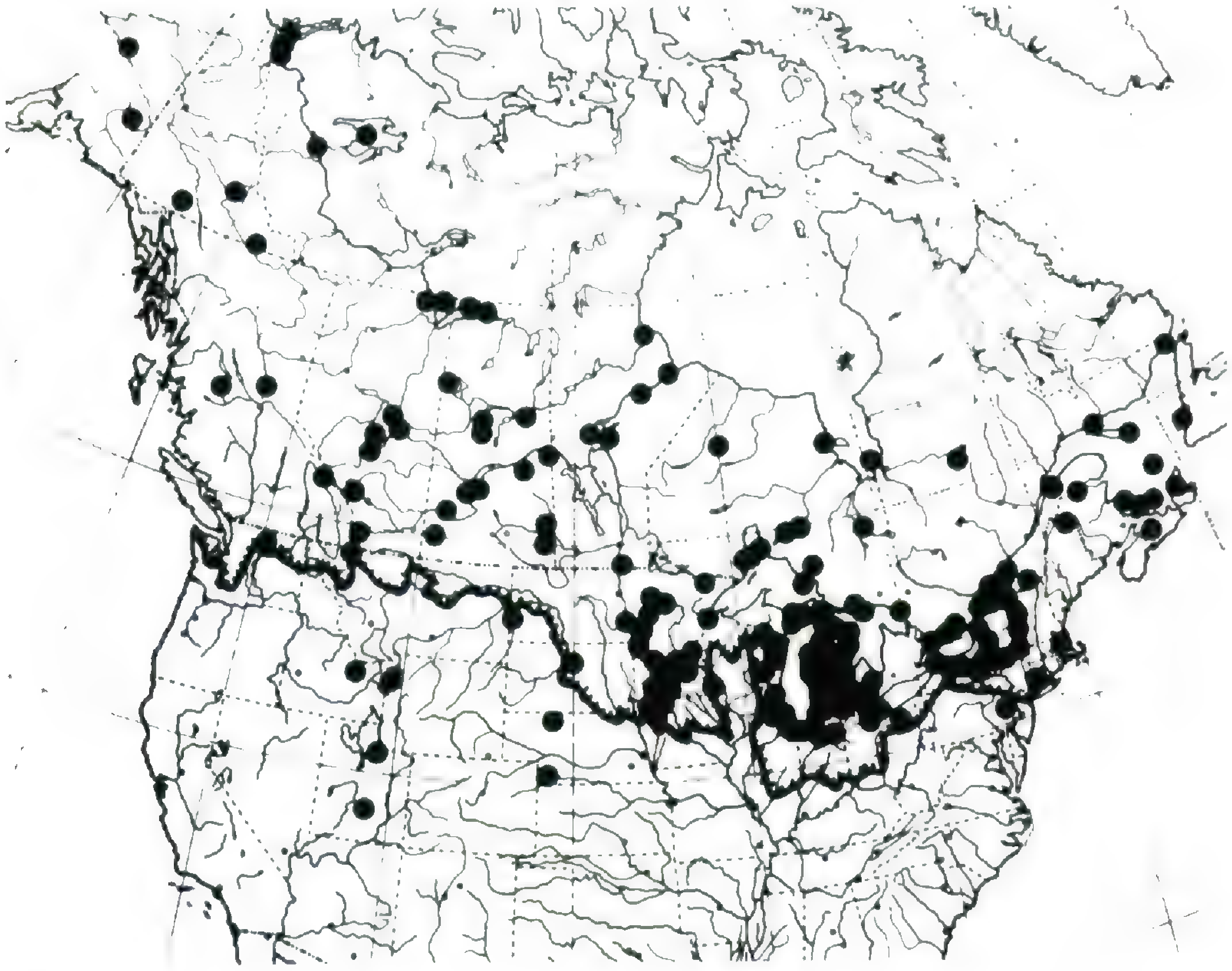

Fig. 3. Map of North America showing the documented distribution of *Potamogeton friesii.* The barred line represents the southern limit of Wisconsin Glaciation in the United States east and west of the Rocky Mountains (after Flint, 1957; Flint, *et al.*, 1959).

omy under *P. compressum* — "*P. mucronatus* Schrader, R. S. III. p. 517!" Neither of these references to *P. mucronatus* constitute publication, since a name is not considered validly published when it originally appears in synonomy. Apparently, the name was not validly published in specific rank until Sonder (1851) applied a description, giving credit to Schrader.

However, Ruprecht (1845) had validly published *Potamogeton friesii* and accurately applied the name to the entity which we now consider to be this taxon. Although I have not seen any of his original specimens, he referred to the illustration cited above in Reichenbach (1845) and also to one in Oeder (1765), both of which are *Potamogeton friesii.*

REPRESENTATIVE SPECIMENS

CANADA: **Alberta:** Bow River Valley, *Brown* 692 (GH, NY, PH); Banff (Vermilion Lakes), *Malte & Watson* 961 (CAN, GH). **British Columbia:** Blackwater Lake, ca. 32 mi. N. of Golden, *Hitchcock & Martin* 7645 (NY, UC). **Manitoba:** Cross Lake, 45 mi N of Lake Winnipeg, *Scoggan* 3573 (CAN). **New Brunswick:** Tidehead, near Campbellton, *Malte* 784 (CAN). **Newfoundland:** St. Georg's Pond, near Bay St. George, *Fernald & Wiegand* 2456 (CAN, GH, PH, NY). **Northwest Territories:** MacKenzie River delta, East branch, 68°40'N, *Porsild* 7243 (GH, US). **Nova Scotia:** GOLDCHESTER CO.: Salmon River, Truro, *Bissell & Linden* 19698 (GH). **Ontario:** HASTINGS CO.: no locality, *Macoun* s.n. (F, K, MO, NY, S); Charlton Island, James Bay, 52°N, 79°30'W, 4292 (CAN, US, photo at DAO). **Prince Edward Island:** KINGS CO.: Black Pond, *Fernald & St. John* 6772 (CAN, GH, K, NY, US); Cove Head, *Macoun* 3000 (CAN, GH, K, MO, NY). **Quebec:** Coffin Island, Magdalen Islands, *Fernald et al.* 6775 (CAN, GH, K, NY, PH, US); Ile de la Grand-Entree, Magdalen Islands, *Marie-Victorin & Rolland-Germain* 9921 (F, GH, NY, PH, US). **Saskatchewan:** Barrier River, ca. 4 mi. W, 3 mi. S. of McKague, *Breitung* 414 (CAN, DAO, NY, UC). **Yukon:** Craig Lake, vicinity of Carcross, *Porsild* 18418 (CAN). UNITED STATES: **Alaska:** vicinity of College, near Fairbanks, *Argus* 1097 (DAO). **Connecticut:** NEW HAVEN CO.: Derby, *Robbins* (GH, NY). **Idaho:** JEFFERSON CO.: Mud Lake, *Sperry & Martin* 670 (US). **Illinois:** COOK CO.: South Chicago, *Hill* 79-1881 (ILL). **Indiana:** WHITLEY CO.: Goose Lake, ca. 7 mi. NW of Columbia City, *Deam* 48794 (GH). **Iowa:** DICKINSON CO.: East Lake Okoboji, *Shimek* (DAO, F, GH, MO). **Maine:** AROOSTOOK CO.: Washburn, Aroostook River, *Ogden & Chamberlain* 2692 (OS). **Massachusetts:** MIDDLESEX CO.: Fresh Pond, Cambridge, *Faxon* (GH, NY, US). **Michigan:** CHEBOYGAN CO.: Black River between mouth and Alverno, *Haynes* 3377 (LAF, OS); *Haynes* 3385 (MO, OS); *Haynes* 3698 (MO, NY, OS); Hook Point, Douglas Lake, *Haynes* 3361 (F, GH, MO, NY, OS, PH, UC, US); mouth of Bessey Creek, Douglas Lake, *Haynes* 3887 (OS); Marl Bay, Douglas Lake, *Haynes* 3711 (ASU, GH, LAF, OS). EMMET CO.: small arm of Carp Lake, *Haynes* 3376 (OS); *Haynes* 3694 (OS); *Haynes* 3747 (OS); *Haynes* 3889 (OS). MANISTEE CO.: Little Manistee River, Manistee, *Hill* (F, GH, ILL, MO, US). **Minnesota:** CASS CO.: Cullen Lake, *Ballard* (ILL, MICH, MO, UC, US). MARTIN CO.: Silver Lake, *Cratty* (GH, ILL, MO, NY, PH, UC, US). **Montana:** GLACIER CO.: marshes above Lower Two Medicine Lakes, Glacier National Park, *Maguire* 482 (GH). **Nebraska:** CHERRY CO.: Dewey Lake, near Valentine, *Tolstead* 477 (GH). **New York:** CORTLAND CO.: Upper York Lake, near Little York, *Haynes* 3347 (MICH, MO, OS, US); *Haynes* 3348 (F, GH, MO, NY, OS, PH, UC, US); *Haynes* 3349 (MICH, OS); *Haynes* 3350 (MICH, OS). ONTARIO CO.: Lake Seneca, Geneva, *Morong* (CAN, GH, NY, S). SARATOGA CO.: Saratoga Lake, *Haynes* 3311 (MICH, MO, OS). WARREN CO.: Dunham Creek near S. end of Lake George, *Haynes* 3330 (GH, MICH, MO, OS, UC, US); *Haynes* 3331 (MICH, MO, OS, US). **North Dakota:** CASS CO.: Fargo, *Whitney* (MU). **Ohio:** ERIE CO.: East Bay, Sandusky, *Osburn & Williamson* (GH). **Pennsylvania:** LEHIGH CO.: Bethlehem, *Noble* (GH, PH). **South Dakota:** FAULK CO.: ponds and rivers, near Jacques, *Geyer* (US). **Utah:** SUMMIT CO.: Lyman Lake, Blacksfork Creek, *Hobson* 52 (GH). **Vermont:** ADDISON CO.: Little Otter Creek, Ferrisburg, *Faxon* (GH, US). **Washington:** OKANOGAN CO.: Bonaparte Lake, *St. John, et al.* 5298 (GH, MO, UC). **Wisconsin:** BROWN CO.: Point Sable, Green Bay, *Schuette* (F, GH, K, MICH, UC). MILWAUKEE CO.: Milwaukee, *Lapham* (GH, K, MO, PH). **Wyoming:** TETON CO.: shallow lake, 10 mi. s. of Moran, *Porter & Porter* 7869 (DAO, UPS, UC).

2. **Potamogeton strictifolius** Ar. Benn. J. Bot. **40:** 148. 1902.

Potamogeton pusillus var. *pseudo-rutilus* Ar. Benn. J. Bot. **39:** 201. 1901. *P. foliosus* × *P. rutilus?* Hagstrom, Kongl. Svenska Vetenskapsakad. Handl. 55(5): 91. 1916. *P. strictifolius* var. *typicus* Fern., Mem. Amer. Acad. Arts **17:** 56. 1932. TYPE: *E. J. Hill* [146], Wolf Lake, Hammond, [Lake Co.] Indiana, 3 Sept. 1900, (lectotype, *fide* Fernald, 1932, at K, but not located; photo of lectotype, CAN! NY!, isolectotype, ILL!).

Potamogeton strictifolius var. *rutiloides* Fern. Mem. Amer. Acad. Arts **17**: 57. 1932. *P. pusillus* var. *rutiloides* (Fern.) Boivin, Naturaliste Canad. **94**: 527. 1967. TYPE: *F. P. Metcalf* 1453, Molly Lake, 10 mi. N of Brainerd, Crow Wing Co., Minnesota, 26 Aug. 1921, (holotype, GH!; isotype, US!).

Stem pale green to green-brown, branched or simple, more or less rounded, slighty ridged, 27-95 cm long, 0.4-0.8 mm diam. Leaves green to olive, usually rigid, 3-5(-7)-nerved, 1.2-6.3 cm long, 0.6-2.0 mm wide; apex acute to nearly bristle-tipped; glands white, green, greenish-brown, or gold, to 0.3 mm diam; lacunae usually absent; lateral nerves joining the midrib 0.8-1.5 mm below the apex. Stipules usually white, fibrous, shredding at tip, connate, 0.6-1.6 cm long, 0.6-2.0 mm diam. Winter buds common, terminal or lateral, 2.5-4.8 cm long, 0.8-2.2 mm wide; inner leaves undifferentiated; outer leaves 3-4 per side, acute, mostly without, rarely with, corrugations at base. Peduncles usually cylindric, rarely slightly clavate, terminal, mostly erect, rarely recurved, 1.0-4.5 cm long, 0.3-0.9 mm diam. Spike cylindrical, 0.6-1.3 cm long, 1.5-5.2 mm diam; verticels 3-4, 1.5-3.2 mm apart. Perianth segments 0.9-1.7 mm long, 0.8-1.5 mm wide. Fruit green-brown, without dorsal or lateral keels, 1.9-2.1 mm long, 1.3-1.8 mm wide; beak central, 0.3-0.5 mm long, 0.2-0.4 mm diam; sides rounded, often centrally depressed; wall texture smooth. Chromosome number, $2n = 52$ (Löve, 1954).

Distribution: Northwestern Northwest Territories to eastern Quebec, south to northeastern Utah and northwestern Connecticut. Fruiting from early July to late September. Fig. 4.

Illustrations: Fernald (1932, pl. 7; 8; 29, fig. 4, 5; and 33, fig. 2, 3).

Bennett, in the original description of *Potamogeton pusillus* var. *pseudo-rutilus*, cited two collections: "Lake Scugog, Ontario, Canada, 1897, W. Scott, ex Prof. Macoun;" and

"Wolf Lake, Indiana, U.S.A., 1900, Rev. E. J. Hill." After receiving more material from Hill, Bennett later raised the taxon to specific rank. Hagstrom (1916) examined additional material sent to him by Hill and ascertained this to be a hybrid between *P. foliosus* and *P. rutilus*. Hagstrom cited the original specimen as being from Lake George, East Chicago, rather than from Wolf Lake. I think Hagstrom made an error in citing this specimen, or possibly Lake George and Wolf Lake refer to the same lake. The original most certainly was from Wolf Lake. Hagstrom did not examine material from Lake Scugog, but based his decision on the 1902 description of *P. strictifolius* by Bennett and other Canadian material he had examined from Sea-Cow-Pond, Crane Lake, Assiniboia, Picanok River, Quebec, and Ottawa River, Quebec [which he said "seem excellently to answer to the description of the fruiting plant of Lake Scugog"]. He concluded that the Lake Scugog material was probably the same as *P. panormitanous* (*P. pusillus* var. *pusillus*). Fernald examined Bennett's collection but overlooked the point of whether the Lake Scugog plant was the same taxon as the Wolf Lake plant. As he could not be certain that the two were the same, he did not deny or accept Hagstrom's decision. He did, however, designate Hill's collection from Wolf Lake, Indiana, September 3, 1900, as the Type [lectotype] of *P. strictifolius*. Fernald did say, with which I concur, that Hagstrom had erred in calling *P. strictifolius* a hybrid of *P. foliosus* and *P. rutilus*.

I also am unable to state with assurance that the specimen from Lake Scugog is conspecific with the one from Wolf Lake. I have corresponded with curators of the herbaria (K, BM, & CGE) where the majority of Bennett's material is located. There is no sheet in Bennett's collection at these herbaria filed under *Potamogeton pusillus*, *P. berchtoldii*, or *P. strictifolius*. As I have photographs from CAN, NY, & US of a sheet with only the two specimens mounted on it, I am certain that it is not correctly filed under the name of another specimen on the same sheet. The photograph from CAN has a paragraph in Bennett's handwriting stating that the sheet was in his collection and that the photograph was taken by his daughter.

I have, however, located a duplicate of Hill's collection from Wolf Lake, and also a second specimen collected by Scott at Lake Scugog on 3 August 1897 (the same day as the one in Bennett's collection). I can not ascertain if Scott's collection is a duplicate of the one sent to Bennett. With its convolute stipules, characteristic winter buds, and one row of lacunae along each side of the midrib, this specimen is rather characteristic of *P. pusillus* var. *tenuissimus*. It is, however, unusual in that the stipules are white rather than the usual greenish-brown of *P. pusillus* var. *tenuissimus*. Until the specimen in Bennett's collection can be located, I am following Fernald in that I cannot be sure to which taxon the Lake Scugog collection should be referred.

Fernald (1932) separated *Potamogeton strictifolius* into two varieties, var. *strictifolius* & var. *rutiloids*, based on the leaf apex shape, rigidity of the leaves, and the coarseness of the stipules. After examining many sheets and hundreds of plants in the field, I have concluded that this variability is both within and between populations. The leaf tips of the isotype of var. *strictifolius* at ILL, for example, vary from very gradually tapering acute to obtuse. Because of this variability within populations and of no apparent range distinctions, I consider *P. strictifolius* to be one taxon. The rigidity of the leaves, I believe to be of ecological rather than of genetic origin.

Morphologically, *Potamogeton strictifolius* is most similar to *P. friesii*. The best way to distinguish the species is by the winter buds. In *P. strictifolius*, the inner leaves of the winter buds are only slightly modified, whereas in *P. friesii* the inner leaves are much shorter than the outer leaves and are oriented at 90° to the outer leaves. Differences in the leaves are difficult to assess. Fernald (1932) and Ogden (personal communication) stress the number of veins — three to five in *P. strictifolius* and five to seven in *P. friesii*.

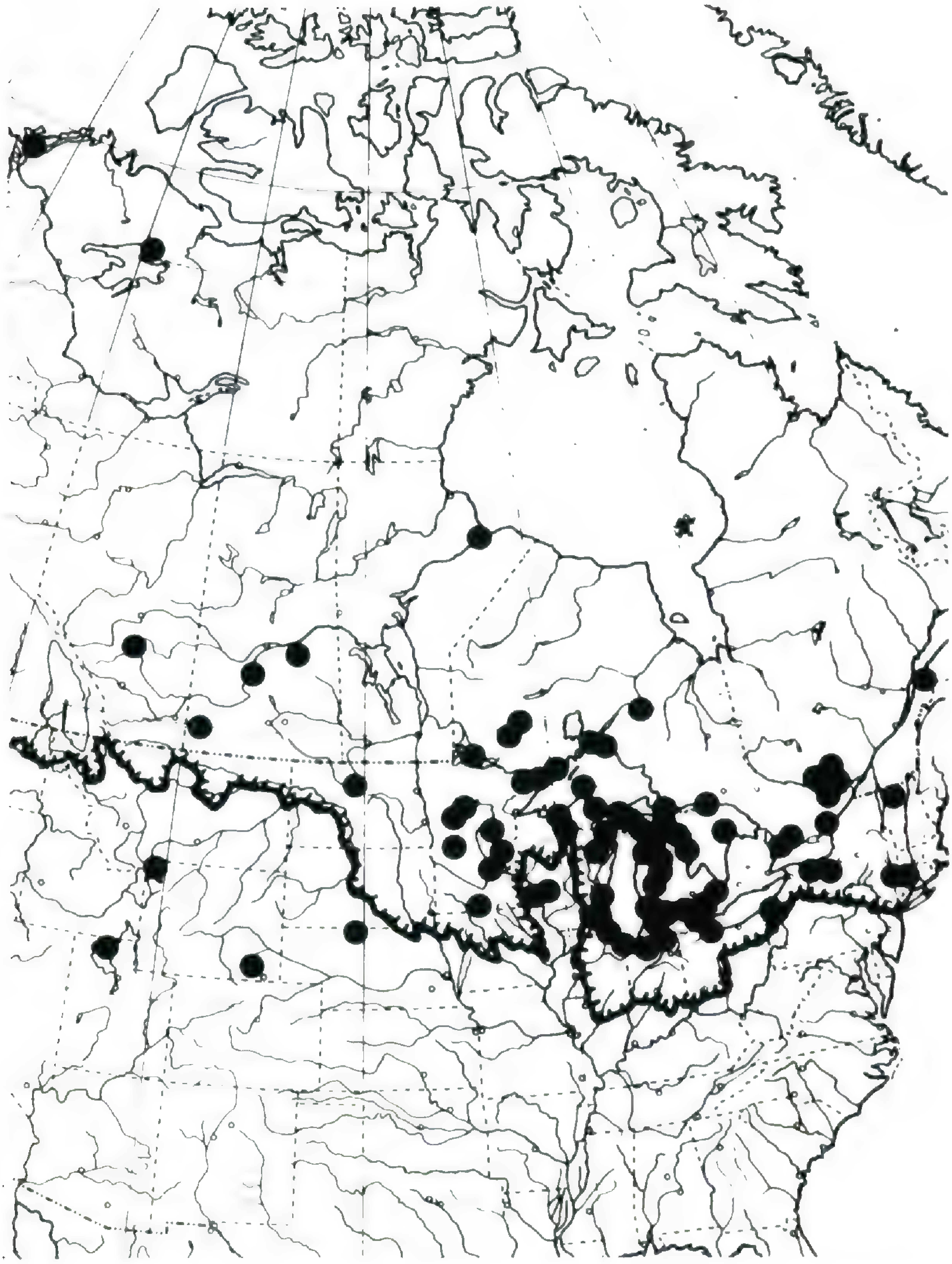

Fig. 4. Map of North America showing the documented distribution of *Potamogeton strictifolius*. The barred line represents the southern limit of Wisconsin Glaciation in the United States east and west of the Rocky Mountains (after Flint, 1957; Flint *et al.*, 1959).

For both species, I find, as does Voss (1972), that the usual number is five. If specimens are sterile and lacking winter buds and I must use vegetative characters, I then rely upon the apex shape and whether the leaves are revolute. In *P. strictifolius,* the apex is usually acute and the leaves are revolute. In *P. friesii,* the apex is obtuse to apiculate and the leaves are usually flat. However, as I indicated earlier and pointed by Voss (1972) one must use these characters with caution. In the late summer the margins of *P. friesii* roll under, thus the leaves become revolute.

REPRESENTATIVE SPECIMENS

CANADA: **Alberta:** Large pond, Lacombe, *Dixon* 691 (DAO, NY). **Manitoba:** York Factory, *Drummond* (GH). **Northwest Territories:** MACKENZIE DIST.: E branch of Mackenzie River, 68°40′ to 68°55′, Reindeer Station, *Porsild* 7234 (CAN). **Ontario:** THUNDER BAY DIST.: Black Fox Lake, *Haynes* 3750 (CAN, GH, LAF, MO, OS); Nipigon, Lake Superior, *Macoun* (CAN, NY, S). **Quebec:** GATINEAU CO.: Danford Lake, 45 mi. N of Ottawa, *Dore* 9032 (DAO, MO). **Saskatchewan:** Pike Lake, Saskatoon, *Fraser* 8 (DAO, GH). UNITED STATES: **Connecticut:** LITCHFIELD CO.: Indian Pond, Sharon, *Eames* 11868 (GH). **Illinois:** COOK CO.: Wolf Lake, Chicago, *Chase* 1709 (CGE, F, GH, ILL). **Indiana:** LAKE CO.: Lake George, East Chicago, *Hill* 144-1903 (GH, ILL, NY). **Michigan:** CHARLEVOIX CO.: Cunningham Lake, ca 6 mi SW of Ironton, *Voss & Haynes* 13602 (MICH). CHEBOYGAN CO.: Black River between its mouth and Alverno, *Haynes* 3379 (GH, MO, OS, US), *Haynes* 3384 (MO, OS, US), *Haynes* 3743 (GH, OS); Black Lake, near mouth of Upper Black River, *Haynes* 3777 (OS); Cheboygan River, *Haynes* 3798 (OS); Douglas Lake near source of Maple River, *Haynes* 3739 (GH, MICH, MO, NY, OS, UMBS, US). WAYNE CO.: Detroit River near Belle Isle, *Wheeler* (GH, ILL, NY, US). **Minnesota:** BECKER CO.: DeSota Lake, *Grant* 3269 (GH, NY, UC, US). **Nebraska:** CHERRY CO.: Willow Lake, *Thomson* 122 (US). **New York:** MONROE CO.: *Clausen & Hinkey* 4196 (GH, NY). **North Dakota:** MCHENRY CO.: Red Willow Lake, *Mabbott* 372 (US). **Ohio:** ERIE CO.: Sandusky Bay, *Pieters* (US). **Pennsylvania:** ERIE CO.: Presque Isle, *Garber* (GH). **Utah:** BOX ELDER CO.: Bear River, *Watson* 1136 (GH, K, NY, US). **Vermont:** CALEDONIA CO.: Sarah Moor Pond, 2 mi NW of Barnet, *Hotchkiss* 7804 (US). **Wisconsin:** WASHINGTON CO.: Big Cedar Lake, *Hotchkiss & Hoehler* 4264 (GH, US). **Wyoming:** ALBANY CO.: reservoir ca 6 mi. NE of Lookout, *Porter* 7370 (DAO, NY, UC, USP). PARK CO.: Firehole River S of Madison Junction, *Porter* 6385 (DAO, MO, NY, UC, UPS).

Potamogeton strictifolius × zosteriformis

Fernald (1932) named *Potamogeton longiligulatus* based upon flowering specimens from Newfoundland. The entity was said to resemble *P. hillii* by its bristle-tipped leaves but differed from the latter species by having numerous-nerved leaves. Voss (1967) reported that, at least in northern Michigan, the entity appeared to be a result of hybridization between *P. strictifolius* and *P. zosteriformis*, a species in the subsection *Compressi* of Hagstrom. Data gathered during my field studies in northern Michigan support Voss' conclusions. I have seen several instances where the putative hybrid was growing between populations of *P. zosteriformis* and *P. strictifolius*. The plants of the putative hybrid were morphologically intermediate between the two species. Therefore, until the putative hybrid can be studied in detail, I accept Voss' concept of the taxon.

SPECIMENS EXAMINED:

CANADA: **Newfoundland:** Straits of Belle Isle, pond in barrens S of Flower Cove, *Fernald & Long* 27330, (holotype, GH!; isotype, PH!, photo at DOA!). **Ontario:** BRUCE CO.: Bruce Peninsula, Stokes Bay, *Krotkov* 8627 (US). LAMBTON CO.: Sarnia Bay, *Dodge* (GH, photo at DAO). UNITED STATES: **Connecticut:** LITCHFIELD CO.: Salisbury, Twin Lakes, *Bissell* (GH). **Illinois:** LAKE CO.: Grayslake, *Dolbeare* 1444 (MICH). **Michigan:** CHEBOYGAN CO.: Black River between its mouth and Alverno, *Bedell & Prescott* 55 (UMBS), *Haynes* 3380 (GH, MO, OS, US), *Haynes* 3381 (GH, MO, OS, US), *Haynes* 3702 (OS), *Haynes* 3744 (OS), *Majors* (GH, NY, UMBS), *Voss* 11118 (GH), *Voss* 11359 (UMBS); Black Lake, bay at mouth of Black River, *Stuckey* 2411 (OS), *Stuckey* 3275 (OS, CAN), *Voss* 11745 (GH, NY), 11760 (UMBS); Cheboygan River, *Haynes* 3799 (OS). ST. CLAIR CO.: Algonac, Big Ditch, *Dodge* s.n. (US); Port Huron, *Dodge* s.n. (NY). SCHOOLCRAFT CO.: Lake McDonald, SE of Whitedale, *Uhler* 96 (US). **Minnesota:** BECKER CO.: Cotton Lake, *Hotchkiss* 6341 (GH). HENNEPIN CO.: Lake Minnetonka, *Keck & Stilwill* 416 (GH). **New York:** COLUMBIA CO.: Beebe Pond near Queechy Lake, *Haynes* 3344 (OS), *Haynes* 3801 (OS), *Smith & Ogden* 45590 (OS).

3. **Potamogeton obtusifolius** Mert. & Koch, in Röhling, Deutschland Flora 855. 1823. TYPE: (type not located), application of the name is from the illustration of *Potamo-*

geton gramineus auct. non L.: *In* Smith, English Bot. **11:** *pl. 2253.* 1811.

Spirillus obtusifolius (Mert. & Köch in Röhling) Nieuwl. Amer. Midl. Naturalist 3: 19. 1913.

Potamogeton compressum var. *tenuius* Wahl. Flora Upsaliensis 60. 1820. TYPE: *G. Wahlenberg,* Upsala Sraklen, Ekebysja near Quam, 22 Aug. 1818, (holotype, UPS!).

Potamogeton obtusifolius var. *angustifolius* Fieber in Berchtold, Oekon.-tech. Flora Bohmens 275. 1838. TYPE: (not located).

Potamogeton obtusifolius var. *latifolius* Fieber in Berchtold, Oekon.-tech. Flora Bohmens 275. 1838. TYPE: (not located).

Stem green to green-brown, slightly compressed, usually without ridges, 35-90 cm long, 0.3-0.7 mm diam. Leaves light green to rufescent, usually flaccid, 3-nerved, 3.0-8.2 cm long, 1.0-3.5 mm wide; apex round to round apiculate; glands yellow-green to gold, 0.2-1.0 mm diam; lacunae of 1-3 rows each side of midrib; lateral nerves joining the midrib 0.2-1.2 mm from apex. Stipules usually white, slightly fibrous, rarely shredding at tip, convolute, 0.6-1.8 cm long, 0.5-1.2 mm diam. Winter buds abundant, terminal, 3.5-7.8 cm long, 2.3-5.1 mm wide; inner leaves undifferentiated; outer leaves 3-4 per side, apiculate to obtuse, without corrugations at base. Peduncles cylindrical, axillary, rarely recurved, 0.8-1.9 (-4.2) cm long, 0.5-1.0 mm wide. Spike cylindrical, 0.8-1.3 cm long, 4.6-7.0 mm wide; verticels 3, crowded or to 2.0 mm apart. Perianth segments 1.4-1.5 mm long, 1.1-1.3 mm wide. Fruit olive-green to brown, 2.5-3.6 mm long, 1.7-2.4 mm wide; keels absent or present, when present, ridged, to 0.2 mm high; beak mostly central, rarely forward, (0.2-) 0.6-0.7 mm long, 0.5-0.7 mm diam; sides rounded; wall texture smooth or rough. Chromosome number $2n = 26$ (Palmgren, 1939).

Distribution: Eastern Yukon to eastern Quebec, south to Washington, Wyoming, and New Jersey. Fruiting from early July to late September. Fig. 5.

Illustrations: Fernald (1932, pl. 14; 30, fig. 3; 34, fig. 4; 39, fig. 1).

In its winter buds, fruit, and peduncles, *Potamogeton obtusifolius* most closely resembles *P. hillii*. When in fruit, however, it can easily be separated from the latter species by its spikes being cylindric, whereas those of *P. hillii* are capitate. Sterile specimens of *P. obtusifolius* can usually be distinguished from *P. hillii* by the former having obtuse leaves and the latter having acute leaves. However, plants of *P. hillii* occasionally possess obtuse leaves.

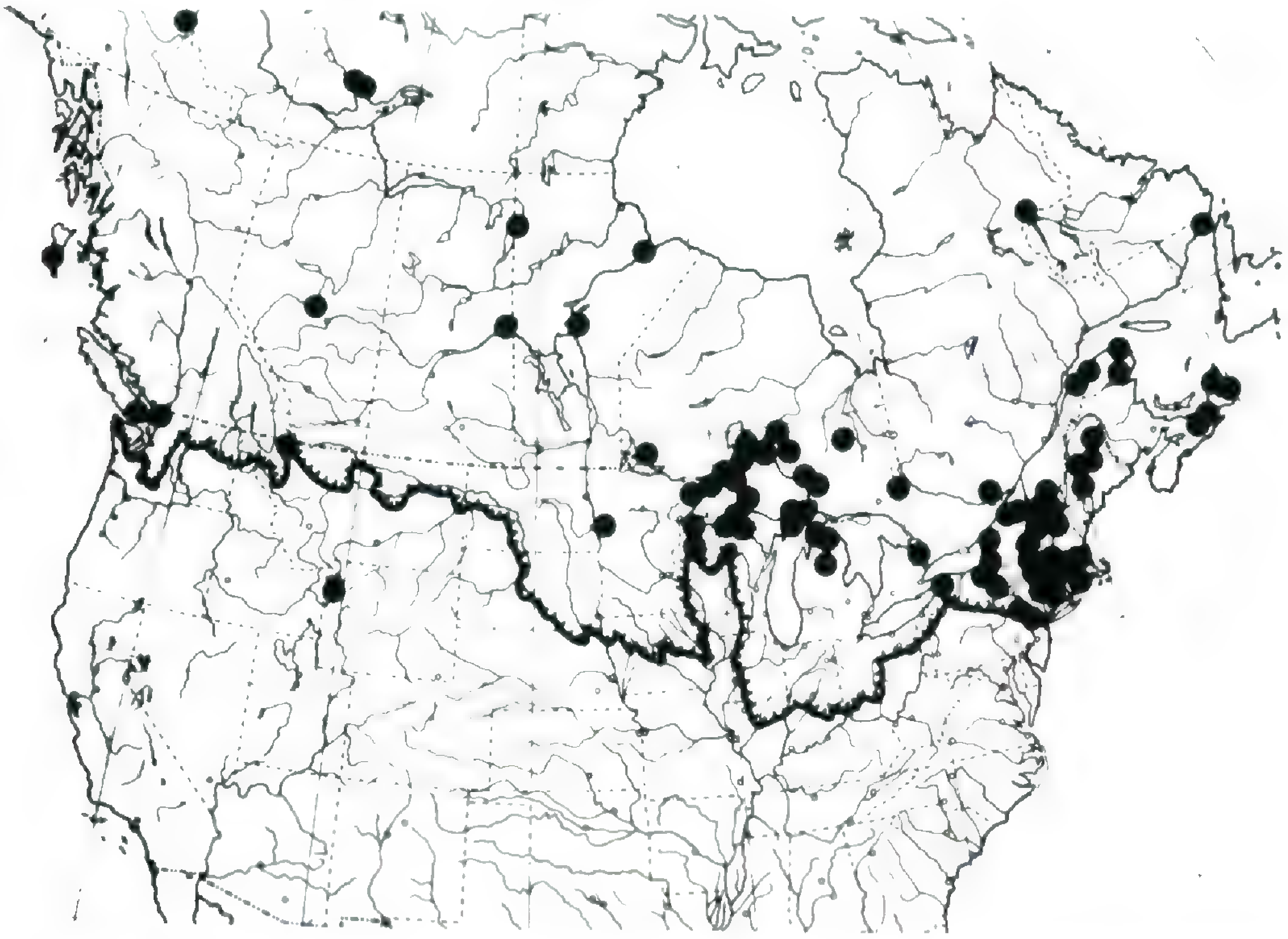

Fig. 5. Map of North America showing the documented distribution of *Potamogeton obtusifolius*. The barred line represents the southern limit of Wisconsin Glaciation in the United States east and west of the Rocky Mountains (after Flint, 1957; Flint *et al.*, 1959).

REPRESENTATIVE SPECIMENS

CANADA: Alberta: ca. 2 mi. W of Glenevis, *Moss* 12449 (CAN, DAO). **British Columbia:** VANCOUVER ISLAND: Cowichen, *Glendenmire* (CAN, GH). **Manitoba:** Fort Churchill, 58°67′N, 94°10′W, *Schofield & Crum* 6787 (CAN, F). **Northwest Territories:** MACKENZIE DIST.: small pool ca. 45.5 mi. WNW of Yellowknife, *Thieret & Reich* 7947

(F, OS, US). **Nova Scotia:** CAPE BRETON CO.: Mira Bay, *Macoun* 20755 (F, GH, CAN). **Ontario:** THUNDER BAY DIST.: Black Fox Lake, *Haynes* 3749 (CAN, GH, LAF, MO, OS, UC); Sibley Twp., Ravine Lake, *Taylor et al.* 232 (CAN, GH, UC). **Quebec:** Lake Memphremagog, Sargents Bay, *Churchill* (GH, K, MO). GASPE CO.: Riviere Bonaventure, *Marie-Victorin et al.* 33764 (F, GH, NY, PH). **Saskatchewan:** MACKENZIE DIST.: Meridian Creek near Amisk Lake, *Hudson* 1550 (DAO). **Yukon:** Sheldon Lake, Canol Road mi. 222, *Porsild & Breitung* 11511 (CAN). UNITED STATES: **Connecticut:** FAIRFIELD CO.: Norwalk River, Ridgefield, *Eames* 11717a (GH). **Maine:** PENOBSCOT CO.: Pushaw Stream, Old Town, *Ogden et al.* 1617 (CAN, GH, MO, NY, US). PISCATAQUIS CO.: cold clear stream, Foxcroft, *Fernald* 478 (GH, MO, US). **Massachusetts:** ESSEX CO.: ditch in Wenham, *Morong* (F, GH, ILL, PH); Pleasant Pond, Wenham, *Faxon* (GH, NY, US), *Ogden & Ogden* 1763 (CAN, DAO, F, GH, ILL, MICH, MO, NY, PH, UC, UPS, US). **Michigan:** KEWEENAW CO.: Beaver Pond, ca. 4 mi, S of Central Mine, *Robbins* (GH, MO, NY, PH). LUCE CO.: Bodie Lake, *Haynes* 3787 (OS). SCHOOLCRAFT CO.: Canoe Lake, *Haynes* 3741a (OS). **Minnesota:** ST. LOUIS CO.: West Two Rivers, Tower, *Hill* 218-1889 (CAN, ILL). **Montana:** GLACIER CO.: Howe Lake, Glacier National Park, *Hazzard* 480 (GH). **New Hampshire:** GRAFTON CO.: pond, Enfield, *Kennedy* (GH). **New Jersey:** MORRIS CO.: Rockaway River near Milton, *Williamson* (GH, PH). **New York:** ALBANY CO.: Alcove, *Shear* (GH, NY, UC). **Pennsylvania:** WAYNE CO.: Howell's Pond, *Twining* (GH, PH). **Rhode Island:** PROVIDENCE CO.: Fountain Spring Brook, Smithfield, *Lovewell* (GH). **Vermont:** ADDISON CO.: Little Otter Creek, Ferrisburg, *Eggleston & Grout* (F, GH, PH, US). CALEDONIA CO.: spring-fed pond, ca. 2 mi. N of Walden Village, *Haynes* 3829 (OS); Coles Pond, Walden Twp., *Haynes* 3837 (OS). **Washington:** SAN JUAN CO.: Summit Lake, Orcas Island, *Sutherland & Kern* 1182 (CAN, NY, UC). **Wisconsin:** ONEIDA CO.: stream, Three Lakes, *Hoffman* (GH, MO). **Wyoming:** TETON CO.: Beaver ponds near Moose, *Porter & Porter* 9405 (GH, UC).

4. **Potamogeton hillii** Morong, Bot. Gaz. (Crawfordsville) **6:** 290. 1881. TYPE: *E. J. Hill,* Stagnant pools, Manistee, [Manistee Co.] Michigan, (holotype, NY!; isotypes, F[2 sheets]!, GH[2 sheets]!, ILL[4 sheets]!, K!, PH!).

Potamogeton porteri Fern. Mem. Amer. Acad. Arts **17:** 73. 1932. TYPE: *T. C. Porter,* Run in Dillerville Swamp, near Lancaster, [Lancaster Co.] Pennsylvania, (lectotype, PH!; isolectotypes, F[2 sheets]!, MO!, NY[2 sheets]!, PH[2 sheets]!).

Stems green to olive, slightly compressed, heavily ridged, 30-60 cm long, 0.5-1.0 mm diam. Leaves pale-green to olive-green, delicate, 3-nerved, 2.0-6.0 cm long, 0.6-2.5 (-4.0) mm wide; apex apiculate to bristle-tipped; glands present or absent, brown to green, 0.1-0.3 mm diam; lacunae of 1-2 rows each side of midrib; lateral nerves joining midrib (0.4-) 0.7-1.7 mm from apex. Stipules white to light brown, slightly fibrous, rarely shredding at tip, convolute, 7.0-16.0 mm long, 0.6-2.2 mm diam. Winter buds rare, terminal, 2.8-3.0 cm long, 1.5-3.0 mm wide; inner leaves undifferentiated; outer leaves 3-4 per side, acute to apiculate, without corrugations at base. Peduncles slightly clavate, axillary or terminal, rarely recurved, 6.0-13.5 mm long, 0.3-1.0 mm diam. Spike globose, (2.0-) 4.0-7.0 mm long, 4.6-7.0 mm diam; verticels 1-2, when 2, these crowded, 0.5-1.0 mm apart. Perianth segments 1.3-1.5 mm long, 1.1-1.5 mm wide. Fruit brown to light greenish-brown, dorsally and laterally keeled, 2.3-4.0 mm long, 2.0-3.2 mm wide; keels forming ridges, without undulations, to 0.2 mm high; beak central, rarely forward, 0.3-0.7 mm long, 0.2-0.6 mm diam; sides rounded rarely centrally depressed; wall texture rough. Chromosome number unknown.

Distribution: In cold stagnant or slow moving, often brown water, from northern Lower Peninsula Michigan to Vermont and south to northeastern Ohio and southeastern Pennsylvania. Fruiting from late June to late August. Fig. 6.

Illustrations: Fernald (1932, pl. 13; 30, fig. 2; 34, fig. 2).

In the original description, Morong cited only the following data: "excellent specimens obtained in August 1880, by Mr. Hill, at Manistee, Michigan . . ." He included no indication as to the location of the specimen. Hill prepared, from Manistee in August 1880, no less than 14 herbarium specimens on at least two separate days. Fernald (1932, p. 169), also giving no specimen location, designated as the type collection the one gathered by Hill on 10 August 1880.

However, in the collection at NY there is a specimen collected on 5 August 1880 by Hill and labeled in Thomas Morong's handwriting as "Type Specimen." Of the many other specimens examined by Morong, none of these others were indicated as types by Morong. Therefore, the 5 August specimen, having been designated by the author, then is the holotype and the one cited by Fernald then is a topotype.

Fernald (1932) named *Potamogeton porteri* based on several sheets collected by Thomas Porter in mill ponds near Lancaster, Pennsylvania. In the body of the original description Fernald did not cite any one specimen as the type. The data he gave are "PENNSYLVANIA: Cold streams or rivulets in Dillerville Swamp, Lancaster Co., October 5 and 6, 1860, *Thos. C. Porter,* distributed as *P. pusillus* and *P. obtusifolius* (TYPE in Herb. Acad. Sci. Nat. Phila.; duplicate in Herb. Gray; fragmentary (sterile) duplicates in Herb. Field Mus., Dudley, and Mo. Bot. Gard.)." In a footnote on the same page he states "Porter's labels, all of material collected on October 5, with the exception of one sheet marked October 6, indicate somewhat different habitats: 'Cold rivulets near Lancaster,' 'Near Lancaster,' 'In a rivulet, Dillerville swamp, Lancaster,' 'Stream in Dillerville Swamp, near Lancaster,' 'Run in Dillerville Swamp, near Lancaster.' "

I have seen the specimens at PH, GH, F, MO, and none of the sheets have the locality data given by Fernald in the body of the text. There are, in fact, three sheets at PH labeled by Fernald as *P. porteri.* He indicated "Type Collection" on two of these sheets, "Run in Dillerville Swamp, near Lancaster, Penn. October 5, 1860" and "Stream in Dillerville Swamp, near Lancaster, Penn. October 5, 1860." On the other sheet, "Cold rivulets near Lancaster, Pa. October 5," Fernald did not indicate "Type Collection." The two specimens labeled as "Type Collection" by Fernald are obviously the same taxon and both match the description. However, the one with data of "Stream in Dillerville Swamp, near Lancaster, Penn. October 5, 1860" is fertile while the other is sterile. Hence, I am here designating the fertile one as the lectotype.

Fernald states (p. 74), "In its large fruit with prominent keel and recurved beak and its essential lack of glands at the base of the stipules *P. porteri* is close to *P. hillii*, but the latter species is wholly different in its acute, attenuate and thinner stipules; and in its attenuate almost bristle-tipped leaves with a single row of lacunae each side of the midrib and with the lateral nerves confluent with the midrib well below the tip." The specimens annotated by Fernald as *P. porteri* vary from ones with narrow leaves with apiculate leaf tips to very broad ones with obtuse leaf tips. The broad leaved specimens are quite distinct from characteristic *P. hillii*. However, the ones with the narrower leaves closely resemble *P. hillii* in all characters mentioned by Fernald. A locality of *P. hillii* in Cheboygan County, Michigan, first located by Dr. E. G. Voss in 1967, was visited by me during the summers of 1970, 1971, and 1972. I noticed a variability within the population from individuals with the characteristic narrow attenuate leaves with delicate stipules to ones with broad obtuse leaves with coarse stipules. Within this one population, a complete gradation exists from characteristic *P. hillii* to characteristic *P. porteri*. For this reason I believe *P. porteri* is a morphological extreme of *P. hillii*.

With the capitate inflorescence, short axillary peduncles, and fruits with a small dorsal keel, *Potamogeton hillii* closely resembles *P. foliosus*. However, it can be distinguished from the latter species by the large 2.3-4.0 × 2.0-3.2 mm fruits (the largest of any *Pusilli*), by the nearly bristle-tipped leaves and by the stipules being convolute. By the nearly bristle-tipped leaves, some individuals resemble *P. longiligulatus*, a proposed hybrid, but can be distinguished from this putative hybrid by the leaves having only 3 veins, whereas those of *P. longiligulatus* have mostly 7-9 veins. From all other *Pusilli, P. hillii* can be separated by its large fruits, short peduncles, and capitate inflorescences.

Fernald (1932) states that the *Pusilli* reproduce, for the most part, not by seeds, but by winter buds. He also states that winter buds are unknown in *Potamogeton hillii.* I have seen one sheet with well developed winter buds and several with ones that were immature. The winter buds, when present, with the inner leaves being unmodified, resemble small ones of *P. obtusifolius* in shape and structure, even in having the leaves round apiculate.

Potamogeton hillii has been considered to be extremely local throughout its range. This distribution is becoming more apparent with the destruction of the aquatic environment by pollution and dredging. In fact, Voss (1967) reported that the type locality of *P. hillii* has been destroyed.

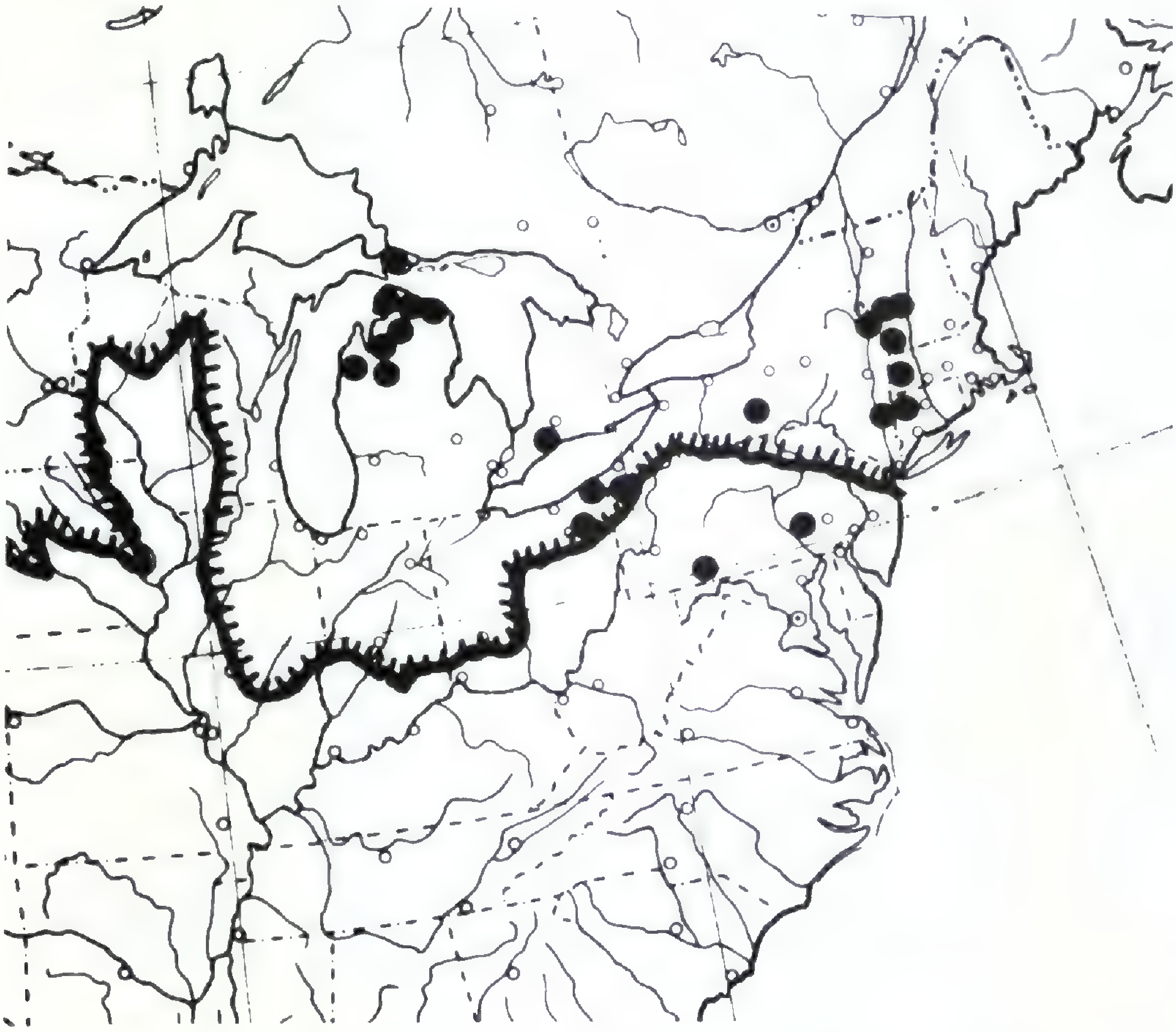

Fig. 6. Map of eastern North America showing the documented distribution of *Potamogeton hillii.* The barred line represents the southern limit of Wisconsin Glaciation (after Flint *et al.*, 1959).

Around 1900, the species was present in northeastern Ohio and northwestern Pennsylvania. This area has become heavily populated, with few if any natural areas remaining. The two Ohio counties, Portage and Ashtabula, have been rather heavily collected over the past 20 years. Some collectors thought they had collected the species, but after examining the specimens, I found them all to be *P. pusillus*. On the other hand, intensive field work in northern Michigan has shown the species to occur in no fewer than four localities within a radius of 30 miles of Cheboygan County. The same situation may prove to be true in other less heavily populated areas of its range, especially northeast New York state, as botanists continue to search for the species.

REPRESENTATIVE SPECIMENS

CANADA: **Ontario:** ELGIN CO.: near St. Thomas, *James* (DAO). UNITED STATES: **Connecticut:** LITCHFIELD CO.: Indian Pond, Sharon, *Eames* 11867 (GH). **Massachusetts:** BERKSHIRE CO.: pond fed by Karner Brook, South Egremont, *Weber* 1626 (CAN, F, GH, MICH, MO, NY, UC, US). **Michigan:** CHEBOYGAN CO.: Elliot Creek, 4 mi. E of Cheboygan, *Haynes* 3389 (GH, MO, OS, UC, US), *Haynes* 3713 (OS). EMMET CO.: Cecil Bay marsh, 4 mi. SW of Mackinaw City, *Voss* 14061 (CAN, GH, MICH, MSC, NY, OS, UMBS, WIS). MACKINAC CO.: small stream ca. 1 mi. S of Engadine, *Haynes* 4025 (ASC, DAO, F, FSU, GH, K, MICH, MO, MSC, NY, OS, PH, SMU, TENN, TEX, UC, US, VDB, WIS, WVA). MANISTEE CO.: Manistee, *Morong* (GH, MICH, NY, US). OTSEGO CO.: outlet of Grass Lake, *Stuckey* 1300 (GH, MICH, NY, OS, UMBS). PRESQUE ISLE CO.: mouth of Black Mallard River, *Haynes* 3390 (F, GH, MO, NY, OS, PH, UC, US), *Haynes* 3714 (OS), *Haynes* 3740 (ASU, GH, LAF, MO, NY, OS, PH, QFA, UC, VDB, US), *Haynes* 3890 (OS). **New York:** THOMPKINS CO.: Ithaca, Lake Cayuga, *Dudley* (CAN, F, GH, MICH, MO, US). WASHINGTON CO.: creek 2 mi. N of Dresden Station road, *Haynes* 3342 (GH, MICH, MO, OS, UC, US). **Ohio:** ASHTABULA CO.: pools, Ashtabula, *Hill* (F, ILL). **Pennsylvania:** BEDFORD CO.: millpond S of Woodbury, *Hotchkiss* 6003 (GH, US). **Vermont:** WINDSOR CO.: Evarts Pond, Windsor, *Dudley* (GH, NY, UC, US).

5. **Potamogeton foliosus** Raf., Med. Repos. Hexade 2, **5**: 354. 1808.

Stems green to olive, slightly compressed and ridged, 4-75 cm long, 0.2-1.2 mm diam. Leaves pale green to olive, rarely rufescent, delicate, 1-3(-5)-nerved, 1.3-8.2 cm long, 0.3-2.3 mm wide; apex acute to apiculate, rarely with a bristle; glands present or absent, black to gold, to 0.5 mm diam; lacunae absent or to 2 rows each side of midrib; lateral nerves joining the midrib 0.5-1.2 mm below the apex. Stipules greenish to brown, rarely white, delicate to fibrous, shredding or not at the tip, connate or convolute, 0.2-2.2 cm long, 0.2-1.7 mm diam. Winter buds uncommon, lateral or terminal, 0.9-2.5 cm long, 0.6-2.0 mm wide; inner leaves rolled into a hardened fusiform structure; outer leaves 1-3 per side, acute to apiculate, without corrugations at base. Peduncles clavate, mostly in axiles of lower, rarely upper, leaves, usually recurved, 0.3-1.1 (-3.7) cm long, 0.3-1.4 mm diam. Spikes capitate to cylindric, 1.5-7.0 mm long, 1.0-6.0 mm diam; verticels 1-2, when 2, these usually crowded, 0.6-1.2 (-2.0) mm apart. Perianth segments 0.4-1.4 mm long, 0.3-1.0 mm wide. Fruit pale green to olive or brown, dorsally keeled, 1.4-2.7 mm long, 1.1-2.2 mm wide; keel undulate winglike, to 0.4 mm high; beak central, rarely forward, 0.2-0.6 mm long, 0.1-0.4 mm diam; sides rounded to centrally depressed; wall texture smooth.

Potamogeton foliosus is most similar to *P. hillii* in its short clavate peduncles and capitate inflorescence. However, when in fruit, *P. foliosus* can be separated from the latter species by the presence of a dorsal undulate wing on the fruit. The fruit of *P. hillii,* on the other hand, is three-keeled — two lateral and one dorsal ridge which does not appear as a thin undulating wing. Vegetatively, *P. foliosus* is most similar to *P. pusillus.* From *P. pusillus* var. *tenuissimus, P. foliosus* often can be distinguished by the near lack of lacunae. From *P. pusillus* var. *pusillus,* however, the separation is not that simple. Fernald (1932) suggests that *P. foliosus* may be separated from *P. panormitanus* [var. *pusillus*] by the absence of nodal glands. Voss (1972), on the other hand, has questioned this character as reliable. In most fruiting specimens of *P. pusillus* [var. *pusillus*] from Michigan, Voss could not find evident nodal glands. Data gathered by me from examination of hundreds of herbarium specimens and many populations in the field support Voss's conclusions. Therefore, I give little value to the absence of glands as a character for separating these two taxa. Although intermediates occur, the only character which I have been able to consider with any reliance is the coarseness of the stipular veins. Those of *P. foliosus,* for example, are usually evident, appearing as ridges extending the length of the stipules. The veins are not usually so evident in *P. pusillus.*

5a. **Potamogeton foliosus** var. **foliosus**

P. foliorum Raf., Med. Repos. Hexade 3, **2**: 409. 1811. (orthographic variant). *P. pauciflorus* Pursh, Flora Amer. Sept. 121. 1814. *P. foliosus* Raf. var. *genuinus* Fern., Mem. Amer. Acad. Arts **17**: 43. 1932. TYPE: *Michaux,* in rivis affluente mari inundatis Carolinae inferioris [South Carolina] (holotype, P; photograph of holotype, GH!).

Potamogeton niagarensis Tuckerm., Amer. J. Sci. Arts Series 2, **7**: 354. 1849. *P. pauciflorus* Pursh var. *niagarensis* (Tuckerm.) Robbins in Gray, Man. Bot. North. U. S., ed. 2. 435. 1856. *P. foliosus* Raf. var. *niagarensis* (Tuckerm.) Morong, Mem. Torrey Bot. Club **3**: 39. 1895. *Spirillus foliosus* (Raf.) Nieuwl. var. *niagarensis* (Tuckerm.) Nieuwl., Amer. Midl. Naturalist **3**: 18. 1913. *P. foliosus* Raf. f. *niagarensis* (Tuckerm.) Hagstrom. Kongl. Svenska Vetenskapsakad. Handl. 55(5): 91. 1916. TYPE: *Tuckerman,* Hogback, Niagara Falls, [Niagara Co.] New York, (holotype, NY!; isotypes, GH!, K!).

Potamogeton pauciflorus Pursh var. *californicus* Morong, Bot. Gaz. (Crawfordsville) **10**: 254. 1885. *P. foliosus* Raf. var. *californicus* (Morong) Morong, Mem. Torrey Bot. Club **3**: 40. 1895. *P. californicus* (Morong) Piper, Contr. U.S. Natl. Herb. **11**: 98. 1906. *P. foliosus* Raf. f. *californicus* (Morong) Hagstrom, Kongl, Svenska Vetenskapsakad. Handl. 55(5): 91. 1916. TYPE: *S. B. & W. F. Parish* 940, submerged aquatic, streams, San Bernardino, San Bernardino Co., California, (holotype, NY!; isotypes GH!, MO!, PH!).

Potamogeton foliosus Raf. var. *macellus* Fern., Mem. Amer. Acad. Arts 17: 46. 1932. TYPE: *E. & C. E. Faxon* Fresh Pond, Cambridge, [Suffolk Co.] Massachusetts, (holotype, GH; isotype, US!).

Stems 4-72 cm long, 0.2-1.2 mm diam. Leaves 1-3 (-5)-nerved, 1.3-8.2 cm long, 0.3-2.3 mm wide; apex acute to apiculate, rarely with a bristle; glands rare, to 0.3 diam; lacunae absent or to 2 rows each side of midrib; lateral nerves joining the midrib 0.5-1.2 mm below the apex. Stipules greenish to brown, delicate to slightly fibrous, rarely shredding at the apex, connate, 0.2-2.2 cm long, 0.2-1.7 mm diam. Winter buds lateral, 0.9-1.8 cm long, 0.6-1.0 mm wide. Peduncles usually clavate, recurved, 0.3-1.1 (-3.7) cm long, 0.3-1.4 mm diam. Spikes usually capitate, rarely cylindric, 1.5-7.0 mm long, 1.0-6.0 mm diam; verticels 1-2, when 2, these crowded, 0.6-1.2 (-2.0) mm apart. Perianth segments 0.4-1.4 mm long, 0.5-1.0 mm wide. Fruit olive to green-brown, 1.5-2.7 mm long, 1.2-2.2 mm wide; keel 0.1-0.4 mm high; beak 0.2-0.6 mm long, 0.2-0.4 mm diam. Chromosome number, $2n = 28$ (Stern, 1961).

Distribution: Widespread, in waters of lakes, springs, streams and rivers, from central Alaska to Nova Scotia and south to southern Guatemala and Jamaica. Fruiting from late May to late October. Fig. 8.

Illustrations: Fernald (1932, pl. 3; 29, fig. 1; 32, fig. 3; 38, fig. 1).

Potamogeton foliosus was first recognized by Michaux (1803) when he reported *P. gramineus?* L. for North America. Rafinesque (1808), noticing that many of the Western Hemisphere plants represented different species from those of Europe, listed several species of Michaux which he later intended to describe. Among these was "*P. gramineum* to be described later as *P. foliosum*." Indeed, he did later describe the taxon (Rafinesque, 1811), but it was spelled as *P. foliorum* rather than as *P. foliosum*. However, the name of *P. foliosum* [*foliosus*] was validly and effectively published in 1808 when he made direct reference to the published description of *P. gramineum* of Michaux.

Pursh (1814) applied a superfluous name — *Potamogeton pauciflorus* — to Michaux's specimen. Other botanists either overlooked or neglected Rafinesque's name and accepted instead the one of Pursh. Tuckerman (1849) recognized that two forms — a large-leaved form and a small-leaved form — of *P. pauciflorus* Pursh [*foliosus*] existed. He divided the group into two species, applying *P. niagarensis* Tuckerm. to the larger-leaved individuals and retaining the name *P. pauciflorus* for the smaller-leaved ones. After noticing considerable morphological integration, Fernald (1932) chose to consider the two taxa at the varietal rank. After having examined Michaux's specimen at Paris, Fernald determined the specimen to be the large-leaved entity. Thus, *P. foliosus* and *P. pauciflorus* actually applied

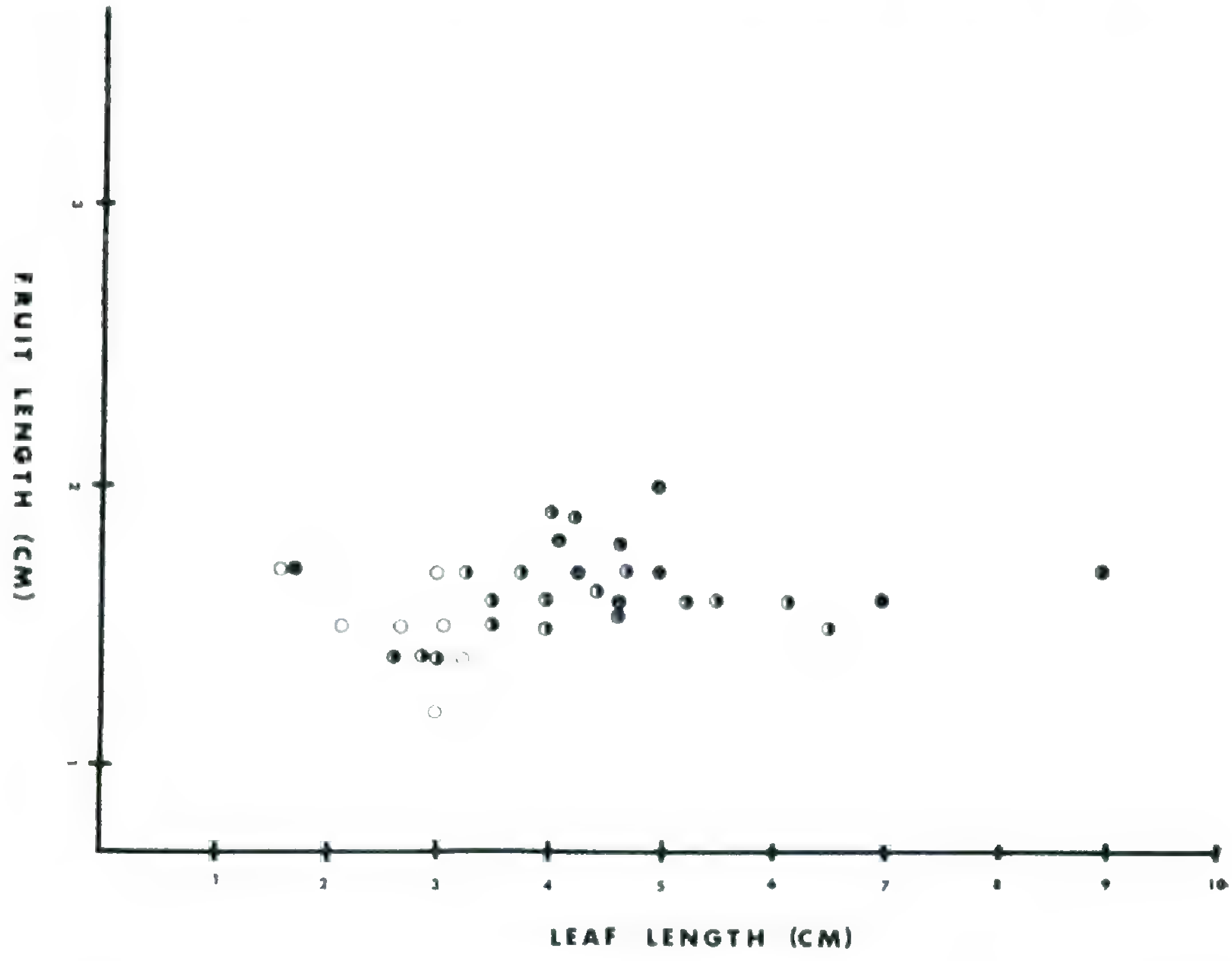

Fig. 7. *Potamogeton foliosus* var. *foliosus*. Scatter diagram comparing leaf length, fruit length, and number of nerves per leaf. 1 nerve, open circle; 3 nerves, half-closed circle; 5 nerves, dot.

to this growth form. Therefore, the smaller-leaved plants were unnamed. Fernald then named the smaller-leaved specimens *P. foliosus* var. *macellus* Fern. and called the larger river form var. *genuinus* [now correctly as var. *foliosus*]. I have examined thousands of specimens in the field and herbarium. Many of these have been plotted on scatter diagrams (see Fig. 7). Although only three char-

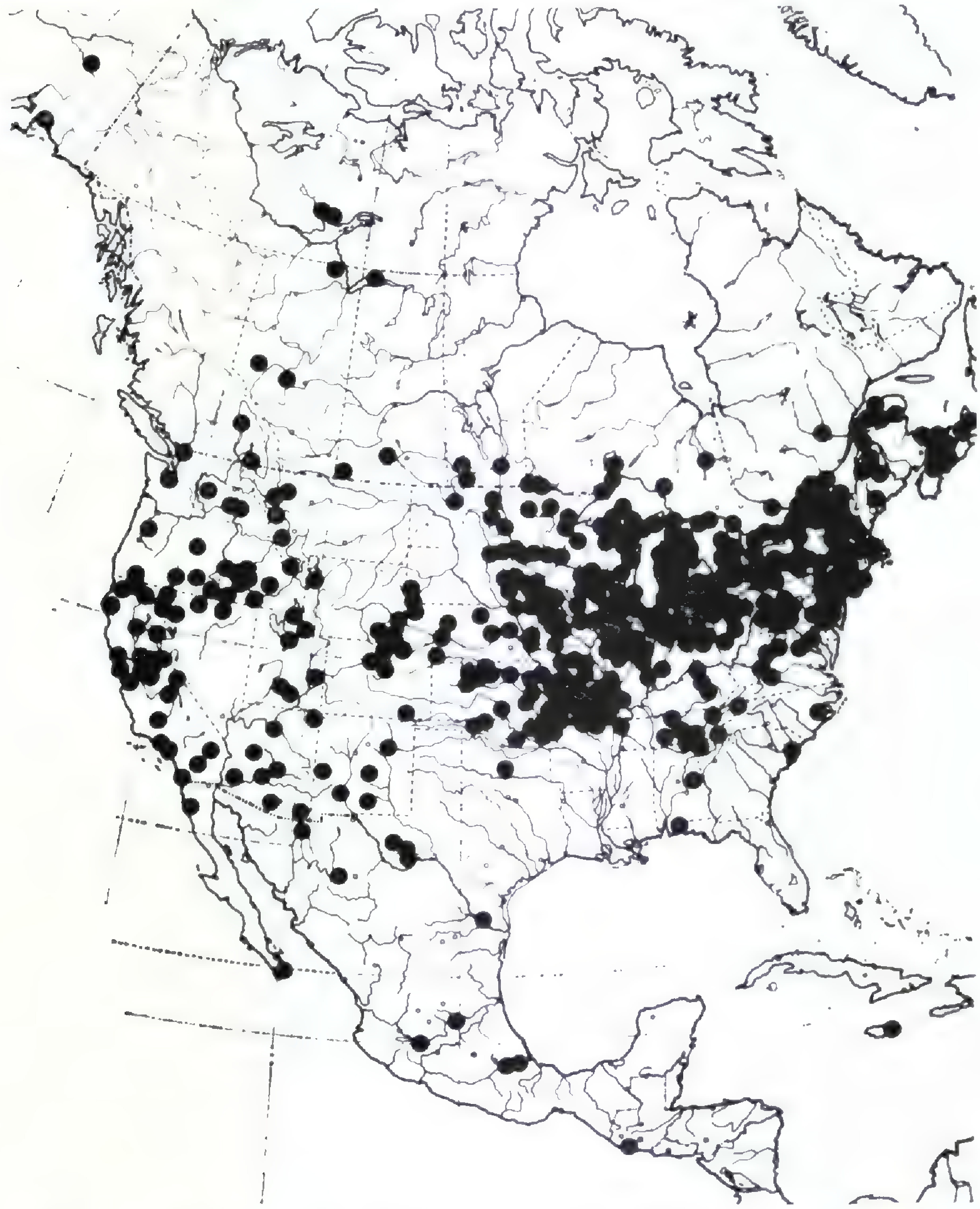

Fig. 8. Map of North America showing documented distribution of *Potamogeton foliosus* var. *foliosus.*

acters are used here, other characters were plotted and similar patterns developed. Data gathered from these studies indicate that a continuous gradient exists from ones with the largest leaves to those with the smallest leaves. The two groups do not appear to be separated into distinct geographical areas, with the intermediates in areas of overlap. Instead, these data indicate that the larger-leaved individuals occur in rapidly flowing waters, the intermediates occur in slow moving streams, and the smaller-leaved plants occur in lakes or ponds. Sculthorpe (1967) indicates that the size and shape of the leaves of many species of *Potamogeton* vary greatly with different rates of water flow. This is probably the situation with *P. foliosus.* I am, thus, considering var. *macellus* to be an ecological growth form of *P. foliosus*, and therefore, am not formally recognizing it.

REPRESENTATIVE SPECIMENS

CANADA: **Alberta:** Wood Buffalo Park, *Raup* 1562 (CAN, NY, UC). **British Columbia:** Revelstoke, *Macoun* 3037 (CAN, NY). **Manitoba:** Little Saskatchewan, Rapid City, *Macoun* 16482 (CAN, GH). **Northwest Territories:** small lake, 38.3 mi. WNW of Yellowknife, *Thieret & Reich* 8356 (F, OS). **Nova Scotia:** KINGS CO.: Canard River, *Smith et al.* 11446 (CAN, DAO). **Ontario:** FRONTENAC CO.: Kingston, Smith Falls, *Fowler* (CGE, MO, US). **Prince Edward Island:** QUEENS CO.: ponds, Southport, *Fernald & St. John* 6782 (CAN, K, NY, US). **Quebec:** NEW-RICHMOND CO.: Bonaventure River, *Marie-Victorin et al.* 33839 (CAN, F, MU, NY, PH). **Saskatchewan:** MOOSE JAW DIST.: Mortlach, *Hudson* 1143 (DAO). GUATEMALA: **Dept. Esquintla:** mountain stream, Finca San Filipe, *Muenscher* 12074 (GH, OS). JAMAICA: **Portland:** Rio Grande, *Maxon & Killip* 265 (ILL). MEXICO: **Baja California:** Rancho San Jacinto, 45 mi. S. of Eusenada, *Wiggins & Demaree* 4749 (F, MICH, MU, NY, US); stream, Santiago, *Wiggins* 5662 (MICH, NY, UC, US). **Chihuahua:** DEPT. DE GUERRERO: stream near Minaca, *Shreve* 7993 (F, GH). **Guanajuato:** DEPT. ATOTONILCO: just S of village of Santuario, between San Miguel Allenda and Dolores Hidalgo, *Ogden* 51149 (OS). **Michoacan:** Rio Duero at Zamora, *Ogden* 51183 (OS). **Puebla:** DIST. DE TEPEACA: San Hipalito, vicinity of Puebla, *Arsene* 2360 (ILL, NY, US). **Sonora:** Fronteras, *Hartman* 992 (GH, NY). **Veracruz:** Orizaba, Engenio, Rio Blenio, *Muller* 1330 (NY). UNITED STATES: **Alabama:** JACKSON CO.: Paint Rock River, Larkin Fork, *Harper* 2998 (GH, MO, NY, PH, US). **Alaska:** 2 mi. SW of College, small pond, *Smith* 1911 (CAN). **Arizona:** Colorado Havasupai Canyon, *Clover* 5218a (MICH, US). **Arkansas:** FULTON CO.: Mammoth Springs, Spring River, *Thomas & Smith* 17094 (OS). **California:** LOS ANGELES CO.: Lancaster, *Elmer* 3504 (GH, K, NY, UC, US). SISKIYOU CO.: near Mt. Shasta, Abrams Lake, *Heller* 13908 (F, ILL, MO, NY, PH, UC, US). **Colorado:** DENVER CO.: Denver, Platte River, *Jones* 600 (F, NY, US). **Connecticut:** LITCHFIELD CO.: Litchfield-Morris Wildlife Sanctuary, Bantam Lake, *Dwyer* 2150 (NY). **Delaware:** NEW CASTLE CO.: near Wilmington, Brandywine Creek, *Commons* (PH). **District of Columbia:** Washington, *Ward* (GH, UPS). **Georgia:** CHATTOOGA CO.: 2.8 mi. E 30°N of Trion, small pond below Greeson Springs, *Duncan & Harris* 12842 (GH, LAF, MICH, US). **Idaho:** BOISE CO.: 20 mi. S of Idaho City, marsh, *Hitchcock & Muhlick* 9947 (NY, UC). **Illinois:** COOK CO.: Englewood, ditches, *Hill* (F, GH, ILL, US). ST. CLAIR CO.: East St. Louis, *Eggert* (CAN, F, ILL, K, MICH, NY, PH, OS, US). STARK CO.: near Wady Petra, prairie pond, *Chase* 1148 (ILL, MO, NY, PH). **Indiana:** LAKE CO.: Wolf Lake, West Bay, *Chase* 1461 (F, ILL, MO, PH, US). **Iowa:** CLAY CO.: Lake Twp, Dan Greene's slough, N end, *Hayden* 820 (MO, NY, PH, US). EMMET CO.: Estherville, running water, *Cratty* (GH, ILL, MO, NY, US). PALO ALTO CO.: Highland Twp, 2 mi. S of Ruthven, Virgin Lake, *Hayden* 10125 (MO, NY, PH, US). **Kansas:** RILEY CO.: ponds, *Pond* 1100 (MICH, MO, NY, US). **Kentucky:** FAYETTE CO.: near Lexington, brook, *Peter* (K, MICH, NY, PH). **Maine:** PISCATAQUIS CO.: Dover, river margin, *Fernald* 479 (MO, US). **Massachusetts:** MIDDLESEX CO.: Cambridge, Fresh Pond, *Morong* (F, MO). **Michigan:** CHEBOYGAN CO.: Douglas Lake, Marl Bay, *Haynes* 3923 (OS). EMMET CO.: small arm of Carp Lake, *Haynes* 3374 (GH, OS, UC, US), *Haynes* 3705 (ILL, OS). *Haynes* 3745 (OS), *Haynes* 3888 (OS). **Minnesota:** CLEARWATER CO.: Bohal Lake, *Grant & Oosting* 3228 (NY, UC, US). **Missouri:** BARRY CO: Eagle Rock, river, *Bush* 511 (CGE, GH, MO, US). BUTLER CO.: Poplar Bluff, *Eggert* (CAN, F, K, MO, OS, US). OREGON CO.: Thomasville, spring pond, *Steyermark & Palmer* 41701 (MO, NY, PH, US). TEXAS CO.: SW of Plato, Roubidoux Creek, *Steyermark* 25006 (DAO, F, NY, OS). **Montana:** MISSOULA CO.: ca. 6 mi. E of Lolo Hot Springs, small slough, *Hitchcock* 23978 (DAO, ILL, NY, US). **Nebraska:** LINCOLN CO.: North Platte, slough, *Shear* 4445 (GH, NY, US). **New Hampshire:** GRAFTON CO.: Hanover, Count River, *Jesup* (MO). **New Jersey:** MORRIS CO.: Oak Ridge, running water, *Mackenzie* 3736 (MO, NY, US). **New Mexico:** LINCOLN CO.: Bonita River, ca. 6½ mi. NW of Alto, *Haynes* 2923 (LAF). **New York:** COLUMBIA CO.: 1¼ mi. SSW of West Copake, Lower Rhoda Pond, *Haynes* 3802 (OS). DUTCHESS CO.: 1½ mi. SW of Pine Plains, Stissing Pond, *Haynes* 3804 (OS). ESSEX CO.: near Ticonderoga, outlet of Lake George, *Haynes* 3333 (OS), *Haynes* 3336 (OS). NIAGARA CO.:

Niagara Falls, mill race near Cataract House, *Hill* 26-1887 (ILL, MICH, MO). PUTNAM CO.: Carmel, Glendia Lake, *Muenscher & Curtis* 5447 (MO, NY, PH, UC, US). WARREN CO.: Lake Luzerne boat launch, *Haynes* 3814 (OS). **Nevada:** ELKO CO.: Copper Mountains, 3 mi. S of Coon Creek Pass, *Maguire & Holmgren* 22411 (CAN, NY, US). **North Carolina:** CHEROKEE CO.: N of Marble, limestone quarry, *Radford* 4812 (NY). **North Dakota:** CASS CO.: Fargo, ditch, *Stevens* 1376 (CAN, UC, US). **Ohio:** AUGLAIZE CO.: Lake St. Marys Fish Hatchery, *Haynes* 3427 (GH, MICH, OS, US); 2 mi. SE of Wapakoneta, borrow pit, *Haynes* 3420 (OS, US). CHAMPAIGN CO.: Kaiser Lake State Park, *Haynes* 3435 (MICH, OS, UC, US). ERIE CO.: 4 mi. NW of Castalia, *Haynes* 3247 (MICH). LOGAN CO.: 1.9 mi. due ESE of Russells Point, *Haynes* 3415 (MICH, OS, PH, US). OTTAWA CO.: Lake Erie, North Bass Island, Fox's Marsh, *Haynes* 3145 (OS). PORTAGE CO.: 5½ mi. NW of Ravenna, borrow pit, *Haynes* 3452 (GH, MICH, MO, OS, US). **Oklahoma:** OTTAWA CO.: Hattenville, overflow pond, *Stevens* 2481 (GH, ILL, K, MO, NY, US). WOODS CO.: Waynoka pond, *Stevens* 1768 (GH, ILL, K, MO). **Oregon:** pond on the Willamette River, *Hall* 492 (F, GH, ILL, MO, NY, US). **Pennsylvania:** BERKS CO.: 1 mi. SE of Pine Forge, Manatawny Creek, *Wilkens* 5619 (GH, PH). **South Carolina:** GEORGETOWN CO.: Georgetown, Hobcaw Plantation, *Alexander* 148 (US). **South Dakota:** PENNINGTON CO.: Sheridan Lake, *Porter* 6593 (DAO, UPS). **Tennessee:** FRANKLIN CO.: Sherwood, *Eggert* (GH, MO, US). **Texas:** JEFF DAVIS CO.: Limpia Canyon, *Tracy* 288 (GH, NY). **Utah:** CACHE CO.: Bear River Range, E side of Tony Grove Lake, *Maguire & Snell* 16048 (DAO, ILL, MICH, NY). GRAND CO.: Hill Creek near Weaver Reservoir, *Holmgren et al.* 2358 (DAO, ILL, NY, UPS). **Vermont:** ORLEANS CO.: ca. 1 mi. W of Craftsbury Common, backwater of Black River, *Haynes* 3839 (OS); 1 mi. S of Craftsbury Common, backwater of Black River, *Haynes* 3840 (OS). WINDSOR CO.: Plymouth, *Eggleston* (F, MO, PH, US). **Virginia:** BOTETOURT CO.: Cloverdale, Tinker Creek, *Wood* 6133 (GH). **Washington:** GRANT CO.: Pond SW of Moses Lake, *St. John et al.* 4960 (MO, UC). **West Virginia:** GREENBRIAR CO.: Dunlap Creek, *Berkley* 1194 (MO). **Wisconsin:** WAUSHARA CO.: Poy Sippi, Pine River, *Hill* (CAN, F, GH, ILL). **Wyoming:** LARAMIE CO.: Laramie Mountains, Middle Fork of Crow Creek, *Porter* 6320 (DAO, MO, NY, UPS).

5b. **Potamogeton foliosus** var. **fibrillosus** (Fern.) Haynes & Reveal, Rhodora **75**: 76. 1973.

Potamogeton fibrillosus Fern. Mem. Amer. Acad. Arts **17**: 51. 1932. TYPE: *W. C. Cusick* 2598, in warm spring, margin of Harney Valley, "P" Ranch, [Harney Co.] Oregon, (holotype, GH!; isotypes, F! K!, MO!, NY!, UC!, US!).

Stems 20-75 cm long, 0.3-1.2 mm diam. Leaves (1-) 3-nerved, 2.1-5.5 mm long, 0.5-1.7 mm wide; apex acute apiculate; glands usually present, black to gold, to 0.5 mm diam; lacunae absent; lateral nerves joining midrib 0.6-0.8 mm below apex. Stipules brown, rarely white, fibrous, shredding at tip, often convolute, 0.4-12.1 cm long, 0.5-1.2 mm diam. Winter buds lateral or terminal, 1.2-2.5 cm long, 0.8-2.0 mm wide. Peduncles clavate, recurved, 6.5-9.2 (-22.0) mm long, 0.4-1.0 mm diam. Spike capitate to cylindric, 1.7-5.5 mm long, 1.0-4.0 mm diam; verticels 1-2, when 2, then 0.6-0.8 mm apart. Perianth segments 0.5-0.7 mm long, 1.1-1.2 mm wide. Fruit pale-green, 1.4-1.7 mm long, 1.1-1.2 mm wide; keel to 0.2 mm high; beak ca. 0.2 mm long, 0.1-0.2 mm wide. Chromosome number unknown.

Distribution: In waters, often warm, of shallow lakes, springs, streams and rivers, from southwestern Washington southward through southeastern Oregon, hence eastward to southeastern Wyoming. Fruiting from mid-June to mid-September. Figure 9.

Illustrations: Fernald (1932, pl. 5; 28, Fig. 5; 32, Fig. 5).

In 1932, Fernald proposed *Potamogeton fibrillosus* based on specimens collected in Wyoming, Idaho, Oregon and Washington. He noted that the new species closely resembled *P. foliosus* Raf. in its foliage, peduncles and small dorsally keeled fruits. Fernald said that *P. fibrillosus* differed from *P. foliosus* by its stipules which disintegrate into "rope-like" fibers and are thus open or convolute, and by having fruits with a less developed keel and more nearly median beak. Fernald (1932, p. 52) stated his reservations in assigning specific rank to this new entity: "The plant will doubtless be found to have a broader range, when it may prove to be a marked geographic variety of the widespread *P. foliosus*."

Several collections, especially from Yellowstone National Park of Wyoming and from southeastern Oregon, are distinct from *Potamogeton foliosus*. In general, these specimens differ from *P. foliosus* not only in having the stipules disintegrating into fibers and fruits with poorly developed keels, but also in having cylindric, interrupted inflorescences and leaves with basal glands — the last two characters not mentioned by Fernald, but are present even on the holotype.

Other collections from the Yellowstone region are not so distinct. One such collection (*Haynes 3849*) has fruits, including the keel, which are identical with those of *Potamogeton foliosus*, but the inflorescence is capitate and the stipules only rarely disintegrate into fibers. Yet, basal glands are present. Flowering specimens from Albany County, Wyoming, taken by C. L. Porter (*3473*) are similar to *P. fibrillosus* in having basal glands and short, clavate peduncles. However, in this collection, the stipules only rarely disintegrate into fibers. Flowering specimens obtained by Maguire (*21578*) in northern Utah commonly produce fibers when the stipules decay, but basal glands are rarely found.

Hitchcock (1969) regarded *Potamogeton fibrillosus* as a distinct species, but conceded its close relationship with *P. foliosus*. Porter (1963) reduced *P. fibrillosus* to synonymy, regarding it only as a local form of *P. foliosus* produced by the rather warm-water conditions of "geyser formations and hot springs" in the Yellowstone area. Porter stated (1963, p. 9) "The warm water hastens disintegrations of the sheaths by bacterial action." This is not always the case, however, in northern Utah or southeastern Oregon where the water is often cool. Here the stipules still form fibers. In the same general region, *P. foliosus* is known to occur in similar environmental conditions and at approximately the same degree of development. Therefore, the possibility that mere bacterial activity (or some other type of mechanical breakdown) being the only cause of the fibrous stipules seems unlikely. For this reason and that the extremes can be distinguished quite easily, Haynes and Reveal (1973) thought that *P. fibrillosus* should be taxonomically recognized. However, since many intermediate forms can be found, they could not justify the specific rank and therefore ranked the taxon at the varietal level.

From var. *foliosus,* the var. *fibrillosus* may be distinguished by its poorly developed keel, cylindric and interrupted inflorescence, fibrous stipules and glands present at the base of most leaves.

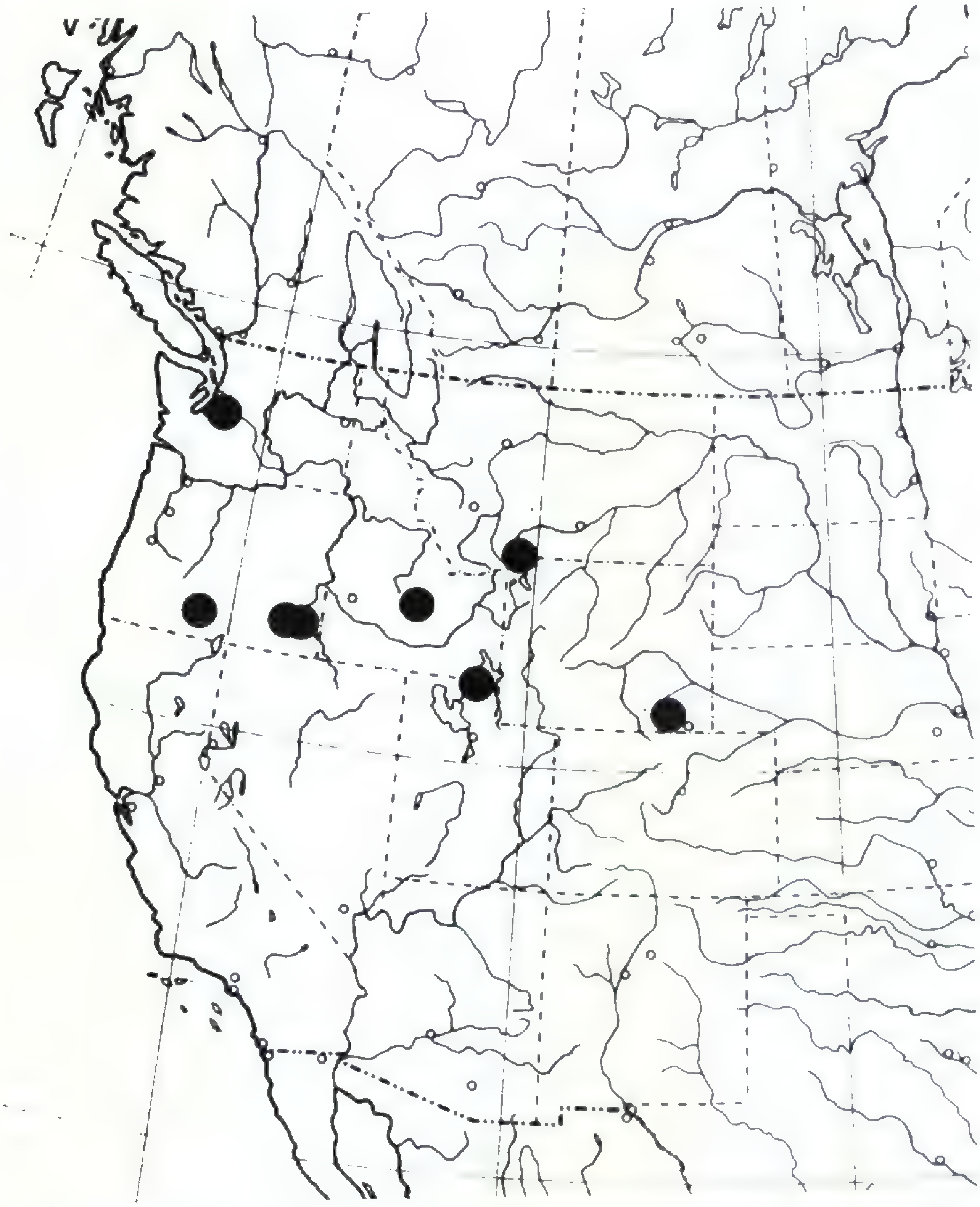

Fig. 9. Map of northwestern United States showing documented distribution of *Potamogeton foliosus* var. *fibrillosus.*

REPRESENTATIVE SPECIMENS

UNITED STATES: **Idaho:** BLAINE CO.: Russian John Ranger Station, *Macbride & Payson* 3790 (UC). **Oregon:** HARNEY CO.: warm spring, near Burns, *Henderson* 8867 (GH); irrigating ditch at Frenchglen, *Thompson* 12068 (NY). KLAMATH CO.: N end of Klamath Marsh, *Peck* 21954 (UC). MALEUR CO.: Otis Creek, *Leiberg* 2340 (GH, US). **Utah:** CACHE CO.: stream, 3 mi. NE of Logan, *Maguire* 16685 (CAN, MO, NY); stream, 2 mi. NW of Logan, *Maguire* 21578 (DAO, F, GH, MICH, MO, NY, US). **Washington:** PIERCE CO.: outlet, Lake Spanaway, near Tacoma, *Thompson* 9657 (GH, NY); unknown locality, Washington Territory, *Brandegee* 1127 (GH, UC). **Wyoming:** ALBANY CO.: N. fork of Pole Creek, *Porter* 3474 (NY, US). PARK CO.: Firehole River, *Jepson* 2540 (GH); Firehole Canyon, Firehole River, *Haynes* 3848 (ILL, OS, PH, UC, US); Midway Geyser Basin, Firehole River, *Haynes* 3850 (GH, MICH, MO, NY, OS); Upper Geyser Basin, *Richardson* (GH); Upper Nez Perce Creek, *Haynes* 3849 (MICH, OS).

6. **Potamogeton clystocarpus** Fern., Mem. Amer. Acad. Arts 17: 79. 1932. TYPE: *J. A. Moore & J. A. Steyermark* 3088, pool in rock, Little Aguja Canyon, Davis Mts., 1575 ft. Jeff Davis Co. Texas, (holotype, GH!; isotypes, MICH!, MO!, NY!, PH!, US!).

Stem light green to brown, terete to slightly compressed, rarely ridged, to 57 cm long, 0.5-0.7 mm diam. Leaves green, 3 (-5)-nerved, 3.2-7.8 cm long, 0.7-1.7 mm wide; apex acute; glands usually present, white to gold, 0.2-0.3 mm diam; lacunae to 4 rows each side of midrib, rarely absent; lateral nerves joining midrib 0.2-0.4 mm below apex. Stipules brown, delicate, not shredding at tip, usually convolute, to 6.2 mm long, 0.5-0.8 mm diam. Winter buds unknown. Peduncles cylindrical, axillary to terminal, erect, 3.2-4.8 cm long, 0.3-0.5 mm diam. Spike capitate to cylindric, 5.5-7.5 mm long, 3.0-5.7 mm diam; verticels 3, 1.5-1.7 mm apart. Perianth segments 1.7-2.0 mm long, 1.5-1.8 mm wide. Fruit brown to yellow-green, dorsally and laterally keeled, 2.0-2.2 mm long, 1.7-1.8 mm wide; keels ridged, without undulations, to 0.2 mm high; beak central, 0.5-0.6 mm long, 0.2-0.4 mm diam; sides depressed, with 1-3 tubercles near base; wall texture rough. Chromosome number unknown.

Distribution: Known only from the type locality. Fruiting from early May to mid-June. Fig. 10.

Illustrations: Fernald (1932, plate 15.30, fig. 5); Ogden (1966, plate 51).

Potamogeton clystocarpus was named by Fernald (1932), based on the "gibbous-tuberculate-based fruits." He suggested the fruits were "so similar to those of the western Eurasian and African *P. trichoides* C. & S. in having basal bosses that they might easily pass as fruits of that species. *P. trichoides,* however, as its name implied, has very bristle-tipped leaves . . . *P. clystocarpus* cannot be referred to it." No other North American pondweed, to my knowledge, has fruits with the basal "bosses." In this character, *P. clystocarpus* is quite distinct. But, as with other *Pusilli,* it is almost impossible to identify with sterile material!

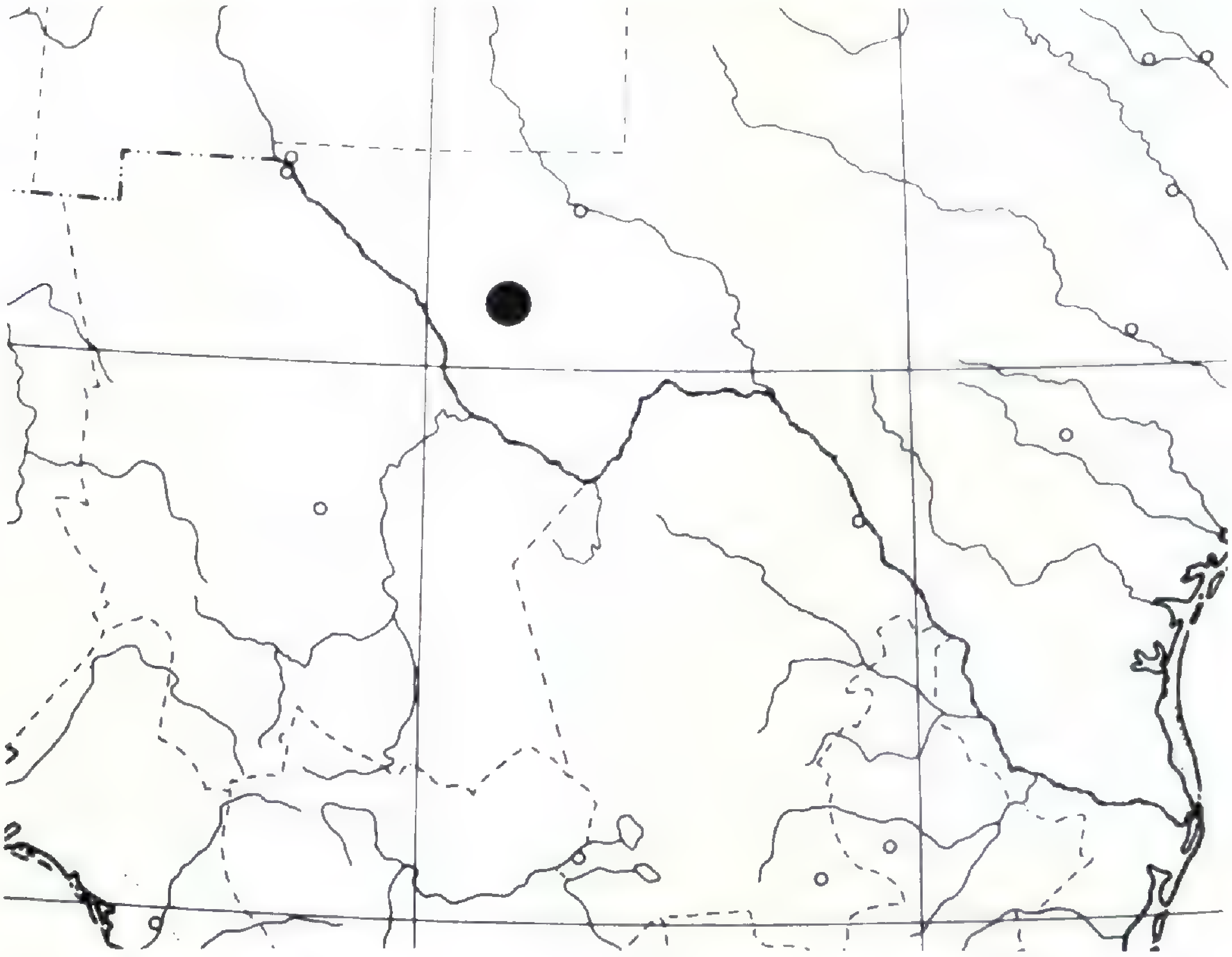

Fig. 10. Map of southwestern North America showing documented distribution of *Potamogeton clystocarpus.*

REPRESENTATIVE SPECIMENS

UNITED STATES: **Texas:** JEFF DAVIS CO.: Little Aguja Canyon, Davis Mts., *Palmer* 34526 (MO, NY, PH), *Correll & Ogden* 25070 (NYS, UC).

7. **Potamogeton pusillus** L., Species Plantarum **1**: 127. 1753.

Stems pale green to olive, terete to slightly compressed, smooth to slightly ridged, 18-150 cm long, 0.1-0.7 mm diam. Leaves pale green to olive, rarely rufescent, delicate to coarse, 1-3 (-5)-nerved, 0.9-6.5 cm long, 0.2-2.5 mm wide; apex subulate to obtuse; glands present or absent, green, gold, brown, or rarely white, to 0.5 mm diam; lacunae absent or to 5 rows each side of midrib; lateral nerves, when present, joining midrib 0.1-1.0 (-2.0) mm below apex. Stipules brown to green or white, delicate, rarely appearing fibrous, not shredding at tip, connate or convolute, 3.1-9.2 mm long, 0.2-0.7 mm diam. Winter buds common, lateral or terminal, 0.9-3.2 cm long, 0.3-1.8 mm wide; inner leaves rolled into a hardened fusiform structure; outer leaves 1-3 per side, subulate to obtuse, without corrugations at base. Peduncles filiform to slightly clavate, axillary or terminal, mostly erect, rarely recurved, 0.5-6.2 (-6.6) cm long, 0.2-0.7 mm diam. Spikes capitate to cylindric, 1.5-10.1 mm long, 0.7-5.2 mm diam; verticels 1-3 (-4), 1.2-4.7 mm apart. Perianth segments 0.7-1.7 mm long, 0.5-1.2 mm wide. Fruit green to brown, without keels, 1.5-2.2 mm long, 1.2-1.6 mm wide; beak forward or central, 0.1-0.6 mm high, 0.2-0.5 mm diam; sides rounded; wall texture smooth or rough.

Potamogeton pusillus has been interpreted variously by botanists. Bennett (1890-1894; 1900-1904) and Morong (1893), for example, considered the taxon to consist of two species, one being divided into several varieties. Hagstrom (1916), on the other hand, divided the taxon into several poorly defined species, with two of these — *P. panormitanus* [var. *pusillus*] and *P. pusillus* [var. *tenuissimus*] — being split into many infraspecific taxa. These two species were separated by the connate versus convolute character of the stipule. Fernald (1932) took the intermediate position and recognized three species — *P. panormitanus* [var. *pusillus*], *P. gemmiparus* [var. *gemmiparus*], and *P. pusillus* [var. *tenuissimus*]. He divided *P. panormitanus* into two varieties and *P. pusillus* into six varieties. These varieties were based on the size of the leaf, apex shape, and number of lacunae bordering the midrib. The latter concept of the taxon was accepted until Dandy and Taylor (1938), after studying the type specimen of *P. pusillus* in the Linnaean herbarium, decided that the name *P. pusillus* actually should be applied to the taxon which had been passing as *P. panormitanus.* For the taxon which had been passing as *P. pusillus,* the next available name in the specific rank was *P. berchtoldii* Fieber. Fernald (1940) finally made the combinations of various varieties to conform with the revised nomenclature. This is the concept that appeared in the eighth edition of Gray's Manual (Fernald, 1950). Gleason and Cronquist (1963), however, did not accept *P. pusillus* and *P. berchtoldii* as two distinct species. They, instead, suggested that although this character may be good for distinguishing certain species, there was no reason to assume that both states of the stipule and gradations between could not occur within one species. As I indicated earlier, a single plant may produce two sets of leaves during one growing season. The first set may have obtuse leaves with 4-5 rows of lacunae; the second, instead, would probably have acute leaves with 1-3 rows of lacunae. In the early summer, this plant would resemble var. *mucronatus* [of Fernald, 1932] and in the late summer, it would resemble var. *tenuissimus* [of Fernald, 1932]. For this reason and because of the ecological variability as explained by Sculthorpe (1967), I have decided to recognize only three taxa.

Fernald (1950) suggested that useful characters in distinguishing *Potamogeton pusillus* from *P. berchtoldii* were length of inflorescence, branching of the plant, and whether the fruit is wider at, above, or below the middle. Voss (1972) had noticed that fruiting specimens with connate stipules [*P. pusillus* var. *pusillus*] from Michigan often lacked glands. Ogden (personal communication) suggested that the presence or absence of lacunae along the midrib often is a reliable character for distinguishing the species. Eighty specimens were examined for the characters mentioned above and other features. Some correlation, although slight, was noticed between the stipule character, the diameter of the glands, and the number of lacunae bordering the midrib. However, for the majority of the characters measured, little or no correlation was observed. Regardless of the inconsistency of the stipule character, the shape of the inflorescence and of the fruit, and the length of peduncle seem to be associated. This is not to say that intermediates do not occur, because they do! In their extremes, the two entities can be separated by the length of the inflorescence, the shape of the fruit, the length of the peduncle, the number of lacunae bordering the midrib, the presence and size of nodal glands, and, finally, the connation of the stipules. No one character can definitely be depended upon, but by using a combination of as many of the above mentioned characters as are present on the plant, one can place the specimen into the correct taxon 70-80% of the time. The remaining 20-30%, however, are almost impossible to identify without depending upon one character taxonomy. Also, var. *tenuissimus* has a more northerly distribution, e.g. into Alaska, and var. *pusillus* has a more southerly distribution, e.g. into Mexico. Because of the morphological integradation and the slight range differences, I have decided to place the two taxa at the varietal level.

When in fruit, *Potamogeton pusillus* should not be confused with any other pusilloid. Its fruit, lacking a keel, a wing, or basal warts, and its delicate stipules separate it from all other species. However, in the sterile state, identification is not so easy. Vegetatively, it closely resembles *P. foliosus*, *P. clystocarpus*, and some individuals of *P. hillii*. I can give no morphological characters which serve to separate *P. pusillus* from *P. clystocarpus* if fruits are lacking. If the specimen is from areas other than western Texas, one can assume the specimen is not *P. clystocarpus*, although this may not be a valid assumption. The stipules of *P. pusillus,* usually lacking slightly fibrous veins, often serve to distinguish the species from *P. hillii* and *P. foliosus.* However, the stipules of the two latter species may, on occasions, appear to lack the fibrous veins. In this instance, the species are impossible to separate. Therefore, one should always make an effort to collect fertile material!

7a. **Potamogeton pusillus** var. **pusillus**

Potamogeton pusillus L., Species Plantarum, 128. 1753. *P. pusillus* var. *typicus* Fern., Mem. Amer. Acad. Arts 17: 81. 1932. TYPE: Europe. (holotype, LINN; photograph of holotype, OS!).

Potamogeton panormitanus Ant. Biv. Bern. in And. Biv. Bern. Nuove piante inedite del barone Ant. Bivona Bernardi 6. 1838. (publication not seen). *P. pusillus* var. *panormitanus* (Ant. Biv. Bern. in And. Biv. Bern) Morong, Mem. Torrey Bot. Club 3: 46. 1893. TYPE: (location unknown).

Potamogeton panormitanus var. *major* Ant. Biv. Bern. in And. Biv. Bern., Nuove piante inedite del barone Ant. Bivona Bernardi 6. 1838. (publication not seen). TYPE: (location unknown).

Potamogeton panormitanus var. *minor* Ant. Biv. Bern. in And. Biv. Bern. Nuove piante inedite del barone Ant. Bivona Bernardi 6. 1838. (publication not seen). *P. pusillus* var. *minor* (Ant. Biv. Bern. in And. Biv. Bern.) Fern. & Schubert, Rhodora 50: 154. 1948. TYPE: (location unknown).

Potamogeton pusillus var. *vulgaris* Fries, Novitiae Florae Suecicae 2nd ed. 49. 1828. TYPE: (type not located), application of the name is from the illustration of *Potamogeton pusillus* L. *In* Smith, English Bot. 2: *pl. 215.* 1794!

Potamogeton pusillus var. *vulgaris* subvar. *interruptus* Robbins in Watson, Bot. U. S. Geol. Expl. Fortieth Parallel 338. 1871. TYPE: *S. Watson,* 1137, Parley's Park in the Wasatch, 6,000 ft. [Wasatch Co.], Utah, (holotype, NY!; isotype, US!).

Stems green to brownish, mostly terete, slightly ridged, 18-150 cm long, 0.2-0.7 mm diam. Leaves pale green, rarely olive, delicate, 1-3-nerved, 1.4-6.5 cm long, 0.5-1.9 mm wide;

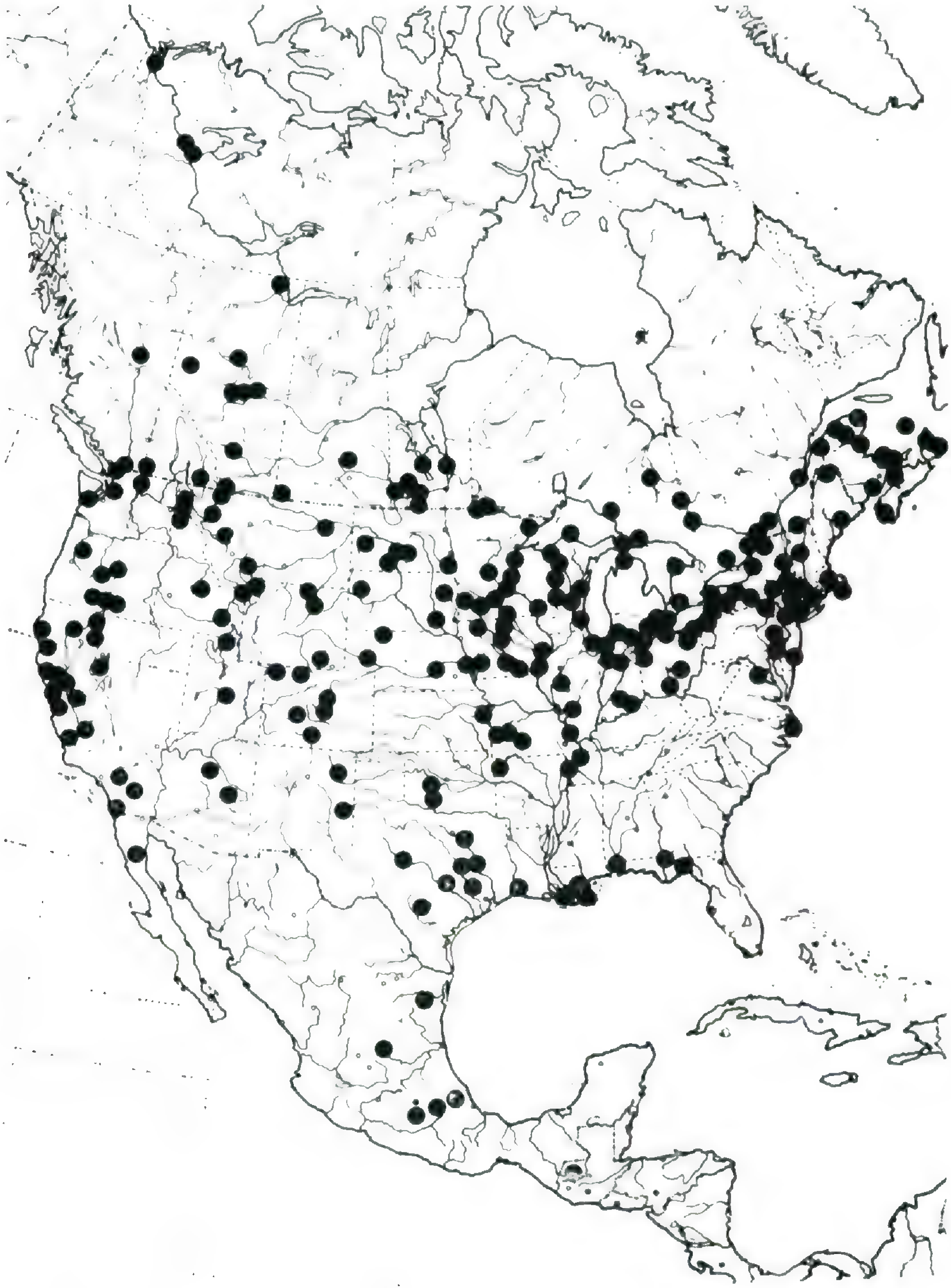

Fig. 11. Map of North America showing documented distribution of *Potamogeton pusillus* var. *pusillus*.

apex acute or rarely apiculate, rarely with a bristle; glands often present, green, gold, brown, or rarely white, to 0.3 mm diam; lacunae absent or to 2 rows each side of midrib; lateral nerves joining midrib 0.1-0.7 mm below the apex. Stipules greenish to brown, delicate, rarely fibrous, usually connate, 2.2-9.2 mm long, 0.2-0.7 mm diam. Winter buds uncommon, lateral or terminal, 0.9-1.5 cm long, 0.3-1.8 mm wide; outer leaves 1-2 per side, acute to apiculate. Peduncles cylindric, axillary, to lower or upper leaves, rarely recurved, 1.0-6.2 cm long, 0.2-0.7 mm diam. Spikes cylindric, 2.5-10.1 mm long, 1.2-4.7 mm diam; verticels 2 or 3 (-4), usually interrupted, 1.4-4.5 mm apart. Perianth segments 1.0-1.5 mm long, 0.7-1.2 mm wide. Fruit green to brown, usually wider above the middle, 1.5-2.2 mm long, 1.2-1.5 mm wide; keel absent; beak forward, rarely central, 0.1-0.6 mm high, 0.2-0.5 mm diam; sides rounded, usually centrally depressed; wall texture smooth. Chromosome number $2n = 26$ (Palmgren, 1939).

Distribution: From central British Columbia to Nova Scotia, south to northern Guatemala and western Florida. Fruiting from early May to late September. Fig. 11.

Illustrations: Fernald (1932, pl. 9; 10; 29, fig. 7, 8; 33, fig. 4, 5; 39, fig. 10).

REPRESENTATIVE SPECIMENS

CANADA: **Alberta:** Wood Buffalo Park, *Raup* 1568 (CAN, GH, NY, UC, US). **British Columbia:** pond near Similkameen River, *Macoun* 70317 (F, GH, NY). **Manitoba:** Desford, pothole, *Love & Love* 6092 (DAO, ILL, US). **New Brunswick:** KINGS CO.: Westfield, Ingleside, cove in St. John River, *Fernald* 1618 (GH, NY). **Northwest Territories:** MACKENZIE DIST.: Norman Wells, MacKenzie River, *Cody & Gutteridge* 7631 (F, NY, US). **Nova Scotia:** CAPE BRETON CO.: Fort Louisbourg, *Smith et al.* 8281 (CAN, DAO). **Ontario:** OTTAWA CO.: Ottawa, Rideau Canal, *Fletcher* (MO, NY, PH). **Prince Edward Island:** Tignish, pools and ponds, *Fernald et al.* 6776 (CAN, K, NY). **Quebec:** Magdalen Islands, Grindstone Island, *Fernald et al.* 6780 (GH, K, NY, US), *Fernald et al.* 6781 (GH, NY, PH, US). **Saskatchewan:** MAPLE CREEK DIST.: 14.7 mi. N of Govenlock, middle Creek, *Bird* 1022 (DAO). GUATEMALA: **Quiche Dept.:** Quiche, pond, *Muenscher* 12085 (UC). MEXICO: **Baja California:** La Encantada, Sierra San Pedro Martir, *Wiggins & Demaree* 4906 (GH, MU, US). **Hidalgo:**

DIST. MOLANGO: Molango, Lake Atexca, *Moore* 3470 (UC). **Morelos:** Zempoala National Park, Lake Zempoala, *Moore* 3435 (GH, US). **Puebla:** vicinity of Puebla, Laguna de San Baltasar, *Arsene* 1323 (US). **San Louis Potosi:** San Louis Potosi, *Schaffner* 533 (K, NY). **Tamaulipas:** vicinity of San Jose, Sierre de San Carlos, *Bartlett* 10397 (F, MICH, US). **Veracruz:** Los Molinos, Perote, pond, *Balls & Gourlay* (K, MICH, UC, US). UNITED STATES: **Alabama:** 7-8 mi. NE of Mobile, Chuckfey Bay, *Hotchkiss & Ekvall* 3902 (US). **Arizona:** GILA CO.: Young's Ranch, *Lemmon* (K, MO, NY, UC, US). **Arkansas:** MISSISSIPPI CO.: S. of Hornersville, Missouri, *Metcalf* 644 (GH, NY, US). **California:** HUMBOLDT CO.: Eel River, near Fernbridge, *Harris* 808 (CAN, DAO, F, GH, ILL, MICH, MO, NY, PH, UPS, US). **Colorado:** ROUTT CO.: ponds between Hayden and Craig, *Porter* 6563 (CAN, DAO, NY, UC, UPS). TELLER CO.: base of Pike's Peak, Lake Osborne, *Parry* (GH, MO, NY). **Connecticut:** MIDDLESEX CO.: Grove Beach, creek, *Enquist* 366 (NY). **Florida:** JACKSON CO.: N of Sneads, Lake Seminole, *Adams* 445 (US). **Idaho:** CUSTER CO.: 15 mi. N of Challis, ditch, *Hitchcock et al.* 23839 (DAO, ILL, NY, UC). **Illinois:** COOK CO.: South Chicago, ditches, *Hill* 89-1875 (F, ILL). **Indiana:** CASS CO.: Lake Cicott, *Deam* 49306 (GH). **Iowa:** CLAY CO.: Lake Twp, Round Lake, *Hayden* 10120 (GH, MO, NY, PH, UC, US). **Kansas:** DOUGLAS CO.: 1½ mi. E and ½ mi. N of Lawrence, ponds, *Richards* 3079 (NY). **Louisiana:** CAMERON PAR.: Sabine National Wildlife Refuge, *Valentine* (OS). **Maine:** AROOSTOOK CO.: Oxbow, Aroostook River, *Ogden* 2661 (OS). **Maryland:** CECIL CO.: Blairs Shore, Elk River, *Long* 57093 (PH). **Massachusetts:** BERKSHIRE CO.: New Marlboro, Lake Buel, *Churchill* (GH, MO). **Michigan:** EMMET CO.: small arm of Carp Lake, *Haynes* 3370 (CAN, FSU, GH, ILL, MICH, MO, MSU, NY, OS, PH, UC, US, WVA), *Haynes* 3706 (ILL, OS). **Minnesota:** ST. LOUIS CO.: Armstrong, near Ely, *Jones* 18543 (ILL, NY, US). **Missouri:** LACLEDE CO.: Gasconade River, between Falcon and Nelio, *Steyermark* 13913 (GH, MO). **Montana:** GALLATIN CO.: ca. 12 mi. NW of West Yellowstone, Hegben Lake, *Haynes* 3841 (OS). LAKE CO.: 0.2 mi. SE of Nine-Pipes Reservoir, pot-hole, *Hitchcock et al.* 23980 (CAN, F, ILL, NY, UC). **Nebraska:** CHERRY CO.: 30 mi. S of Valentine, small pond, *Porter* 6445 (DAO, NY, UPS). **Nevada:** STOREY CO.: vicinity of Reno, Sparks, irrigation ditch, *Hitchcock* 443 (GH, US). **New Jersey:** SUSSEX CO.: Catfish Pond, *Griscom* 9750 (GH). **New Mexico:** SAN MIGUEL CO.: Montezuma, Peterson Reservoir, *Drouet & Richards* 3308 (F, GH). **New York:** ST. LAWRENCE CO.: Lisbon, Sucker Brook, *Phelps* 269 (CAN, GH, NY, US). **North Carolina:** DARE CO.: Currituck Sound, inlet S of Duck, *Radford* 5758 (DAO, UC). **North Dakota:** BURLEIGH CO.: 7 mi. E of Bismark, slough, *Metcalf* 356 (US). **Ohio:** PORTAGE CO.: ca. 5½ mi. NW of Ravenna, small pond, *Haynes* 3450 (OS). **Oklahoma:** COMANCHE CO.: Wichita Mountains Wildlife

Refuge, Lake Quanah Parker, *McMurry* 1219 (NY). **Oregon:** WHEELER CO.: 15 mi. E of Mitchell, roadside pond, *Hitchcock et al.* 23779 (CAN, DAO, F, ILL, NY, UC). **Pennsylvania:** BERKS CO.: 1 mi. NW of Moselem Springs, *Brumbach* 2841 (PH). **South Dakota:** CODINGTON CO.: outlet of Lake Kampeska, *Over* 17149 (US). **Tennessee:** OBION CO.: Walnut Log, *Sharp* 7933 (OS). **Texas:** TRAVIS CO.: Colorado River, ca. 5 mi. below Austin, *Barkley* 13313 (F, GH, MO, PH, UC). WALLER CO.: Hempstead, *Hall* 620 (F, K, MO, NY, US). **Utah:** CACHE CO.: 1 mi. W of Logan, marsh, *Maguire* 13883 (CAN, GH, DAO). **Vermont:** WINDSOR CO.: Windsor, mill pond, *Hellquist* 1813 (Boston State College). **Virginia:** FAIRFAX CO.: Dyke, *Metcalf & Sperry* 1688 (GH). **Washington:** GRAYS HARBOR CO.: slough near ocean beach, *Otis* 2116 (GH, NY, PH, UC). **Wisconsin:** LA CROSSE CO.: Lake Onalaska, *Hartley* 1826 (DAO, F, ILL, US). **Wyoming:** ALBANY CO.: Laramie River E of Lookout, *Porter* 6352 (DAO, MO, NY, UPS).

7b. **Potamogeton pusillus** var. **tenuissimus** Mert. & Koch in Röhling, 857. 1823. TYPE: (location unknown).

Potamogeton tenuissimus (Mert. & Koch in Röhling) Reichen. Icones Florae Germanica Helveticae 7: 14. 1845. *P. berchtoldii* var. *tenuissimus* (Mert. & Koch in Röhling) Fern. & Schubert, Rhodora 42: 246. 1940.

Potamogeton berchtoldii Fieber, in Berchtold, Oekon.-tech. Flora Bohmens, 277. 1838. TYPE: (location unknown).

Potamogeton berchtoldii var. *mucronatus* Fieber in Berchtold, Oekon.-tech. Flora Bohmens 277. 1838. *P. pusillus* var. *mucronatus* (Fieber) Graebner in Ascherson & Graebner, Das Pflanzen. 4(11): 115. 1907. TYPE: (location unknown).

Potamogeton berchtoldii var. *acuminatus* Fieber in Berchtold, Oekon.-tech. Flora Bohmens 278. 1838. TYPE: (location unknown).

Potamogeton pusillus var. *polyphyllus* Morong, Bot. Gaz. (Crawfordsville) 5: 51. 1880. *P. berchtoldii* var. *polyphyllus* (Morong) Fern. Rhodora 42: 246. 1940. TYPE: *T. Morong*, oozy pool in South Natick, [Middlesex Co.], Massachusetts, (holotype, NY!).

Potamogeton pusillus var. *elongatus* Ar. Benn., in Macoun, Cat. Canadian Plants 4: 371. 1888. TYPE: *J. Macoun* 4140, Spullamasheen River at and above Enderby, British Columbia, Canada, (holotype, K[?]; isotype, GH!). *P. pusillus* var. *capitatus* Ar. Benn., *nom. illeg.*, J. Bot. 39: 201. 1901. (Superfluous when published).

Potamogeton pusillus var. *cuspidatus* G. Fisher, Ber. Bayer. Bot. Ges. 11: 116. 1907. TYPE: (location unknown).

Potamogeton lacunatus Hagstrom, Kongl. Svenska Vetenskapsakad. Handl. 55(5): 120. 1916. *P. pusillus* var. *lacunatus* (Hagstrom) Fern. Mem. Amer. Acad. Arts 17: 85. 1932. *P. berchtoldii* var. *lacunatus* (Hagstrom) Fern. Rhodora 42: 246. 1940. TYPE: *T. Morong*, Ashland, in lacu Wauhakune, [Middlesex Co.], Massachusetts, (lectotype here designated, UPS!).

Potamogeton turionifera f. *tenuis* Hagstrom, Kongl. Svenska Vetenskapsakad. Handl. 55(5): 91. 1916. TYPE: *J. Macoun*, Algonquin Park, Cache Lake, Ontario, Canada, (lectotype here designated, C!; isolectotypes, C!, CAN!, GH!).

Potamogeton turionifera f. *mucronulatus* Hagstrom, Kongl. Svenska Vetenskapsakad. Handl. 55(5): 91. 1916. TYPE: *J. Macoun*, Ottawa, Brigham's Creek, Ontario, Canada, (holotype, C!; isotypes, C!, CAN!, GH!).

Potamogeton pusillus var. *colpophilus* Fern. Mem. Amer. Acad. Arts 17: 90. 1932. *P. berchtoldii* var. *colpophilus* (Fern.) Fern. Rhodora 42: 246. 1940. TYPE: *J. F. Collins, M. L. Fernald, & A. S. Pease*, brackish pools and dead waters near the mouth of Dartmouth River, Gaspe Co., Quebec, Canada, (holotype, GH!; isotypes, CAN!, NY!, US!).

Stem light green to olive, terete to slightly compressed, usually smooth, 22-74 cm long, 0.1-0.5 mm diam. Leaves pale green to olive, rarely rufescent, delicate, 1-3 (-5)-nerved, 0.9-5.4 cm long, 0.2-2.5 mm wide; apex acute to obtuse; glands usually present, green to brown or white, to 0.4 mm diam; lacunae usually present, 1-5 rows each side of midrib; lateral nerves, when present, joining midrib 0.3-1.0 (-2.0) mm below apex. Stipules brown to green, rarely white, delicate, mostly convolute, 3.1-5.0 mm long, 0.2-0.5 mm diam. Winter buds common, lateral or terminal, 1.2-3.2 cm long, 0.7-1.2 mm wide; outer leaves 1-3 per side, acute to obtuse. Peduncles cylindrical to slightly clavate, axillary or terminal, rarely recurved, 0.5-4.6 (-6.6) cm long, 0.2-0.7 mm diam. Spikes capitate to cylindric, 1.5-7.2 mm long, 0.7-5.2 mm diam; verticels 1-3, when of 2 or 3, then these crowded, 1.2-2.5 mm apart. Perianth segments 0.7-1.0 mm long, 0.5-0.7 mm wide. Fruit green to brown, usually wider at or below the middle, 1.6-2.1 mm long, 1.2-1.5 mm wide; keels absent; beak usually central, rarely forward, 0.2-0.5 mm long, 0.2-0.4 mm diam; sides usually rounded, rarely centrally depressed; wall texture smooth. Chromosome number, $n = 13$; $2n = 26$ (Taylor & Mulligan, 1968).

Distribution: Central Alaska to Labrador, south to California and northern Florida. Fruiting from early June to late September. Fig. 12.

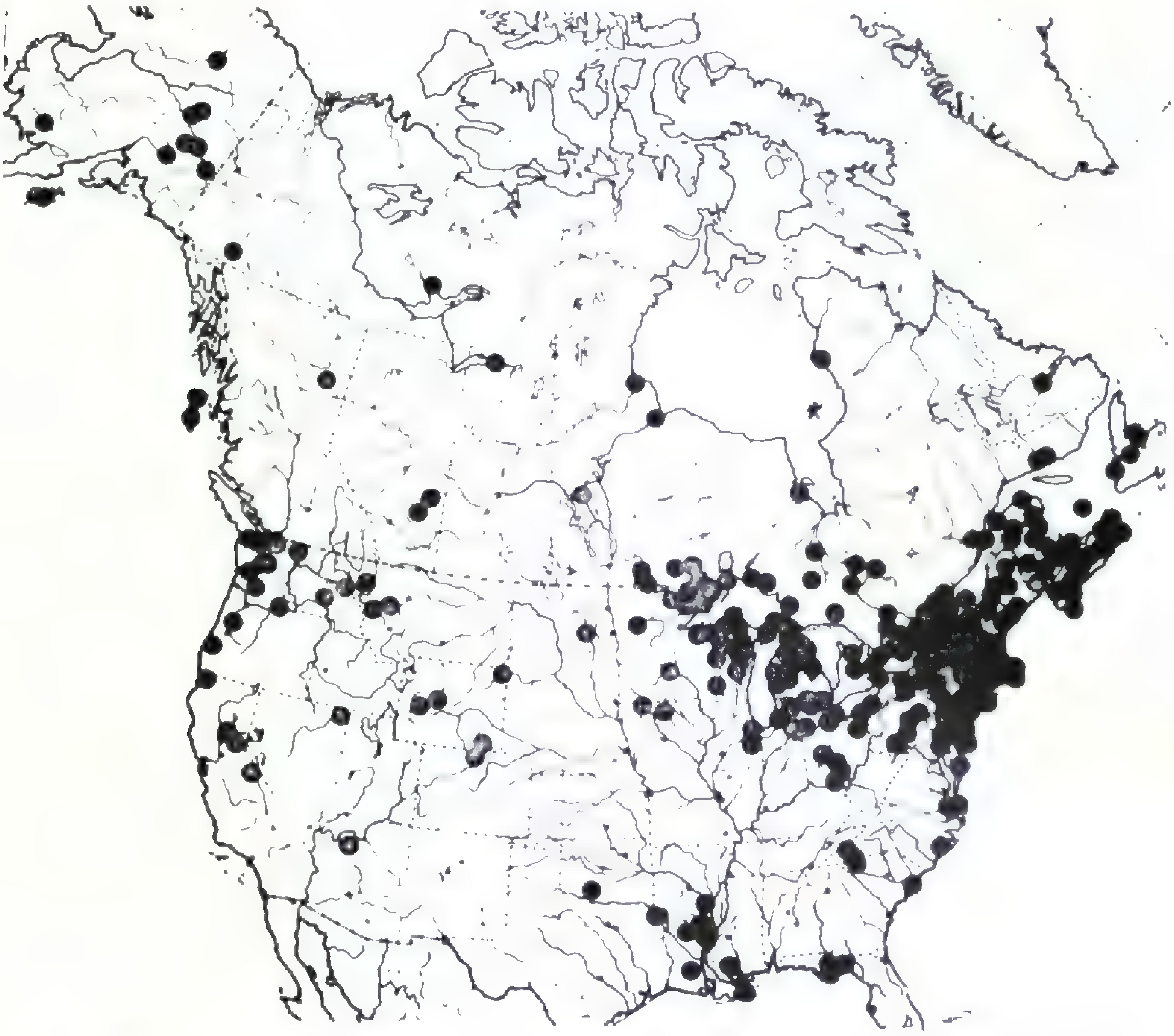

Fig. 12. Map of North America showing documented distribu- of *Potamogeton pusillus* var. *tenuissimus*.

Illustrations: Fernald (1932, pl. 16-20; 30, fig. 6-9; 31, fig. 1; 35; 39, fig. 9).

REPRESENTATIVE SPECIMENS

CANADA: **Alberta:** CRAIGMYLE DIST.: Craigmyle, *Brinkman* 538 (US). **British Columbia:** QUEEN CHARLOTTE ISLANDS: Graham Island, 2 mi. NW of Tlell, $n = 13$, *Calder & Taylor* 35688 (DAO); Moresby Island, White Swan Lake, $2n = 26$, *Calder & Taylor* 35297 (DAO). VANCOUVER ISLAND: Lost Lake near Victoria, *Macoun* (CAN, GH, NY, US). **Labrador:** Goose Bay, 53°20′N, 60°09′W, *Gillett & Findlay* 5910 (DAO, NY). **Manitoba:** CHURCHILL DIST.: Gillman Lake, *Schofield* 1524 (DAO, GH). **New Brunswick:** CHARLOTTE CO.: Grand Manan, *Weatherby & Weatherby* 7284 (CAN, GH). **Newfoundland:** Harry's River, near Bay of St. George, *Fernald & Wiegand* 2453 (CAN, GH, NY). **Northwest Territories:** small pool 45.5 mi. WNW of Yellowknife, *Thieret & Reich* 7944 (CAN, F, OS, US). **Nova Scotia:** Sable Island, *St. John* 1125 (CAN, GH, NY, PH, US). **Ontario:** THUNDER BAY DIST.: Black Fox Lake, 12 mi. E of Terrace Bay, *Haynes* 3751a (OS); small lake 0.2 mi. NE of Coldwell, *Haynes* 3773 (ASC, CAN, FSU, GH, ILL, MICH, MO, MSU, NY, OS, PH, UC, US, WVA). ESSEX CO.: Fox's Pond, *Haynes* 3251 (OS), *Roberts* 1567 (OS). **Prince Edward Island:** QUEENS CO.: Watervale, *Erskine* (DAO). **Quebec:** MAGDALEN ISLANDS: ridges back of the Narrows, Alright Island, *Fernald et al.* 6778 (CAN, GH, K, NY, US). **Saskatchewan:** Cornwall Bay, Lake Atabaska, 59°27′N, 108°27′W, *Raup* 6633 (CAN, DAO, F, GH, NY). **Yukon:** Lewes River, Whitehorse, *Porsild & Breitung* 10644 (CAN). UNITED STATES: **Alaska:** Goldstream Creek, 51 mi. N of Fairbanks, 65°N, 147°30′W, *Porsild & Porsild* 115 (CAN, GH, US). **Arkansas:** DREW CO.: Taxodium swamp, Tillar, *Demaree* 17394 (F, MO, NY, UC). **Arizona:** COCONINO CO.: Crater Lake, N of Mt. Agassy, *Lemmon* 3244 (GH). **California:** BUTTE CO.: cold spring, Jonesville, *Copeland* 604 (F, GH, K, MICH, MO, MU, NY, UC, US). **Colorado:** JACKSON CO.: Big Creek Lake, *Porter* 6433 (DAO, UPS). **Connecticut:** TOLLAND CO.: Stafford, *Morris* (F, GH, ILL, US). **Florida:** FRANKLIN CO.: 6 mi. NE of Carrabelle, *Adams* 442 (GH, UC, US). **Idaho:** SHOSHONE CO.: St. Maries River, 7 mi. SE of Clarkia, *Cronquist & Jones* 6038 (CAN, DAO, GH, ILL, MICH, NY, UPS, UC, US). **Illinois:** COOK CO.: South Chicago, *Hill* 88-1880 (ILL). **Indiana:** STEUBEN CO:. Crooked Lake, *Williams* (MO). **Iowa:** DICKINSON CO.: Manhattan Pond, Lakeville Twp. *Thorne* 13015 (UC). **Louisiana:** CALDWELL PAR.: Horseshoe Lake, 8 mi. NNW of Columbia, *Thomas* 4224 (OS). **Maine:** PENOBSCOT CO.: Stillwater River, Old Town, *Ogden & Steinmetz* 1600 (CAN, GH, NY, US). **Maryland:** HARFORD CO.: Spesutie Island, *Moldenke* 9398 (NY). **Massachusetts:** NORFOLK CO.: Charles River, Dedham, *Fernald & Svenson* 410 (CAN, DAO, F, GH, ILL, MICH, MO, NY, UC, UPS, US). **Michigan:** CHEBOYGAN CO.: Black River, between its mouth and Alverno, *Haynes* 3378 (GH, ILL, OS, US), *Haynes* 3387 (OS); Marl Bay NW corner of Douglas Lake, *Haynes* 3712 (GH, ILL, MO, OS, UC), *Haynes* 3924 (OS). LUCE CO.: Bodie Lake, *Haynes* 3790 (OS); bog lake, 6½ mi. NE of Newberry, *Haynes* 3718 (OS). SCHOOLCRAFT CO.: Seney Wildlife Refuge, *Haynes* 3741 (OS). **Minnesota:** KOOCHICHING CO.: ditch 2 mi. E of Tilson Bay, Rainy Lake, *Moore & Moore* 11778 (DAO, GH, ILL, NY, UC, US). **Montana:** MISSOULA CO.: Ft. Missoula, *Hitchcock* 23968 (DAO, NY, UC). **Nevada:** ELKO CO.: Hot Creek Field, NE of Golliher Pasture, *Holmgren* 1401 (DAO, NY, UC). **New Hampshire:** CHESHIRE CO.: East Jaffrey, *Deane* (GH). **New Jersey:** CAMDEN CO.: Newton Creek, West Collingswood, *Adams* 370 (GH, MO, PH). **New York:** CORTLAND CO.: borrow pit just N of Little York, *Haynes* 3353 (OS). ESSEX CO.: outlet of Lake George, near Ticonderoga, *Haynes* 3336 (OS). SARATOGA CO.: Saratoga Lake, *Haynes* 3301 (OS), *Haynes* 3307 (OS). SUFFOLK CO.: Wading River, Riverhead, *Miller* (F, GH, US[4]). WARREN CO.: Dunham Bay, S end of Lake George, *Haynes* 3326 (GH, MICH, MO, NY, OS, US), *Haynes* 3329 (CAN, GH, ILL, MICH, MO, NY, OS, PH, UC, US); Lake Luzerne, *Haynes* 3812 (OS). **North Carolina:** CRAVEN CO.: 2 mi. SW of Blades, *Radford* 5856 (DAO, GH, NY). **North Dakota:** STUTSMAN CO.: Jim Lake, Pingree, *Mabbott* 316 (NY). **Ohio:** JACKSON CO.: Sec. 10, Jefferson Twp., *Roberts* 795 (CAN, LAF, MICH, OS, PH, US). LOGAN CO.: Indian Lake State Park, *Haynes* 3418 (OS). OTTAWA CO.: Middle Bass Island, Lake Erie, *Haynes* 3134 (OS); Squaw Harbor, Put-in-Bay, Lake Erie, *Haynes* 3127 (MICH). PORTAGE CO.: Twin Lakes, *Haynes* 3448 (OS). VINTON CO.: Lake Alma State Park, *Haynes* 3463a (OS). **Oklahoma:** COMANCHE CO.: Creek near Cache, *Stevens* 1369 (GH, ILL, K, MO, NY, US). **Oregon:** Porter Lake of Willamette River, 5 mi. S of Corvallis, *Wentz* 344 (MICH, MO, NY, OS, US). **Pennsylvania:** LUZERNE CO.: Lily Lake, *Small* (F, ILL, MU, NY). **Rhode Island:** NEWPORT CO.: Block Island, *Fernald et al.* 8448 (PH). **South Carolina:** GEORGETOWN CO.: Georgetown, *Forster* (NY). **Texas:** BOWIE CO.: Club Lake, 3 mi. W of New Boston, *Correll & Ogden* 25248 (LAF). **Vermont:** CALEDONIA CO.: beaver pond, Walden Twp., *Haynes* 3828 (MICH, OS). ESSEX CO.: Brunswick, *Eggleston* 1654 (GH, NY, US). LAMOILLE CO.: Wolcott Pond, Wolcott, *Haynes* 3826 (OS). **Virginia:** SUSSEX CO.: Chappell's Millpond, W of Lumberton, *Fernald & Long* 12236 (GH, PH). **Washington:** KLICKITAT CO.: Columbia River, Bingen, *Suksdorf* 2570 (F, GH, MO, US). **Wisconsin:** JUNEAU CO.: Glacial Lake Wisconsin, Cutler Twp. *Hartley* 8276 (GH, US). **Wyoming:** ALBANY CO.: Swastika Lake, Medicine Bow Mountains, *Porter* 6190 (DAO, GH, UC, UPS). CROOK CO.: pool 7 mi. N of Moorcroft, *Porter & Miller* 5974 (DAO, MO, UC, UPS).

Potamogeton perfoliatus × pusillus var. tenuissimus

Morong (1880) named *Potamogeton mysticus* based upon a collection from Mystic Pond, Massachusetts. The entity was said to have the habit of *P. perfoliatus,* a species of subsection *Perfoliati* of Hagstrom, but differed from this species by its delicate stature. Morong noted that the entity had never been known to fruit. Ogden (1943), however, based upon the extreme rarity of the entity and that it was not known to fruit, proposed it to be a hybrid with *P. perfoliatus* as one of its parents. He examined the stem anatomy of the entity, as well as studying the plants in the field. The stem anatomy appeared to be intermediate between *P. perfoliatus* and the *Pusilli.* At the one locality in which Ogden found the putative hybrid, *P. berchtoldii* var. *tenuissimus* [*P. pusillus* var. *tenuissimus*] was present. He thus suggested the entity to be a result of hybridization of *P. perfoliatus* and *P. berchtoldii* var. *tenuissimus* [*P. pusillus* var. *tenuissimus*]. Again, until the entity can be studied in depth, I am accepting the concept of Ogden.

SPECIMENS EXAMINED:

UNITED STATES: **Maine:** CUMBERLAND CO.: Scarboro, West Scarboro, Scarboro River, *Ogden et al.* 1731 (CAN, MO, NYS, US); Scarboro, West Scarboro, Stuart Brook, *Steinmetz & Martson* 539 (CAN, F, ILL, UC, US). **Massachusetts:** MIDDLESEX CO.: Medford, Mystic Pond, *Booth* (US), *Faxon* (ILL, US), *Morong* 11 Aug. 1879 (lectotype here designated, NY!; isolectotypes, K!, MICH!, NY[3]!), *Morong* (K, NY). **North Carolina:** DARE CO.: Currituck Sound, inlet S of Duck, *Radford* 5757 (GH, NY, UC).

7c. **Potamogeton pusillus** var. **gemmiparus** Robbins in A. Gray Man. Bot. North. U. S. 5th ed. 489. 1867. TYPE: *Robbins,* Valley of the Blackstone, Uxbridge, Massachusetts, (lectotype here designated, NY!; isolectotypes, GH!, NY!, PH!, US!).

Potamogeton gemmiparus (Robbins in A. Gray) Morong, Bot. Gaz. (Crawfordsville) 5: 51. 1880.

Stems pale green, terete, smooth, 30-140 cm long, 0.1-0.3 mm diam. Leaves pale green, uninervate, 1.1-6.0 cm long, 0.2-0.7 mm wide; apex subulate; glands gold, to 0.3 mm diam; lacunae absent or to 2 rows each side of the midrib. Stipules white, convolute, 4.1-7.2 mm long, 0.2-0.4 mm diam. Winter buds abundant, terminal or lateral, 1.2-2.8 cm long, 0.7-1.5 mm wide; outer leaves 1-2 per side, subulate, much longer than inner. Peduncles cylindric, axillary or terminal, 1.1-2.8 cm long, 0.2-0.5 mm diam. Spike cylindric, 2.5-5.5 mm long, 1.2-3.0 mm diam; verticels 2-3, to 3.5 mm apart. Perianth segments 1.0-1.7 mm long, 0.7-0.8 mm wide. Fruit rare, greenish-brown, 1.9-2.0 mm long, 1.5-1.6 mm wide; beak central, 0.1-0.2 mm long, 0.2-0.3 mm diam; sides centrally depressed; wall texture rough. Chromosome number unknown.

Distribution: South-central Quebec south to central Massachusetts and Rhode Island. Fruiting late August to late September. Fig. 15.

Illustrations: Fernald (1932, pl. 12; 30, fig. 1; 34, fig. 1).

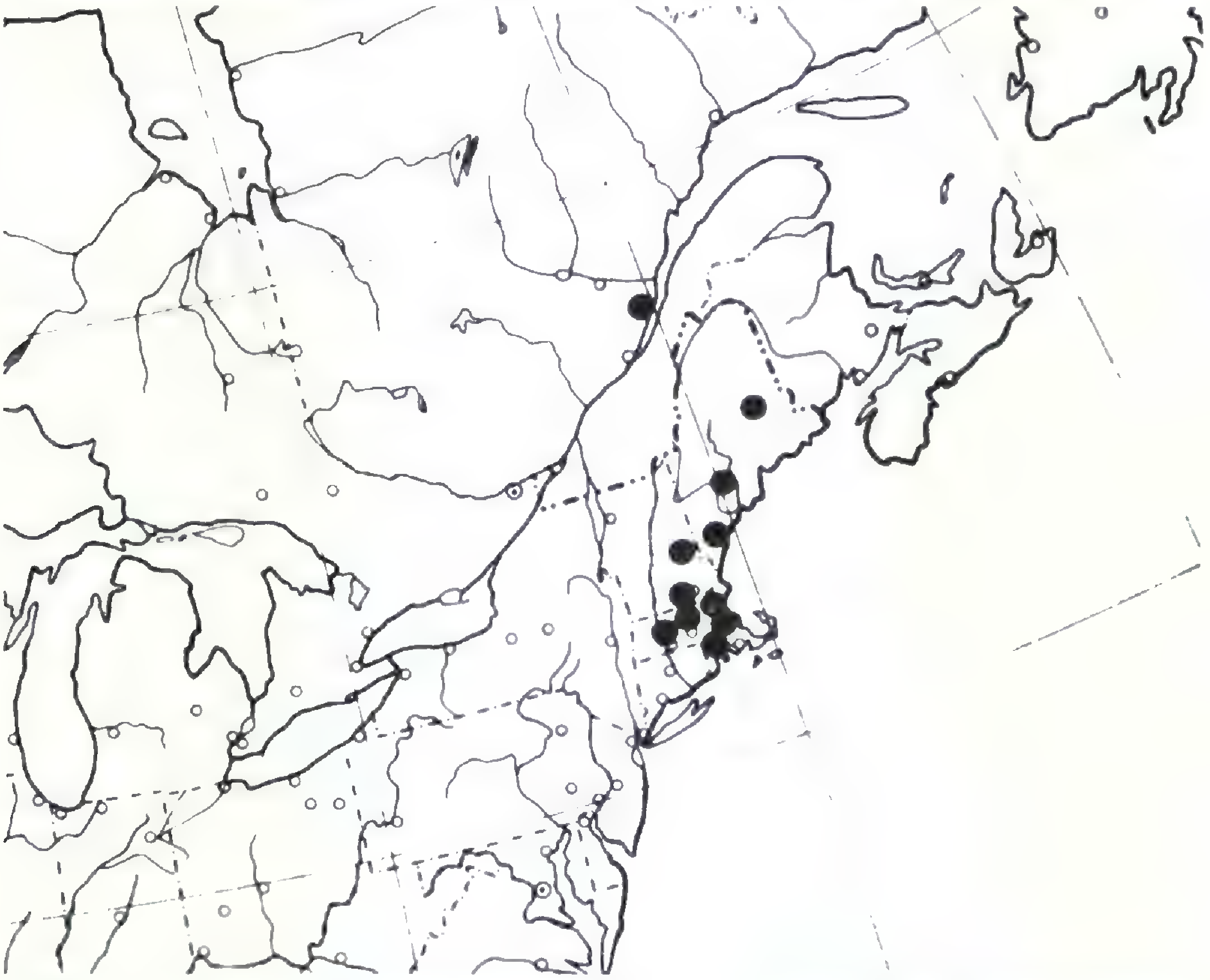

Fig. 13. Map of northeastern United States and southeastern Canada showing documented distribution of *Potamogeton pusillus* var. *gemmiparus*.

REPRESENTATIVE SPECIMENS

CANADA: **Quebec:** Saint-Tite, comte de Champlain, Lake Pierre-Paul *Gauthier* 2273 (GH, photo at DOA). UNITED STATES: **Maine:** CUMBERLAND CO.: Horseshoe Pond, North Fryeburg, *Hellquist* 4457 (MICH). KENNEBEC CO.: Belgrade Stream, Belgrade, *Hellquist* 4501 (MICH). PENOBSCOT CO.: Upper Stillwater, *Fernald* (UC, US), *Fernald* (GH). **Massachusetts:** HAMPSHIRE CO.: Amherst, *Jesup* (GH, NY). MIDDLESEX CO.: Charles River, South Natick, *Morong* (NY). NORFOLK CO.: Charles River, Dedham, *Fernald & Svenson* (GH). WORCESTER CO.: Uxbridge, *Morong* (CGE, F, ILL, MICH, MO, NY, US). **New Hampshire:** CARROLL CO.: Conway Lake, Eaton, *Hellquist* 4469 (MICH). HILLSBOROUGH CO.: Pine Island Pond, Manchester, *Krochmal* 265 (GH). **Rhode Island:** PROVIDENCE CO.: Central Pond, Ten Mile River, East Providence, *Collins* (GH).

8. **Potamogeton groenlandicus** Hagstrom, Kongl. Svenska Vetenskapsakad. Handl. 55(5): 127. 1916. TYPE: *Hartz*, Kingua Orpiksnit, 68°30′, Greenland, (lectotype here designated, C!).

Potamogeton pusillus ssp. *groenlandicus* (Hagstr.) Boch. 1952. Meddel. Grønland **147**(9): 44.

Stems light green, terete, smooth, 20-50 cm long, 0.2-0.3 mm diam. Leaves pale to deep green, 7-9 nerved, 2.6-8.8 mm long, 0.7-1.7 mm wide; apex acute to apiculate; glands usually present, white, 0.1-0.7 mm diam; lacunae absent or to three rows present each side of the midrib; lateral nerves joining the midrib 0.7-1.2 mm below the apex. Stipules brown, delicate, convolute, 4.5-19.1 mm long, 0.2-0.4 mm diam. Winter buds common, terminal or axillary, 4.2-8.4 cm long, 1.4-2.5 mm wide; inner leaves unmodified; outer leaves 2 per side, acute to apiculate, without corrugations at base. Peduncles rare, cylindric, terminal, ca 18.2 mm long, ca 0.5 mm diam. Spikes cylindric, ca 5.0 mm long, ca 3.5 mm diam; verticels 3, crowded, ca 1.0 mm apart. Perianth segments ca 1.1 mm long, ca 0.7 mm wide. Fruit unknown. Chromosome number unknown.

Distribution: Western Greenland. Flowering in late August. Fig. 14.

Illustrations: (apparently none).

In 1916, Hagstrom named *Potamogeton groenlandicus* from several sterile specimens. He distinguished this species from other *Pusilli* by its possessing 5-9 nerves per leaf. "In this respect," he stated, "this species constitutes an interesting link between the *Pusilli* and the *Oxyphylli* and would be ranked with the latter as well as with the former." He added that the ligules and leaf-apices, however, unite it with the *Pusilli.* Fernald (1932), after examining as many specimens as available [but not the Type], concluded the taxon to be conspecific with *P. pusillus* var. *mucronatus* [var. *tenuissimus*]. He stated that he had been unable to convince himself that the leaves were more than three-nerved. He added that this character alone does not warrant specific rank. I have examined the material at Copenhagen and at all the large herbaria of the United States and Canada. In my opinion, the leaves *are* 5-9 nerved. I agree with Fernald, however, that one vegetative character is not enough to separate two species, especially when one is

Fig. 14. Map of Greenland showing documented distribution of *Potamogeton groenlandicus.*

known only from non-fruiting material. However, both Fernald and Hagstrom overlooked the winter buds. In *P. groenlandicus*, the inner leaves of the winter buds are not modified into hardened fusiform structures, as in *P. pusillus*. Instead, the winter buds are similar to those of *P. obtusifolius*, in that the inner leaves are unmodified. To my knowledge, only one population of fertile individuals has been found, this being in flower. The flowers are most similar to *P. pusillus*. Because the winter buds and number of nerves are so different from *P. pusillus*, I am currently accepting *P. groenlandicus* at the specific level. However, material should be gathered and cultivated. If fruiting does occur, then the correct affinities of this endemic taxon can be ascertained.

REPRESENTATIVE SPECIMENS

GREENLAND: **Christianshaab Dist.**: Christianshaab, *Hartz* (C). **Egedesminde Dist.**: Egedesminde, 67°44′N, *Porsild* (CAN, GH, MO, NY, US). **Frederikshaab Dist.**: Frederikshaab, 62°00′N, 49°40′W, *Jørgensen & Larsson* (CAN); Ivigtut, *Berlin* (C). **Godhavn Dist.**: Disko, near Arktisk Station, 69°15′N, *Porsild* (CAN, F, GH, US); Disko, Godhavn, *Laegaard* 350 (CAN, US); Disko, near Godhavn, 69°14′N, *Porsild* 228 (GH, US); Disko, Sinigtik, 69°25′N, *Porsild* (CAN, GH); Disko, Skauseklippen, 69°25′N, *Porsild* (F). **Godthaab Dist.**: vicinity of Godthaab, 64°10′N, 51°43′W, *Porsild* 8273 (CAN); Godthaab Fjord, Itivnera, 64°22′N, *Porsild* (GH); Godthaab Fjord, Jersiutilik, *Trapnell* 402 (GH, K). **Jakobshavn Dist.**: Jakobshavn, *Sorensen* (C). **Julianehaab Dist.**: Igaliko Fjord, Qagssaarssuk, *Polunin* 10779 (CAN); vicinity of Julianehaab, 60°43′N, 46°05′W, *Porsild* 8120 (CAN). **Ritenbenk Dist.**: Ritenbenk, 69°44′N, *Hansen* (C); Sarkak, pool on gneiss, *Seward & Holttum* (CGE, K); 5 km E of Sarkak, *Beschel* 12163 (CAN, photo at DAO). **Sukkertoppen Dist.**: Ungarsivik Lake, 65°25′N, 52°50′W, *Porsild* 8870 (CAN). **Upernavik Dist.**: Laksefjord, Proven, *Porsild* 8837 (CAN).

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SARRACENIA ALABAMENSIS, A NEWLY RECOGNIZED SPECIES FROM CENTRAL ALABAMA[1]

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In February, 1953, while collecting pitcher plants at Elmore, Alabama, for taxonomic studies, we located a colony of *Sarracenia* with frozen leaves. As we were seeking plants of *S. oreophila* (Kearney) Wherry at Wherry's published range extension for that species at Elmore, and since the frozen leaves were mostly large and widely expanded at the orifice, much resembling the published photographs of the yellow flowered *S. oreophila*, which we had not at that time seen, we assumed our discovery to represent that species. When the plants flowered in our greenhouse, however, the flowers were small and red. This seemed to place the plant in *S. jonesii* Wherry, which was widely accepted at that time. After observing and growing the plant for two seasons, we became convinced that either the published description of *S. jonesii* was too narrow, or that the plant was not *S. jonesii* at all. Our next step was to visit the type locality of *S. jonesii* in North Carolina to observe and obtain plants for comparison. They proved not to be the same, so we began the studies leading to this paper.

With the help of the late Dr. R. M. Harper, who made his field notes available to us, and who, in 1955, guided us to his colonies of pitcher plants in Central Alabama, we were able to obtain a wide sampling of the population and to locate other colonies of our own. Because there has long been controversy and confusion among *Sarracenia* taxonomists over the treatment of the taxa related to *S. rubra* Walter, we visited the Elmore and Chilton County colonies eight times at various seasons in the period from 1953 to 1973 to better understand this related species.

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Since 1953, we have grown this plant, which we call the Alabama Canebrake Pitcher Plant, continuously, both in our greenhouses, and, since 1966, outdoors as well, at Saginaw, Michigan. Although its small red flowers with obovate petals indicate a close relationship to *S. rubra,* it shows a number of differences. In this connection, those interested in significant taxonomic characteristics in *Sarracenia* may wish to refer to the remarks of MacFarlane (1908), Wherry (1929, 1935), Bell (1949), and McDaniel (1966).

Unlike *Sarracenia rubra* (MacFarlane, 1908) our plant produces two types of pitchers and occasional phyllodia each season. Its spring pitchers, similar in size to the leaves of *S. rubra,* differ markedly in developing a curved form and in lacking the external dark maroon coloring of the veins, pitcher rim and hoods found in that species. The summer pitchers, straight and usually much larger and more tapered than those of *S. rubra* (excepting *S. rubra* ssp. *jonesii*), differ from those of both of those taxa in possessing a softer texture, a visibly fine pubescence, and a paler yellow-green color. The major veins are maroon colored mainly only on the inside of the pitcher tube. The hoods of the summer pitchers are from 2-8 times larger than those of summer leaves produced in *S. rubra.* The greater expansion of the hood, the stronger reflexion of the hood neck margins, the strongly rolled orifice rim, the leaf size, and overall yellowish green coloration give the summer leaves a profile more suggestive of the pitcher of *S. flava* or *S. oreophila* than of *S. rubra.*

The flowers, while less useful than the leaves for species delineation within this genus (c.f. Bell, 1949, p. 140), differ from *Sarrecenia rubra* in their larger size, lighter red coloring, petal shape, in their erose petal margins, and in their fainter fragrance (Fig. 1). In addition, the plant produces flower scapes abundantly; often two or three scapes develop from one terminal growth in vigorous plants, making large flowering clumps spectacular. The regular production of multiple blooms from one terminal bud is an unusual feature in *Sarracenia.*

Figure 1. Comparison of flowers of *Sarracenia alabamensis*, Chilton Co. Ala., (left) and *S. rubra*, Crestview, Florida (right). Note differences in color tone, shape of petal lobe, and detail of petal margins.

Since, in addition to its structural differences, its range is disjunct from *Sarracenia rubra* and probably from that of all other species except *S. oreophila*, we consider it a distinct species.

MacFarlane (1908) has pointed out that all immature *Sarracenia* leaves tend to resemble closely those of *Sarracenia minor* Walter and do not show good specific differences. While he spoke mostly of very young pitcher leaves, we believe that all specific differences are best displayed by the largest leaves of the season. In our description we give the usual size ranges, but we urge readers to standardize their comparisons, when possible, by examining the largest seasonal leaves of related taxa. Because we believe that vague size references without standardized points of measurement have contributed to the problems in understanding the taxa related to S. *rubra*, we have tried to be quite exact in our measurements. Pitcher length was measured from the point of attachment to the rhizome to the rim of the pitcher orifice; it does not include the hood. The length of hood refers to the distance from the narrowest part of the hood-constriction (neck) to the tip of the hood, and hood width refers to measurement across its widest point. To facilitate measurement comparisons of the tubular pitchers in fresh or herbarium material, we give width figures for pressed pitchers rather than diameters for inflated pitchers.

The panduriform petals present problems for accurate measurement comparisons, being divided into a cuneate basal portion, an isthmus, and an obovate distal portion. For purposes of comparison, the length of the basal cuneate portion of the petal was measured as the distance from the petal attachment along the median line to the widest point of the segment; the length of the distal petal lobe we measured from the widest point of the basal portion to the tip of the petal.

We have based the following description upon both cultivated specimens and those collected in the wild.

Sarracenia alabamensis Case & Case, sp. nov.

Rhizoma valde ramosum, ramis confertis; *folia* trimorpha; folia vernalia ascidiformia, maxima plerumque plus minusve sigmoidea, tubo basi angusto, sursum gradatim ampliato, 17.7-49.5 cm. longo, 0.7-3 cm. lato; ala ventralis [adaxialis] ad medium expansa, 0.4-1.5 cm. lata, versus orem et basin attenuata; tubi venae extus plerumque incoloratae, intus atropurpureae; operculum cordatum, acutum, subundulatum vel convexum, 1.9-7 cm. longum, 1.7-6 cm. latum, venis intus prope basin coloratis; collum 0.8-3 cm. latum.

Folia maxima ascidiformia aestivalia quam vernalia multo majora, foliis *S. flavae* vel *S. oreophilae* similia, suberecta, recta vel subsigmoidea, extus dense pubescentia, 24.5-48.5 cm. longa, ad basin longe angustata, in quarta parte superiore parum ampliata, 3.1-6.7 cm. lata; peristomium valde revolutum, adaxiale incisum; ascidii textura tenuis, mollis, ex salmoneo flavo-viridis, demum pallide flavo-viridis; tubus prope orem extus obscure areolatus, areolis albidis, venis intus valde purpureis, extus plerumque (maximis interdum exceptis) incoloratis; operculum magnum, expansum, cordatum, fere tam latum quam longum, 3.7-9.5 cm. longum, 3.4-8.6 cm. latum; collum 1.3-3.4 cm. latum; textura inter venulas convexa; operculum salmoneum, demum pallide flavo-viride, intus (necnon praecipue collum peristomiumque) iridescens.

Phyllodia laminaria pauca, interdum e gemmis terminalibus majoribus oriunda, ascidia vernalia sequentia, aestivalia praecedentia, prope basin valde recurvata, ultra medium latiora, apicem versus denuo recurvata, 4-6.5 cm. longa, 0.3-0.8 cm. lata.

Folia squamiformia pauca, triangularia, amplitudine admodum variabilis.

Scapi numerosi, interdum aliquot per ramulum terminalem, 34.5-57.6 cm. longi.

Calyx applanatus 4.5-6 cm. latus.

Sepala ovata, rotundata vel subacuta, 1.7-2.6 cm. longa, 1.1-2.2 cm. lata, sub anthesi falcato-incurvata, ovarium mox cingentia, demum patentia vel reflexa, marginibus vetustate valde revolutis.

Petala panduriformia, 3.4-4.6 cm. longa, extus sanguinea (anglice "Oxblood Red"); pars basalis cuneata 0.7-1 cm. longa, basi 0.3-0.4 cm. lata, maxime 0.9-1.1 cm. lata; constrictio mediana marginibus reflexis; lamina ultra constrictionem in isthmum brevem parallelilateralem tum in lobum obovatum erose marginatum 2.7-3.6 cm. longum, 1.8-2.5 cm. latum expansa.

Ovarium tuberculatum, paullo compressum, 0.8 cm. longum, 0.9 cm. latum. Stylus umbraculiformis, umbraculo valde convexo, 3.5-4.2 cm. lato.

TYPE: **Alabama:** ELMORE CO.: very rare and local in wet gravelly or peaty soil and around springheads and rills in open grassy swales, and in thickets of *Rhododendron, Alnus, Magnolia virginiana, Rhus vernix* and *Arundinaria tecta;* along the railroad between Elmore and Speigner. Type plant collected in June 1971, *Case & Case* S-500 (US), but all specimens prepared from clonal divisions grown in our greenhouse and taken May 1, 1972 (flowering) and July 27, 1972 (large summer leaves).

REPRESENTATIVE SPECIMENS EXAMINED

Alabama: CHILTON CO.: Clanton, *Pollard & Mason* (US); sloping gravelly bog near Jasmine, 28 Apr. 1921, *Harper* (NY, US); Jasmine, 18 Apr. 1921, *Harper* (NY); gravelly bog, near Adams, 17 June 1955, *F. & R. Case,* C-100 (MICH), C-101, C-102 (NY); boggy rill feeding Mulberry Creek, Pletcher, 17 June 1955, *F. & R. Case et al.,* C-103 (US); cultivated material, Canebrake-*Magnolia glauca* bog, Adams, grown at Saginaw, Michigan, *F. & R. Case* S-520, S-522 (US), S-524, S-527, S-528 (NCU), S-521, S-525, S-526 (MICH); boggy soil around springhead, with *Arundinaria tecta, Magnolia virginiana,* Jasmine, 19 Apr. 1973, *F. & R. Case* C-104 (NCU), C-105 (US). ELMORE CO.: Slightly damp sandy soil 1½ miles S. of Speigner, 14 Apr. 1934, *Harper* (PH); boggy depression along railroad near station, Elmore, 13 July, 1935, *Wherry* (PENN); approximately 1½ miles north of Elmore along railroad, damp boggy ground, specimen from a cultivated plant (Oct., 1955), collected 16 Feb. 1953, *F. & R. Case,* C-106 (US).

DISTRIBUTION AND ECOLOGY

This extremely rare plant is known to occur only in small, very localized colonies among the Fall Line Sand Hills of Chilton, Autauga, and Elmore Counties, Alabama, north of the Alabama River in an area roughly bounded by the Coosa River to the east, and the Mulberry River to the west. The soils there derive from rocks generally regarded as Upper Cretaceous in origin (Harper, 1922). Except for Wherry's report of *Sarracenia oreophila* at Elmore, Alabama, no other *Sarracenia* is reported to grow within the range of *S. alabamensis*.

Sarracenia alabamensis occurs in somewhat sandy-gravelly bogs, usually on sloping ground, or in damp peaty or mucky soil around small spring-heads and tiny rills. It is not usually a plant of sphagnum beds although species of *Sphagnum* may occur in isolated patches nearby. The colonies we have observed are extremely small compared to those of most of the other southern species, and range from single clumps to one group of perhaps 100 plants in a 20 by 50 foot area. According to Harper's (1922) observations and our own, the following plants commonly grow with the Canebrake Pitcherplant: *Magnolia virginiana, Alnus* sp., *Arundinaria tecta, Acer rubrum, Rhus vernix, Smilax laurifolia, Osmunda cinnamomea, Pteridium aquilinum* var., *Juncus* sp., *Drosera capillaris, Pinguicula* sp., *Aletris aurea, Rhexia* sp., *Pogonia ophioglossoides, Rhododendron* sp., and *Calopogon tuberosum.*

The pitcher plant grows most often in open stands of *Magnolia virginiana, Arundinaria tecta,* and *Alnus,* in the "Canebrakes" of the region, or in open boggy swales. Tolerant of more shade than most of the trumpet-leaf sarracenias, the species nevertheless reaches its most vigorous and distinctive development when growing in full sunlight. Although few of the large, distinctive summer leaves develop on heavily shaded plants, the species is able to flower sparingly even when so shaded that not even the curved spring pitchers can develop without severe deformity.

Hardest to detect of the sarracenias, this species probably has always been very limited in distribution in modern times, for its habitat is very restricted and by nature it occurs in small stands among other plants. But recent developments within its range have caused further restriction.

In 1921, Harper (1922) reports, the bogs in which *Sarracenia alabamensis* grew were open, with woody plants rather small and scattered, the bulk of the vegetation sun-loving. It was still generally thus at both Elmore and in Chilton County when we first saw this species in 1953 and

1955. At that time the swamps were shrubby but open, and small rills lined with pitcher plants were frequent. The entire area was sparsely inhabited, remote, and the roads were limited, temporary, and unditched. In contrast, on visits in the past few years, we found much change. The bogs have not burned in some years. No longer are they open; dense stands of magnolia and maple, solid canebrakes, tangles of *Smilax*, and alder, rob the bogs of light. The sarracenia is much rarer today, and seedlings scarcely can be found. Good roads reach the area, and farms, cattle raising operations, use of herbicides, ditching and draining, all have taken considerable toll of the habitat. Perhaps the greatest change in the pitcher plant habitat here has been the invasion of the bogs and openings by the Japanese honeysuckle, *Lonicera japonica* Thunb., which destroys virtually all native species in the bogs it invades.

DISCUSSION

The Alabama Canebrake Pitcher Plant has many features of interest. It is the only trumpet leaved *Sarracenia* to produce pitchers which differ significantly in size and form with the season (Fig. 2).

The usually recurved, shorter, spring pitchers are less voluminous than the often very much larger, erect, summer pitchers. In these spring leaves, the laminar wings expand at or just below the middle, pushing the pitcher into a loosely sigmoid curve. The upper, sharply expanded part of the tube and hood is erect. In effect, these early leaves seem almost deformed, as in a plant growing under drastically shaded conditions or in one which shows the effects of an application of an herbicide. This leaf form, produced in other species only under conditions of ecological duress, is entirely normal and comprises the usual spring pitcher in this species, even on plants growing in full sun (Fig. 2). But occasionally, on extremely vigorous, uncrowded plants in very wet, sunny situations, the plant produces the large summer type pitchers without first producing the recurved leaves.

Figure 2. *Sarracenia alabamensis.* Three spring type, curved leaves (left) and three of the larger, straight summer leaves (right). Note the obscure white, areole-like markings near summit of pitcher tube on the right-hand specimen.

A single clone may produce either type of pitcher in the first wave of growth in different years, but the trend is clearly toward recurved spring pitchers. In a group of about 50 study clones grown in our greenhouses, roughly 90% of the plants will produce the recurved pitchers in a given season. In the wild, in more competitive (and perhaps darker) situations all except two of several hundred clones we have observed have produced the recurved spring pitchers. These two plants had produced only the large summer-type pitchers that season.

The variable form of the early leaves of the season, sometimes as recurved, reduced smallish pitchers with an unusual development of wing tissue, sometimes as fully developed phyllodia, and occasionally as erect, summer-type pitchers, suggests to us that these variations occur at least partly in response to a combination of degree of light intensity and increasing daylength. Phyllodia and the recurved, reduced pitchers do not reappear in the autumn; at that time only smaller, fully erect, summer-type pitchers develop.

MacFarlane (1908) has stated that phyllodia represent an advanced leaf type, developed by reduction of the superior pitchered portion of the wing while the inferior lamina remains full sized or enlarged. He notes that occasional leaves intermediate between normal pitchers and phyllodia appear in all the phyllodium-forming species. We suggest that the variable structure of the spring leaves in *Sarracenia alabamensis* represents a stage in the evolution of a laminar phyllodium from a pitcher, one in which the exact degree of pitcher reduction in response to daylength and light intensity has not yet become stabilized. The fact that these variable leaves occur only in spring and that in other species which regularly produce phyllodia, such leaves are strictly seasonal, seems to strengthen this interpretation.

The summer pitchers of the Canebrake Pitcherplant are fully erect, remarkable for their relatively large size, and great volume. The tissue of these large summer pitchers possesses a soft substance lacking the waxy-thickened quality of the other trumpet leaf species. This, together with the fine, dense pubescence, gives to the pitcher a unique "feel," prompting Dr. Wherry to remark that this is the only "*rubra* type" *Sarracenia* one can readily identify in the dark.

Other features of the summer pitcher include its very light green color when grown in bright light, and the presence in many leaves of a few rather obscure, whitish areole-like areas scattered on the outer pitcher-tube surface near its orifice. These cannot be seen from within. These faint areoles seem to be the consequence of the extreme tissue expansion characteristic of the summer pitchers. They are not structurally quite the same as those in the truly areolate species, but they may offer interesting evidence as to the mode of origin of areoles within this genus. Because all taxa related to *Sarracenia rubra* have become controversial and because other taxa in the *rubra* alliance do not show areoles at all, some botanists may seize upon this feature as evidence that *S. alabamensis* represents a hybrid population of some sort, not a species.

We cannot regard these areole-like tissues as evidence of any recent hybridization with an areolate species for several reasons. The areolae do not appear on the spring leaves in this taxon; in the known hybrids between other areolate and non-areolate species, the areolae occur in all leaves of mature plants and even on the larger seedling leaves. In known areolate hybrids, the white transparent areoles extend from outer to inner tube tissues. Also, no areolate species occurs in contact with the known range of this species. If these areole-like formations be of hybrid origin, it is ancient hybridization and the whitish markings have become a fixed although obscure characteristic of the larger summer leaves.

Although we have already stated our interpretation of the nature of the recurved spring pitchers above, the intermittent production of full phyllodia in *Sarracenia alabamensis*, coupled with Wherry's report of *S. oreophila* within its range at Elmore, may lead some to say that *S. alabamensis* represents a hybrid swarm of *S. oreophila* with *S. rubra*. Several points ought to be made in this connection. Since *S. oreophila* is a large yellow-flowered species, and *S. rubra* a small red-flowered one, any hybrid population ought to produce orange, or yellow and red mottled flowers of intermediate size as are reported for all other hybrids between *S. rubra* and yellow flowered species. Not one plant of our more than 50 study clones produces anything but medium to dark oxblood red small flowers. *S. rubra* Walter does not occur in the region of *S. alabamensis*. The population of *S. alabamensis* is an extremely uniform one in structure and behavior: even the variability of the spring leaf structure and the variability in occurrence of the areole-like markings on the larger summer leaves are uniform features of the species. There is none of the type of variation in leaf structure or coloration so characteristic of *Sarracenia* populations where hybridization can be demonstrated.

In an effort to ascertain whether this plant might represent a population of direct hybrid origin between *Sarracenia oreophila* and *S. rubra*, we hand pollinated a plant of *S. rubra* from Fruitdale, Ala., with pollen of *S. oreophila* from De Soto Falls, Ala. The resulting hybrid plants, grown in our greenhouse, were intermediate between the parents in leaf structure and size and produced the orange-red flowers typical of such hybrids. The hybrids did produce laminar phyllodia, but, surprisingly, these were of an erect type as in *S. leucophylla* and did not resemble closely those of either *S. oreophila* or *S. alabamensis*. Leaf coloration patterns and pitcher hood conformation were unlike *S. alabamensis*. No recurved pitcher leaves of the *S. alabamensis* spring pitcher type have appeared. We could not find justification in the structure of these hybrids for suspecting a recent hybrid origin for *S. alabamensis* involving these two possible parents.

The tendency toward phyllodia, the presence of very large summer leaves resembling more in profile those of *Sar-*

racenia flava, *S. oreophila*, or *S. leucophylla* than those of *S. rubra* which it resembles in flower and spring leaf, and the tendency to produce tissue areas resembling faint, random areolae, could be interpreted as placing this species in a central primitive position from which differing selective factors have led in one direction toward the *S. rubra* types and in another toward the phyllodium-producing groups. Its presence as a relict in an area of ancient soil derivation (Harper, 1922) in an area largely devoid of other pitcher plants suggests to us that this is a possibility.

HISTORY

In the earliest published reference to this plant, R. M. Harper (1918) referred the plant to *Sarracenia sledgeii* MacF. [*S. alata* (Wood) Wood], although he was certainly skeptical, for in his discussion of the distribution of *S. sledgeii* he says: "East of Mobile Bay, I have seen a few specimens [of true *sledgeii*] in the southern part of Baldwin County, Alabama, and what appears to be the same thing (though it may be a variety of the next [*S. flava*]) in boggy places among the long-leaf pine hills in Chilton and Autauga Counties, near the center of the State." At that time Harper had not seen the plant in flower. In April, 1921, Harper found the flowers to be small and dark red, so he identified the plants as *S. rubra* Walt., although his locality was farther inland than the known distribution of that species (Harper, 1922).

In 1932, Wherry, guided by Harper, visited some of these colonies but stated: "We located a colony of a red flowered pitcher plant but it was not in good enough condition to establish its identity" (Wherry, 1934) [Possibly Wherry's uncertainty was because of the presence of the peculiar, recurved spring pitchers which simulate pitchers deformed by shading]. In the September, 1973 issue of the *Carnivorous Plant Newsletter*, Dr. Wherry refers to this plant which he saw in our greenhouse in September 1955, after having seen it with Harper in the wild, as an "undescribed species from Alabama."

Wherry's discovery of *Sarracenia oreophila* at Elmore, Ala. represents the only known contact of the range of *S. alabamensis* with another species. At this station both species apparently grew in proximity, for both have been collected in summer leaf there and determined by various taxonomists as *S. oreophila.* The difficulty of determining certain summer plants of *S. alabamensis* from *S. oreophila* is emphasized by the fact that Wherry's July 13, 1935, Elmore, Ala. specimen (PENN), determined by both Wherry and McDaniel as *S. oreophila,* is in our opinion *S. alabamensis.* This is indicated by the small size of the flowers, dark sepals, the shape and size of the phyllodia, and in this particular specimen, smaller pitcher size than is typical of flowering-sized *S. oreophila* (see Fig. 3). The difficulty of separating all specimens of the two species without the presence of petals to indicate flower color, is further pointed up by McDaniel's comments (1966, pp. 45, 46) on the plants of the Elmore area: "... the Harper collection from Elmore County, Ala. differs in certain details of which the much reduced phyllodia seem to be the most significant. Additional collecting both in Elmore County and in the lower Coosa River Valley is needed to determine the status of this central Alabama population."

Indeed, the dissimilar spring and summer pitchers on well developed plants of *Sarracenia alabamensis* have led to much historical confusion and to determinations of or references to it in the literature in the past as *S. sledgeii, S. flava, S. jonesii, S. rubra,* and *S. oreophila.* Yet those who have seen vigorous living specimens agree it is distinct.

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Figure 3. A specimen of *Sarracenia alabamensis* from Elmore, Ala., showing the fully reduced laminar phyllodia occasionally produced in this species which, in combination with the large summer leaves, give to this specimen a strong resemblance to *S. oreophila*.

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