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Errata corrected - see p 120 of vol. 68.

The New England Botanical Club, Inc.

Botanical Museum, Oxford St., Cambridge 38, Mass.

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RHODORA.—A quarterly journal of botany, devoted primarily to the flora of North America and floristically related areas. Price, $6.00 per year, net, postpaid, in funds payable at par in United States currency in Boston; single copies (if available) $1.80. Back volumes 1-58, with a few incomplete, can be supplied at $5.00 per volume. Volume 59— available at $6.00. Somewhat reduced rates for complete sets can be obtained upon application.

Scientific papers and notes, relating directly or indirectly to the plants of North America, will be considered by the editorial committee for publication. Articles concerned with systematic botany and cytotaxonomy in their broader implications are equally acceptable. All manuscripts should be double-spaced throughout. Please conform to the style of recent issues of the journal. Illustrations can be used only if the cost of engraver's blocks is met through the author or his institution. Forms may be closed five weeks in advance of publication. Extracted reprints, if ordered in advance, will be furnished at cost.

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NEW ENGLAND BOTANICAL CLUB

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MONOGRAPH OF THE GENUS ELODEA: PART 4 AND SUMMARY.

HAROLD ST. JOHN[1]

I. MONOGRAPH OF THE GENUS ELODEA, PART 4: THE SPECIES OF EASTERN AND CENTRAL NORTH AMERICA.

INTRODUCTION

A preliminary discussion was given in part one of this monograph and it does not need repetition here. Each of the four parts of this study covers the species of a large natural area. Since the species flower but briefly, and have delicate, largely evanescent flowers, they are poorly represented as dried herbarium specimens. Hence, for practical use, an artificial key, based mostly on foliage characters, is here included. With it, plants having well developed median and upper leaves can be identified with reasonable surety. Illustrations of typical leaves are here provided.

The other parts of this monograph have been printed elsewhere, so written that they can be assembled into a single whole. Part 1, The Species Found in the Great Plains, the Rocky Mountains, and the Pacific States and Provinces of North America, Res. Stud., Washington State Univ. 30 (1962) 19-44, fig. 1-5; Part 2, The species found in the Andes and western South America, Caldasia 9 (1964) 95-113, figs. 1-8, is in press in Mutisia; Part 3, The species found in northern and eastern South America, Darwiniana 12 (1963) 639-652, fig. 1-3, tab. 1. Also two species formerly

[1]Botanist, B. P. Bishop Museum, Honolulu, Hawaii, 96819, U.S.A.

placed in *Elodea* were treated in the author's monograph of the genus *Egeria* Planchon, Darwiniana **12** (1961) 293-307, figs. 1-2; **12** (1962) 523.

ARTIFICIAL KEY TO SPECIES OF NORTH AMERICA, FROM THE ATLANTIC SLOPE TO THE GREAT PLAINS.

1. Middle and upper leaves in whorls of 4-5; staminate spathe 2-4-flowered; filaments glandular above, at least 3 times as long as the anthers; pistillate petals 8 mm. wide. This species of *Egeria* is here included because of its superficial similarity to *Elodea*, and because it was long considered a member of that genus. .... *Egeria densa*.
1. Middle and upper leaves in whorls of 2-3; staminate spathe 1-flowered; filaments non-glandular, shorter than the anthers; pistillate petals 0.5-1.5 mm. wide. .... Genus *Elodea*.
    2. Middle and upper leaves opposite; pistillate spathe 3-7 cm. long. .... 21. *E. longivaginata*, p. 34.
    2. Middle and upper leaves in whorls of 3 (-4); pistillate spathes shorter.
        3. Middle and upper leaves less than 1 mm. wide; stamens equal and equally attached on the hypanthium. .... 20. *E. linearis*, p. 29.
        3. Middle and upper leaves all, or some of them, more than 1 mm. wide.
            4. Middle and upper leaves 0.3-1.5 mm. wide, flaccid, divergent, not imbricate at tip of stem; pistillate sepals 1.1 mm. long; staminate flowers sessile, at anthesis detached and floating. .... 18. *E. Nuttallii*, p. 6.
            4. Middle and upper leaves 1-5 mm. wide, firm or subflaccid; all flowers long-stalked by the hypanthium base, not liberated.
                5. Upper leaves usually 2-5 mm. broad, firm, dark green, closely imbricate; flowers dioecious; pistillate sepals 2-2.2 mm. long. .... 19. *E. canadensis*, p. 12.
                5. Upper leaves 1-2 mm. broad, subflaccid, pale green, loosely imbricate; flowers perfect; sepals 2.7-3 mm. long. .... 17. *E. Schweinitzii*, p. 2.

DESCRIPTION OF SPECIES

17. **Elodea Schweinitzii** (Planch.) Casp., Monatsber. Kgl. Preuss. Akad. Wissensch. **1857** (1857) 46; also in Pringsheim's Jahrb. Wissensch. Bot. **1** (1858) 468; *Apalanthe Schweinitzii* Planch., Ann. Mag. Nat. Hist. II, **1** (1848) 87; Ann. Sci. Nat. Bot. III, **11** (1849) 76. Fig. 3 a-c, 4.

Description of all specimens examined: Submerged aquatic; stems slender, dichotomously branched; lower leaves opposite, ovate-lanceolate to lanceolate, smaller than the upper; medium and upper leaves 8-14 mm. long, 1-2 mm. broad, in whorls of 3, linear to lance-linear, finely serrulate, subflaccid and pale green; spathe 10-16 mm. long, narrowly urceolate, sharply bidentate at apex; flower perfect, exserted from the spathe by the thread-like elongating hypanthium 2-6 cm. long; sepals 2.7-3 mm. long, 1-1.2 mm. broad, elliptic, dark striate; petals 2.7 mm. long, 0.9 mm. broad, white, delicate, spatulate; stamens three, filaments 0.3 mm. long, stout; anthers 0.8-1.8 mm. long, elliptic; ovary narrowly cylindric; style slender, equaling the hypanthium; stigmas 3-4, linear-oblanceolate, entire (or bifid), usually one of them shorter than the others which are twice the length of the sepals; capsule and seeds unknown.

Holotype: "in Americae septentrionalis provinciis confederatis [United States], loco proprio non indicato, *Schweinitz* in Herb. Hook." The holotypic specimen bears only the following data: North America, *Schwein.* (K)! Type examined! An apparent isotype lacks the locality and bears only the abbreviation *Schwein.* of the collector's name (K)!

UNITED STATES. New Jersey: N. Caesar. 1834, *Torrey* (P); without locality, *Gray* (M); without locality or collector (K). Pennsylvania: Bet. [hlehem], 1832, *Schweinitz* (K), sterile, but likely an isotype; Nazareth, [*Schweinitz*], (PH), from Schweinitz's own herbarium, doubtless an isotype; ubi, 1829, *Schweinitz* (BR), likely an isotype; Bethlehem, unio itiner, 1832, *Moser* (B, CAS, G, NY, P); in der Lecher bei Bethlehem, Juli 1832, *Princ Wiedensis* (BR); Bethlehem, *Wolle* (MO, PH). American Borealis: without data, (PH).

Elodea Schweinitzii is a member of the subgenus *Apalanthe,* a small group containing only two other species: *E. Brandegeae* St. John of California, and *E. granatensis* Humb. & Bonpl. of South America. Their distinctive feature is the possession of perfect flowers.

Elodea Schweinitzii is of very local occurrence. The holotype was collected by L. B. Schweinitz, but its label gave no locality data. There are, however, several other specimens collected by him, and doubtless some or all of them are isotypes. The one retained in his own herbarium was labeled Nazareth, while others are marked Bethlehem. Bethlehem, Pennsylvania was a small city and Nazareth an adjacent village. Schweinitz spent his life there, and made most of his collections in that immediate vicinity. It seems that this *Elodea* with perfect flowers was then locally common there. It will be noted that the last collection of it was made in 1832. In 1940 the writer drove to eastern Pennsylvania and explored the region of Bethlehem and Nazareth. Unfortunately by this time Bethlehem had long been a center of steel mills and the streams of the vicinity were opaque and foul from the waste discharged by the mills. No aquatic flowering plants of any kind were to be seen in the despoiled streams.

The three collections recorded from New Jersey give no more precise locality. John Torrey certainly collected in New Jersey, but Asa Gray did so little if at all. No subsequent collections are known to confirm the New Jersey locality. The writer doubts it and thinks that the specimens probably came from Bethlehem, Pennsylvania and were labeled in the casual, inexact manner so often characteristic of botanists of that century.

The floras of eastern Pennsylvania and of New Jersey are very well known. For some 150 years these regions have been intensively botanized by numerous local, resident botanists. No one of them in the last 130 years has rediscovered *Elodea Schweinitzii.* It seems that this species is extinct in Pennsylvania, and that its report from New Jersey was erroneous.

In the other species of *Elodea* the morphology of the flowers is invariable. Not so in *E. Schweinitzii,* as the flowers show considerable variability. Planchon described in his Latin diagnosis that the flowers had: "three stamens; filaments slender, longer than the anthers; anthers obovate, compressed, . . . stigmas three, bipartite (?), the lobes recurved twice longer than the outer parianth lobes." The usual flowers have three stamens, three staminodia, and three or four undivided stigmas. Caspary described one specimen of Moser's 1832 collection as having 7 stamens and no stigmas. The writer has not found this specimen and cannot confirm the statement. Although Caspary maintained *Elodea Schweinitzii* (Planch.) Casp. he did so largely in confidence on the work of Planchon. Caspary studied the type specimen in Herb. Hooker, but found the only two flowers partly destroyed. In one of these he could observe 2 petals and 3 stigmatic lobes, but he could not confirm the flowers as bisexual. He did see elsewhere several specimens of the bisexual plants from Bethlehem, collected by Schweinitz and by Moser, but he classified them as *E. canadensis,* a species as he interpreted it having either hermaphroditic or dioecious flowers. It is obvious now that these specimens with hermaphroditic flowers collected at Bethlehem were the genuine *E. Schweinitzii.*

One of the flowering specimens collected by Wolle (MO) has a loose staminate flower tangled in the leaves. On dissection this proved to have 9 stamens and to be a staminate flower of *Elodea canadensis.* The other specimen on this Wolle collection has an abnormal flower with a large, coriaceous, swollen hypanthium, probably due to insect injury. The "New Jersey" specimen, Gray (M) has 3 good flowers, one of which has one stigma deeply split, apparently accidentally so, down the median submembranous tissue. In the Delessert Herbarium (G) there are two sheets of the 1832 Moser collection. One has a flower with 3 good stamens, but the 3 stigmas are bifid 3/4 way down. Their lobes are narrow, but flat, and more delicate in texture than those of *E. canadensis.* The duplicate of this (P) bears branches with one old and two good flowers. Of these one has 4 entire stigmas, while the other has 4 stigmas of which only one is bifid for 0.7 mm. On the Torrey specimen "N. Caesar." (P), of the three flowers one has 4 entire stigmas, and the other good flower has 4 stigmas, three entire and one shortly bifid. The 1829 Schweinitz (BR) specimen has the stigmas bifid 3/4 way.

In sum it can be seen that this species is unusual in its variability in floral morphology. A possible explanation would be that the species was of recent origin by hybridization and that it was not fully homozygous. Opposed to that hypothesis is the fact that in the general area there are only two other species, *E. canadensis,* and *E. Nuttallii.* Both of these species have dioecious flowers and in their pistillate flowers have the male element represented by sterile staminodia. Obviously they were derived from ancestors with perfect flowers. The species with perfect flowers represent the primitive state in the genus. Consequently it is not reasonable to look upon *E. Schweinitzii,* a species with perfect flowers, as a putative hybrid of two species with dioecious flowers.

18. (7. of part 1.) **Elodea Nuttallii** (Planch.) St. John, Rhodora **22** (1920) 27-28, as to basionym, non sensu St. John (1920); *E. occidentalis* (Pursh) St. John, Rhodora **22** (1920) 27-29, sensu St. John (1920), not as to basionym; *E. minor* Farw., Rept. Mich. Acad. Sci. **17** (1916) 181; *E. canadensis* Rich. in Michx. var. *angustifolia* (Britton ex Rybd.) Farw., Am. Midl. Nat. **10** (1927) 203; *Anacharis Nuttallii* Planch., Ann. & Mag. Nat. Hist. II, **1** (1848) 86, and Ann. Sci. Nat. Bot. III, **11** (1849) 74, *A. occidentalis* (Pursh) Victorin, Contrib. Lab. Bot., Univ. Montréal **18** (1931) 40; *Serpicula occidentalis* Pursh, Fl. Am. Sept. **1** (1814) 33, a superfluous epithet since Pursh should have adopted the epithet *canadensis; S. verticillata* L. f. β var. *angustifolia* Muhl., Cat. Pl. Amer. Sept. (1813) 84, *nomen nudum; Philotria minor* Small, Fl. S. E. U. S. (1903) 47; *P. Nuttallii* (Planch.) Rybd., Bull. Torrey Bot. Club **35** (1908) 461-462, 465, a provisional name; *P. Nuttallii* (Planch.) Rybd. ex Britton & Brown, Ill. Fl. N. E. U. S. ed. 2, **1** (1913) 105; *P. occidentalis* House, Bull. N. Y. State Mus. 243-244 (1923) 55. Fig. 2 e-i, 4.

Description of all specimens examined: Submerged aquatic; stems slender, dichotomously branched, often freely so; lower leaves opposite, lance-ovate, smaller than those above; median and upper leaves 6-13 mm. long, 0.3-1.5 mm. wide, whorled in threes or occasionally in fours, linear or narrowly lance-linear, pale green and flaccid, finely serrulate; staminate spathes borne at the median axils, sessile, ovoid, apiculate, 2-parted to well below the middle, the two acuminate teeth often twisted, forming the apiculate tip, the body 2 mm. long; staminate flower single in each spathe, sessile, at maturity breaking loose, floating to the surface and there opening; sepals 1.9-2.1 mm. long, 1.5-1.7 mm. wide, ovate, sometimes reddish-tinged; petals usually wanting, or when occasionally present 0.5 mm. long, ovate-lanceolate; stamens 9, and 1.2 mm. long, the 3 central ones slightly elevated on a common stalk, the 6 outer ones at a lower level and with separate filaments, the anthers 1 mm. long, 0.6 mm. wide, broadly ellipsoid; pistillate plants bearing in the upper axils spathes 9-25, but usually 10-15 mm. long, narrowly cylindric, somewhat ovoid at base, slightly enlarged at the bifid tip, the two acuminate teeth slightly spreading; pistillate flower stalked by a slender, thread-like, elongating hypanthium as much as 9 cm. in length; sepals 1.1 mm. long, 0.5 mm. wide, obovate, dark-striate; petals 1.3 mm. long, 1 mm. broad, white, delicate, broadly obovate; staminodia three, 0.5 mm. long, acicular; capsule 5-7 mm. long, 1.5-2 mm. in diameter, sessile, narrowly ovoid to fusiform; seeds 3.5-4.5 mm. long, 0.5-0.8 mm. in diameter, cylindric, short beaked, pilose; style slender, equaling the hypanthium; stigmas 3, slender, bifid, somewhat exceeding the sepals.

Holotype: "in America septentrionali." The type specimen is Herb. Thomas Nuttall, *Udora canadensis*, Phil.[adelphia], (BM). Specimen examined! It has the narrow leaves and the small pistillate flower of the species formerly called *E. occidentalis* (Pursh) St. John.

Range: In fresh (or rarely brackish) waters, Quebec to North Carolina, westward to Minnesota, Kansas, and Colorado, then in northern Idaho.

NORTH AMERICA: 1825, *Barrett* (W); *Brendel* (B); en 1868, *Durand* (P); *Engelmann* (G, K, P, W), with staminate flowers, labelled Udora verticillata minor, and probably isotypes of it; ditto, but with pistillate flowers, *Engelmann* (BR, K, S); *Leconte* (P); *Wolz* (ZT).

CANADA. QUEBEC: cult., Jard. Bot. Montréal, ex l'île Ste.-Thérèse, Richelieu, *Rolland-Germain 7498* (FSU, S); Saint-Jerome, Laurentides, *Victorin 20322* (GH).

UNITED STATES. *J. Blake* (BM). MAINE: Cobossee Contee L., *Battey* (NEBC); Unity Pond, Burnham, *Bean* (NEBC); Messalonskee R., Waterville, *Chamberlain 774*, *Fernald 2750* (BRU, GH, NEBC); Cathance R., Bowdoinham, *Fassett 14* (F), *94*, (NY), *Fernald & Long 12748* (NEBC, PH); S. Poland, *Furbish* (NEBC); E. Livermore, *Furbish* (NEBC); Androscoggin L., N. Leeds, *Furbish* (NEBC); Haley Pond, Rangeley, *Furbish* (NEBC); L. Auburn, *Merrill 508* (NEBC), *963* (US), *s.n.* (NY). NEW HAMPSHIRE: Connecticut R., West Moreland, Cheshire Co., *Krochmal 1227* (NHA); Beard's Brook, Durham, Strafford Co., *Hodgdon 5889* (NEBC, NHA); tidewater, Durham, *Hodgdon 5893* (NHA); Beard's Brook, Durham, *Hodgdon & Hooghkirk 5890* (NHA); Ashuelot R., Hinsdale, Cheshire Co., *Hodgdon & F. Steele 10048* (NHA); Province L., Wakefield, Carroll Co., *Pease 29912* (NEBC); Pontook Res., Dummer, *Pease 36781* (NEBC, NHA); Crescent L., Wolfboro, Carroll Co., *Seymour 4824* (NEBC); S. Charlestown, Sullivan Co., *Seymour 21058* (NEBC); Conway L., Conway, Carroll Co., *F. L. Steele 3374* (NEBC). VERMONT: without locality, *Chapman* (UC); Windsor, *Eggleston 2085* (GH). MASSACHUSETTS: Somerville, *Bailey* (NEBC); Congamond L., Congamond, *Blewett & Harger 6631* (PH); Alewife Brook, Medford, *Boott* (GH); Harwich, *F. S. Collins 2445* (NEBC); Back Bay Fens, Boston, *Collins 3639* (NEBC), *s.n.* (NEBC); Fresh Pond, Cambridge, *Deane* (NEBC), *Deane and E. & C. E. Faxon* (GH, NEBC); Great S. Pond, Plymouth, *Fernald, Hunnewell & Long* (NY); Agawam R., Wareham, *Fernald & Svenson 758* (NY); Muddy R., Brookline, *Forbes* (NEBC); Great S. Pond, Plymouth, *Glück* (NEBC); Heard's Pond, Wayland, *Kennedy* (GH); Beaver Brook, Middlesex Co., *Kidder* (NY); Spot

Pond, Stoneham, *Kingman* (GH); Fresh Pond, Cambridge, *Morong* (NY), *Pease 2063* (NEBC); L. Cochichewick, N. Andover, *Pease 2638* (NEBC); W. Cambridge, *St. John 679* (NEBC, PH); Beaver Brook, Waverley, Belmont, *Seymour 3620* (S); Agawam R., Wareham, *L. B. Smith & H. K. Svenson 825* (NY); Fresh Pond, Cambridge, *Young* (NEBC). RHODE ISLAND: Olney Pond, Lincoln, *J. F. Collins* (NY); Mill Pond, Lonsdale, *Greene* (BRU). CONNECTICUT: Waterbury, *Blewitt 573* (NEBC); Farmington R., New Hartford, *Blewitt 586* (NEBC); Connecticut R., Hartford, *Blewitt 609* (NEBC); Pistapaug Pond, Durham, *Blewitt 1680* (NEBC); Stony Brook, E. Haven, *Blewitt 1980* (NEBC); Congamond L., Suffield, *Castle & Dann 114* (CU); Kensington, *Cowles* (GH): Beaver Cr., Milford, *E. H. Eames* (NEBC); Bantam L., Litchfield, *Eaton* (GH); without locality, *Gray 4606* (BM), *s.n.* (CP, O); Housatonic R., Orford, *Harger* (UC); Simsbury, *Holcomb* (GH); without locality, *M. Mitchell* (G); Norwich, *Setchell* (UC); Middletown, *Ware 3472* (NEBC); Boardman's Pond, E. Hartford, *Weatherby 367* (NCSC); Pistapaug Pond, Wallingford, *Weatherby 3373* (NEBC); E. Haven, *Weatherby 3591* (NCSC); Putnam, *Weatherby 3777* (NEBC); Old Lyme, *Woodward* (GH); Hartford, *Wright* (GH); Wethersfield, *Wright* (GH); without locality, *Wright*, in part (MO); without locality, Herb. *D. Don*, Herb. Martii (BR). NEW YORK: Jamaica Reservoir, *Bicknell 176* (NY); Hudson R., Hastings, *Bicknell* (NY); S. Pond, Bedford, *Cushman & Wood* (NY); Fall Cr., Ithaca, *A. J. Eames & K. M. Wiegand 13351* (CU); Woodside, *Ferguson 4147* (NY); Cold Spring Hbr., *Ferguson 4414* (NY); Oyster Bay, *Ferguson 4832* (NY); Millneck, *Ferguson 7843* (NY); Great S. Pond, Babylon, *Ferguson 8027* (NY); Baldwin, *Ferguson 8154* (NY); Millneck, *Ferguson* (NY); Salmon R., Selkirk, *Fernald, Wiegand & Eames 14123, 14124* (CU, GH); Wading R., *Glück* (Glück Herb.); Watertown, *Gray*, in part (NY); Troy, *J. Hall* (F); Clove L., Staten I., *Hollick* (NY), *Heuser* (B); Long I., *Hennecart* (P); Black R. Bay, *Keyes* (UC); Quogue, *Knight* (NY); Mohegan L., *Leggett* (F); Peekskill, *Leggett* (NY); Ithaca, *Muenscher 13352* (CU); Hudson R., Catskill, *Muenscher & Curtis 5570* (CU); Great Pond, Riverhead, *St. John 2548a* (CU, GH); Pocantico Hills, W. Chester Co., *N. Taylor 847* (NY); Hotaling I., Hudson R., New Baltimore, *Taylor 1372* (NY); 3rd. Ave., (New York), *Torrey & Gilman* (NY); Ontario See, Charlotte, *Weinland* (B); N. Fairhaven, *Wiegand 13358*, in part (CU). NEW JERSEY: Oldmans Cr., Woodstown, *Adams 263, 264* (GH, PH); Newton Cr., Collingswood, *Adams 294* (PH); Camden, *Boice* (PH); Bayhead, *Cannon* (CAS); without locality, *Enneandr* (MO); Fishhouse Sta., (Delaware R.), *Glück* (Glück Herb.); Brindletown, *Grove 490* (PH); Silver L., Belmar, *Harshberger* (PH); Rahway, *Heuser* (B, M); Paulsboro, *Jahn 167* (PH); *Swedesboro, Lippincott* (PH); Crosswicks Cr., *B. Long 6036* (PH); Delaware R., Delair, *Long 6293* (PH); Budd's L., Morris Co., *Mackenzie 1505*

(NY); Barnegat Bay, Bay Head, *Mackenzie 4731, 5095* (NY); Delaware R., Bordentown, *Mackenzie 6833* (NY); Delaware R., Delair, *Mackenzie 7352* (NY); Hibernia, *Mackenzie* (NY); Swartswood L., Sussex Co., *Mackenzie* (NY); Camden, *Martindale* (L, PH); without locality, *Morong,* in part (MO); Delaware R., Delair, *Pennell 6498* (NY); without locality, *Pursh,* in part (K); Sussex Co., *Rusby* (BRU); Princeton, *Schott* (F, US); without locality, *Torrey* (K); Budd's L., *Vail* (NY). PENNSYLVANIA: Lagrange, *Adams 76* (PH); Neshaminy Falls, *Adams 99* (PH); Darby Cr., Delaware Co., *Barker* (PH); Stroudsburgh, *Bicknell* (NY); York Furnace, *Brown* (PH); Falls of Schuylkill, *Carson* (PH); Fulton Twp., *Carter* (PH); York Furnace, *Crawford* (PH); Perkiomen Cr., Schwenkville, *Driesbach 1598* (PH); Philadelphia, *Engelmann* (B); Darby Cr., Adele, *Fogg* (PH); Pt. Pleasant, *Fretz* (PH); Cobbs Cr., *Githens* (PH); Philadelphia, *Griffith 260* (PH), *s.n.* (P), *James* (GH); York Furnace, *Keller* (PH); Neshaminy Cr., *Long 4595* (PH); Wissahickon Cr., Penllyn, *Long* (PH); Cobbs Cr., *MacElwee* (PH); Fishing Cr., Columbia Co., *Meredith* (PH); Greenlane, *Mumbauer 313* (PH); Philadelphia, Nutt(all), perhaps an isotype of *E. Nuttallii* (PH); Brinton's Bridge, Brandywine Cr., Chester Co., *Pennell 2280* (NY), *5110* (PH); White Clay Cr., Avondale, *Pennell 5014* (PH); Chester Cr., Darling, Middletown Twp., *Pennell 5058* (PH); Unionville, *Porter* (PH); Allentown, *Pretz 5175, 6227* (PH); Saucon Cr. Center Valley P. O., *Pretz 7279* (PH); McCalls Ferry, *Small* (NY); river, Harrisburg, *Small* (NY); Collen Brook, *B. H. Smith* (PH); canal, Belmont, *C. E. Smith* (PH); Philadelphia, *Watson* (L); Dunning Cr., Cessna, *W. F. Westerfeld 6357* (FSU); Steelton, *C. S. Williamson* (PH); Martins Cr., *Williamson* (PH); Del(aware) R., above Richmond, *Wister* (PH); Delaware R., Philadephia, *Zantzinger* (MO). DELAWARE: Wilmington, Herb. *Canby* (GH); New Castle City, *Commons* (NY); Brandywine Mill Race, Wilmington, 1874, *Commons* (MO, NY), and in 1896 (PH); Red Clay Cr., Greenbank, *Commons* (PH); Wilmington, *Rhoads 831* (PH); Middleton, *Van Pelt & Long* (PH). MARYLAND: Miles R., Easton, Talbot Co., *Earle 4281* (DUKE); Plummers I., *Killip 32656* (US); by Canal, *Maxon 6329* (US); Annapolis, *Rothrock* (F); Havre de Grace Light, *Shull 146* (GH, MO, US); Baltimore Co., *K. A. Taylor* (NY); Great Falls, *Ward 126* (US), without collector (US). DISTRICT OF COLUMBIA: Eastern Branch, Potomac, *Boettcher 2543* (CAS); Potomac pools, *Morris* (F); Georgetown, *Van Eseltine & Moseley 203* (US); Potomac, Washington, *E. S. Steele* (US); Washington and vicinity, *Steele* (C, CP, DUKE, G); Great Falls, *Ward* (US); Washington, *Ward* (US). WEST VIRGINIA: Cacapon R., Hardy Co., *Moldenke 6765* (NY). VIRGINIA: Appomatox R., Hopewell, *Fernald, Long & Smart 5592* (GH); Suffolk, *Kearney 1697* (US); Great Falls, *McAtee 2311* (US); Hunting Cr., *McAtee 2339* (US); Black Pond, Fairfax Co., *Muenscher 3614* (CU); Mountain L., Salt Pond Mt., Giles Co., *Thorne 11395* (FSU); Four Mile Run, Alexandria, *Tidestrom 94* (S). NORTH CAROLINA: Jordans Mill Pond, Seaboard, *Beal 3737* (NCSC); Garysburg, *Beal 3816* (NCSC); Knotts I., Currituck Co., *Beal 3956* (NCSC); Wiggins Rd., Wilson Co., *Beal 4114* (NCSC); Moore's Pond, Youngsville, *Beal 5690* (NCSC); L. Logan, Sunburst, Pisgah Natl. For., *Beal 5835* (NCSC); Linville R., Pineola, *Beal 6006* (NCSC); Alligator R., Fort Landing, Tyrrell Co., *Radford 4616, 5409* (NCU); Perquimans R., Hertford, *Radford 4686* (NCU); State Fish Hatchery, Marion, McDowell Co., *Radford 4886* (NCU); Pensacola, Yancey Co., *Radford 4956* (NCU); Currituck Sound, Duck, Dare Co., *Radford 5436* (NCU); Boone's Mill Pond, Jackson, *Radford 5739* (NCU); Island Cr., Trent R., Jones Co., *Radford, Haesloop & Miller 7683* (NCU); Jack Smith Cr., New Bern, Craven Co., *Whitford 231* (NCSC); Avery Co., *Whitford* (NCSC); L. Myra, Wake Co., *Whitford* (NCSC). ALABAMA: Little Bay Batte, Lower Mobile Bay Delta, *Lueth 53* (DUKE). MICHIGAN: Jacobsville, *Herman 7642* (K). OHIO: without locality, *Lx* (= *Lesquereux*), (BERN, G); Loraine, *Herb. Oberlin College* (US); Fox L., Wayne Co., *Selby & Duvel 1321* (NY); Columbus, *W. T. S(ullivant)*, (G, M); Geauga L., Portage Co., *Webb* (GH). INDIANA: Blue R. Lake, Whitley Co., *Deam 14458* (Deam Herb., UC); Wolf L., Noble Co., *Deam 20721* (Deam Herb.); Wabash R., Fountain Co., *Deam 22982* (Deam Herb.). KENTUCKY: Kentucky R., *Peter* (K, L, NY); Lexington, *Short* (K, P). MISSISSIPPI: Horseshoe L., Holmes Co., *F. A. Cook* (US). WISCONSIN: Wisconsin R., Merrill, *Fassett 7376* (WIS); Mineral L., Mellen, *Fassett 7377* (WIS); L. Superior, Oronto, *Gillman* (GH); Madison, *Hale* (F); Milwaukee, *Hase* (NY); Whitewater, *Kleeberger* (CAS); Milwaukee, *Lapham* (G); L. Mendota, Madison, *Mahoney* (WIS); Sullivan, *Shallert* (ZT); Whitney's Slough, Green Bay, *Shuette* (F); Point Sable, Green Bay, *Shuette* (F, K); St. Francis R., s. Wisc., *Widman* (MO). ILLINOIS: Cook Co., *Babcock* (MO); Indian L., *Eggert* (CAS, F, MO, UC, US); Keokuk Reservoir, Niota, *Eyles 318* (NCSC); Chicago, *Gates 632* (F); Chicago R., Bowmanvil, *Gates 913a* (F); Athens, *E. Hall* (F, G, P), *1079* (GH); without locality, *Hall* (GH); Oquawka, *Patterson* (F, NY); Murphys(boro), *Shuette* (F, UC); Pecatonica, *Swezey* (CAS). MINNESOTA: Winona, *Holzinger* (US); L. Winona, *Holzinger* (NY); without locality, *Holzinger* (CS); Swan L., Nicollet Co., *Metcalf 6* (CU, US); L. Chisago, *Metcalf 1232* (GH); Crystal L., Blue Earth Co., *Moore 23682* (S); Center City, *B. C. Taylor* (B, BM, G, NY, RM, S, UC, US, WS). IOWA: Pike Cr., Muscatine Co., *Davidson 4409* (NCSC); Harper's Ferry, *D. E. & M. S. Eyles 338* (NCSC); Fayette, *Fink* (GH); Johnson Co., *Fitzpatrick* (MO); without locality, *Harvey* (GH); Swan L., Madison, *Thorne 10472* (NCSC). MISSOURI: Kennett, *Bush* (MO); Carondelet, *Dewart* (MO), without collector (WU); Poplar Bluff, *Dewart*, in part (MO); Gascondy, *Emig 218* (MO, US); American bottom, opposite St. Louis, *Engelmann* (MO); St. Louis, *Engelmann*, holotype and isotypes of *Udora verticillata* Spreng. var. *minor* Engelm. (B, NY); St. Louis, *Gurney* (MO); Pink's slough, Allentown, *Kellogg* (MO); Jefferson City, *Krause* (MO); Ha-ha-tanka, Camden Co., *Metcalf 924* (US); Rich Hill, Bates Co., *Metcalf 992* (GH); Wayland, *Metcalf 1089* (NY, US); Forest Mill, *E. J. Palmer 3765* (MO, NY), *3766* (GH, US); Flat Cr., Barry Co., *Redfearn & T. Stombaugh 4210* (FSU). NEBRASKA: Carter L., Omaha, *Kiener 17601* (G); Enders L., *Thomson 9* (US); Sweetwater Lakes, *Thomson 177* (GH, NY, US). KANSAS: Linn Co., *Clothier 1052* (GH, MO, NY, P, US, WU); Leavenworth, *Fendler* (GH). COLORADO: Larimer Co., *Cowen* (RM). IDAHO: L. Coeur d'Alene, *Epling & Houck 10053* (LA); Fernan L., Coeur d'Alene, *Rust 373* (US). WITHOUT LOCALITY: *Goldie* (K); *Torrey* (K).

The sterile specimens formerly listed for Oregon (Rhodora 22: 29, 1920) are now known to be *Elodea columbiana* St. John.

The record for Alabama, Mobile Bay Delta, Lueth 53, seems far out of range, and its occurrence there seems best explained as an escape from aquarium culture. Prof. J. Ewan agrees with this interpretation.

Again, the occurrence in northern Idaho, in and near Lake Coeur d'Alene, is remote from the rest of the range. The shores of the lake are a favorite hunting ground, and local sportsmen have imported and established duck food plants to attract the birds. They have successfully established *Zizania interior*, and it seems probable that *Elodea Nuttallii* was introduced in the same manner.

Cultivated specimens of the species are known from Germany, and the species is established in England, Holland, and probably in some other European countries.

Elodea Nuttallii is the type and only member of the section *Natator*. Its sessile staminate buds which are liberated to expand and float on the surface of the water are unique. They usually lack petals but have 9 stamens in two series, 6 outer, and 3 central.

Planchon's species was tranferred and adopted by Rydberg as *Philotria Nuttallii* (Planch.) Rydb., but only as a provisional name. Later, in 1913, it was validly published, as *P. Nuttallii* (Planch.) Rydb. ex Britton & Brown. It is evident that Rydberg did not examine Planchon's holotype.

Rydberg cited six collections as this species, from New York, New Jersey, and Virginia. These specimens, in the New York Botanical Garden, have been reexamined. They differ in foliage and in flowers from the true *E. Nuttallii.* Instead, there is no basis of separation in the acuteness of their leaves or in the structure of the staminate flowers from the older *E. canadensis.* The writer positively refers these specimens, which represent the sense of *Philotria Nuttallii* Rydb. (but not of Planch.), to the synonymy of *E. canadensis.*

19. (3. of part 1.) **Elodea canadensis** Rich. in Michx., Fl. Bor.-Am. **1** (1803) 20; Richard, L. C., Mém. Inst. de France **12** (2), (1811-1812 = 1814) 3-4; *E. canadensis* var. *latifolia* (Casp.) Aschers. & Graebn., Syn. Mitteleur. Fl. **1** (1897) 403; *E. canadensis* var. *latifolia* var. *repens* Sanio, Verh. Bot. Verein Prof. Brandenburg **32** (1891) 121, an illegitimate epithet; *E. canadensis* var. *latifolia* subvar. *repens* Aschers. & Graebn., Syn. Mitteleur. Fl. **1** (1897) 404; *E. canadensis* var. *Planchonii* (Casp.) Farw., Am. Midl. Nat. **10** (1927) 203; *E. Planchonii* Casp., Monatsber. Kgl. Preuss. Akad. Wissensch, **1857** (1857) 47; also in Prinsheim's Jahrb. Wissensch. Bot. **1** (1858) 468-469, 500-501; *E. latifolia* Casp., Monatsber. Kg. Preuss Akad. Wissensch. **1857** (1857) 46, (and reprint p. 11, 1857); also in Pringsheim's Jahrb. Wissensch. Bot. **1** (1858) 467-468; *E. oblongifolia* Michx. ex Casp., Pringsheim's Jahrb. Wissensch. Bot. **1** (1858) 462; *E. iowensis* (as *Iowensis*) Wylie, Proc. Iowa Acad. Sci. 17 (1910) 82, a provisional name; and in Science n.s. **33** (1911) 263; *E. ioensis* Wylie, State Univ. Iowa, Nat. Hist. Bul. **6**(4) (1913) 48, *pl. 1-2; Anacharis Alsinastrum* Babington, Ann. & Mag. Nat. Hist. II, **1** (1848) 83-84, 86; also in Ann. Sci. Nat. Bot. III, **11** (1849) 74; *A. canadensis* Planch., Ann. & Mag. Nat. Hist. II, **1** (1848) 86, and in Ann. Sci. Nat. Bot. III, **11** (1849) 75; A. canadensis Planch. var. *Planchonii* (Casp.) Victorin, Univ. Montréal, Contrib. Lab. Bot. **18** (1931) 40; *A. Planchonii* (Casp.) Rydb., Fl. Prairies & Plains Cent. N. Am. (1932) 57; *A. Planchonii* (Casp.) Peck, Man. Higher Pl. Ore. (1941) 76-77; *Philotria canadensis* (Rich. in Michx.) Britton, Science II, **2** (1895) 5; *P. Planchonii* (Casp.) Rydb., Bull. Torrey Bot. Club **35** (1908) 462-463; *P. iowensis* (as *Iowensis*) Wylie, Proc. Iowa Acad. Sci. **17** (1910) 82; and Science *n.s.* **33** (1911) 263; *Udora canadensis* (Rich. in Michx.) Nutt., Gen. N. Am. Pl. **2** (1818) 242, as to basionym, but excluding the linear-leaved Philadelphia specimen which is the holotype of *E. Nuttallii; Serpicula canadensis* (Rich. in Michx.) Eaton, Man. Bot. ed. 5, (1829) 390. Fig. 1, 2 a-d, 5.

Description of all specimens examined: Submerged aquatic, root-

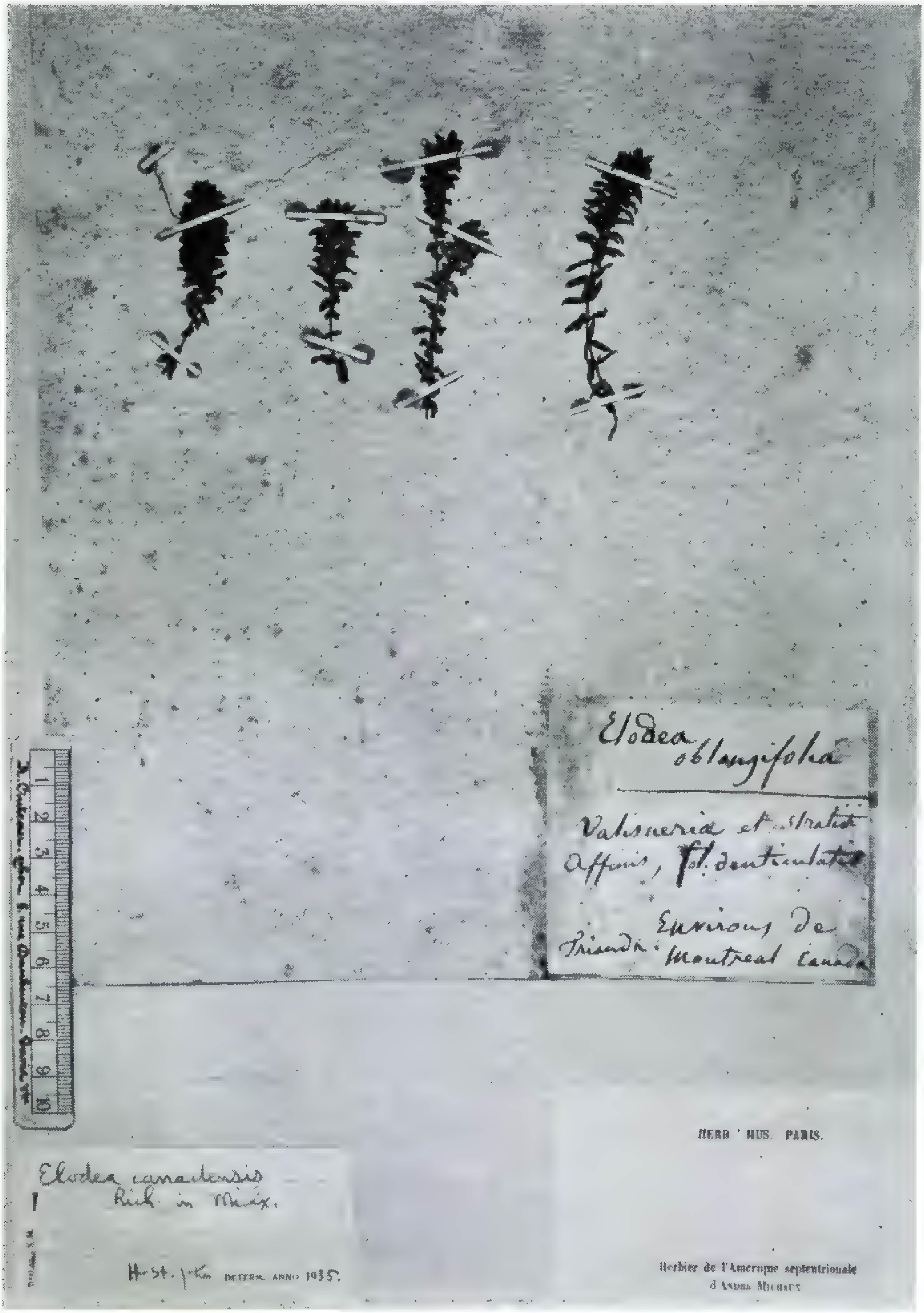

PLATE 1308

Fig. 1. *Elodea canadensis* Rich. in Michx. Holotypic sheet in the Museum National d'Histoire Naturelle, Paris.

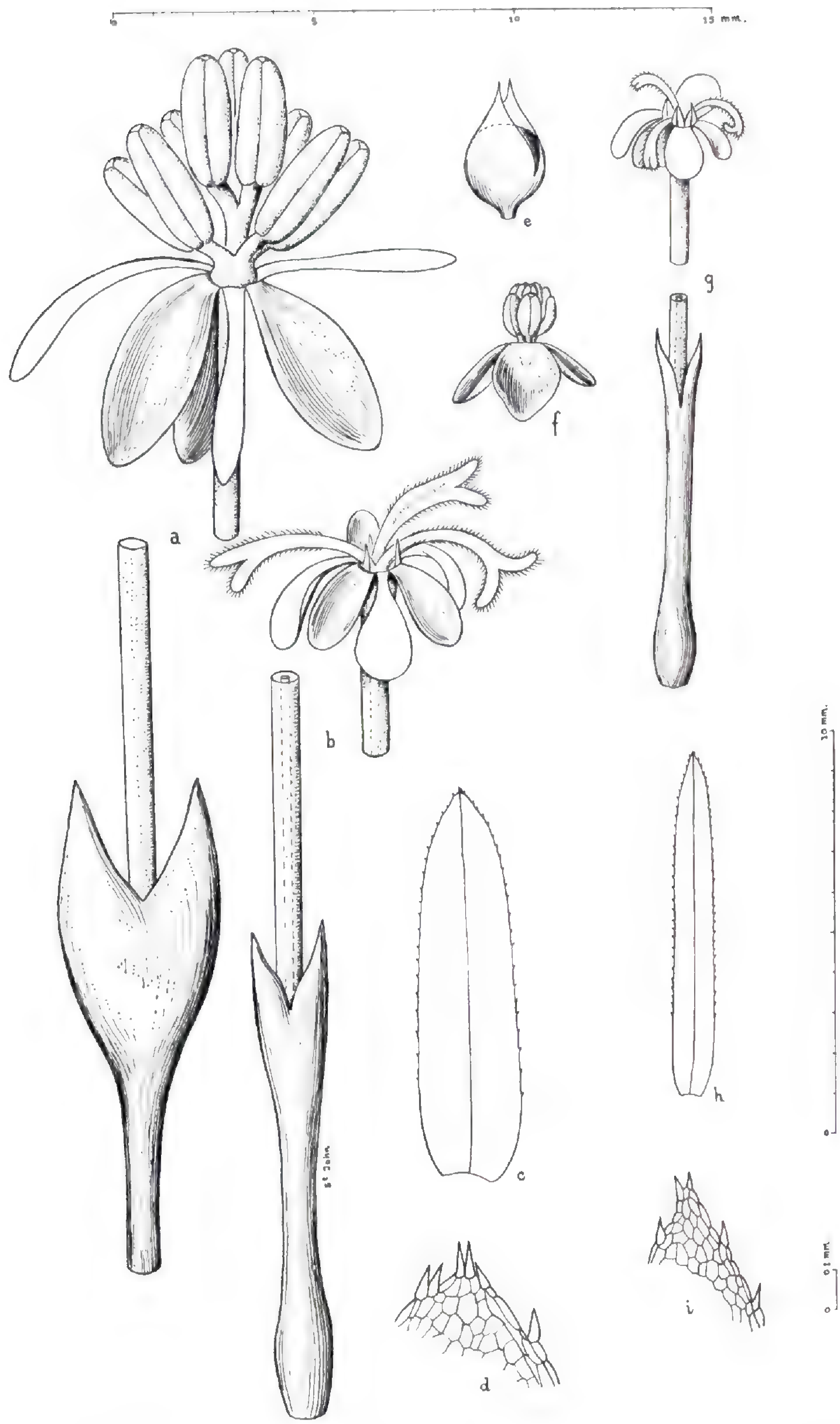

Fig. 2. *Elodea canadensis* Rich. in Michx., staminate flower, from L. N. Gooding 597, × 5; *b*, pistillate flower, from Cayuga Lake, W. R. Dudley, × 5; *c*, leaf from holotype, × 5; *d*, leaf apex of same, × 50; *e*, *Elodea Nuttallii* (Planch.) St. John, staminate spathe and bud, from Okuawka, Ill., H. N. Patterson, × 5; *f*, expanded staminate flower, from Old Lyme, Conn., R. W. Woodward, × 5; *g*, pistillate flower, from Center City, Minn., B. C. Taylor, × 5; *h*, leaf, from H. St. John 1,827, × 5: *i*, leaf apex of same, × 50.

ing in the mud; plants dioecious; staminate plants rarely observed, their stems 2-10 dm. long; lower leaves opposite, small, lance-ovate; median and upper leaves in whorls of 3 and 7-17 mm. long, 1-4 mm. broad, linear, lance-linear, or lance-oblong, bright green, thin, firm or subflaccid, finely serrulate; staminate spathes borne in the upper axils, 15 mm. long, the lower half narrowed into a peduncle-like base, the upper half 6-8 mm. long, 4 mm. wide, inflated, ellipsoid or ovoid, the apex resembling a gaping mouth, due to the two acute, salient lobes; staminate flowers peduncled by the slender, thread-like, elongating base of the hypanthium which is 3-20 cm. long; sepals 3.5-5 mm. long, 2-2.5 mm. wide, elliptic, dark striate; petals 5 mm. long, 0.3-0.7 mm. wide, white, very delicate, the basal half a linear claw, the apical half linear lanceolate; stamens 9, the 3 inner raised on a common, fused stalk; anthers 2-3.5 mm. long, 1 mm. wide, oblong-ellipsoid; pistillate plants with stems slender, dichotomously branched; lower leaves opposite, ovate, much smaller than the upper ones; median and upper leaves in whorls of 3, and 6-13 mm. long, 1-5 mm. broad, oblong, ovate-oblong or lance-ovate, firm, dark green, serrulate, crowded and strongly imbricate at tip of the stem; pistillate spathe 10-20 mm. long, borne in upper axils, cylindric, the apex bidentate and with two broad teeth; pistillate flower exserted from the spathe by the thread-like, elongating base of the hypanthium which is 2-28 cm. long; sepals 2-2.2 mm. long, 1.1 mm. broad, oblong elliptic, dark striate; petals 2.6 mm. long, 1.3 mm. wide, broadly elliptic-spatulate, white, delicate; staminodia three, 0.7 mm. long, acicular; style equaling the hypanthium; stigmas three, 4 mm. long, broad, 2-cleft at apex; ovary 3 mm. long, lance-ovoid; ovules 3-4, erect; capsules 6 mm. long, 3.2 mm. in diameter, ovoid; seeds 4.5 mm. long, narrowly cylindric, glabrous.

Holotypus: "in rivulis Canadae." Environs de Montreal, *Elodea oblongifolia, A. Michaux* (P)! Type examined! Though the specimens bear the name *E. oblongifolia,* it was published as *E. canadensis*

Range: In fresh ponds and streams, especially in calcareous areas, from Quebec, abundant southward to North Carolina, Alabama, and Arkansas, westward to Manitoba, British Columbia, Colorado, and central California, but absent in the higher Rocky Mountain region.

NORTH AMERICA, Herb. *Durand* (P); in 1823, *Greville* (K); *Michaux* (P); in 1827, *Schweinitz* (B); donné par *W. Hooker* (P).

CANADA: *Cleghorn* (K); Ny. He. [Norway House] to Canada, *R. D.* (K); Herb. *Sprengel* (B). QUEBEC: Corris Sta., Cleveland, *Chamberlain & Knowlton* (GH); L. Memphremagog, *Churchill* (GH, K), Aug. 18, 1906, *Churchill* (GH); L. Bernard, Farrellton, Hull Co., *Rolland-Germain 6472* (S); flum. St. Laurent, Mont Real, *Hennecart* (P); Magog L., Orford, *Knowlton* (GH); R.-aux-Serpents, Deux-Montagnes Co., Pere *Louis-Marie* (S); Hull, *Macoun 27001* (CAN);

Farm Pt., Gatineau R., *Macoun 61033* (CAN); Ste. Anne de Beaupré, *Macoun 68806* (CAN, GH); Hull, *Macoun 85553* (CAN); Pickanock R., *Macoun* (GH); Ottawa R., Hull, *Macoun* (F); St. Lawrence R., Caughnawaga, *Victorin 8171* (BM, DEAM HB.); R. St.-Laurent, Montréal, *Victorin 9910* (P); Longueuil, *Victorin 11256* (DEAM HB., P, US); Montréal, *Victorin 20318* (GH, P, S); Longueuil, *Victorin 24725* (S); Montréal, *Victorin 28388* (K, S); Pt. à Bison, Co. de Beauharnois, *Victorin 28393* (K, S); rapides Richelieu, Chambly, *Victorin & Germain 33905* (S); R. Richelieu, St.-Mathias, Chambly Co., *Victorin & Germain 7310* (K, LD); R. Richelieu, St.-Mathias, Chambly Co., *Victorin & Germain 7410* (FSU, S); R.-des-Prairies, Hochelaga Co., *Victorin & Germain 33996* (S); Ile Ste.-Therese, St.-Jean Co., *Victorin & Germain 45631* (C), *49140* (G), *49147* (W); Ste.-Rose, Laval Co., *Victorin & Germain 49306* (C, W); Ile Ste.-Therese, Sainte-Jean Co., *Victorin & Germain 49361* (G, M, W); Melocheville, Saint-Laurent R., *Victorin, Germain & Boivin 4302* (S), Lac Olive, Reg. de l'Abitibi, *Victorin, Germain & Meilleur 44974* (C); Ile Calumet, Ottawa R., *Victorin, Germain & Rouleau 2017* (W); Ste.-Anne de Sorel, Richelieu Co., *Victorin, Germain & Rouleau 6534* (C, S). ONTARIO: Kapuskasing R., Cochrane Dist., *Baldwin & Breitung 3515* (K); Cochrane, Lillabelle L., *Baldwin & Breitung 3898* (K); German Twp., Timmins, Cochrane Co., *Baldwin & Breitung 4062* (S): Detroit R., Herb. *Boott* (GH); London, *Burgess 2208* (BM); Frog L., Hardwick, *Garton 1676* (G, W); Chelsea, *Harrington* (CAN); St.-Thomas, Elgin Co., *L. E. James 1711* (C, G, L, W); Sparrow L., *Kirk 679* (L); Stokes Bay, Bruce Penin., *Krotkov 8649* (NY); St. Clair Flats, *McAtee 3424* (US); Kaministiqua R., Neeling, Thunder B. Dist., *Mayall & Cormack 24* (W); Lake Region, *Macoun* (K); Bay of Quinte, *Macoun* (CAN); Niagara Falls, *Macoun 82331* (CAN); Kenora, Lake of the Woods, *Ostenfeld 552* (C, CP); Celdwell, *Ostenfeld 584a, 584c* (C, CP); L. Superior, Coldwell, *Rendle & Good* (BM); Toronto, *Scott* (CAN); Jock R., Beckwith, Lanark Co., *Senn 552* (S); Moose Factory, *Spreadborough 62633* (CAN); Toronto, *Sturtevant* (MO); Pancake R., Algoma Dist., *Taylor, Hosie et al.* (S); L Ontario, Belleville, Hastings Co., *Victorin, Germain & Jacques 45855* (GB); Niagara, *C. S. Williamson* (PH). MANITOBA: R. des Marais, Otterburne, *Bernard 58284* (S): Brandon, *Macoun 13724* (B, CAN, F); Souris R., N. W. T., *Macoun 27002* (CAN, GH); Wekusko L., *Scoggan 6680* (C, K, S); Grassy R., Tramping L., *Scoggan 6900* (C, K); Whiteshell For. Res., *Scoggan 8723* (K); Minnedosa R., Elphinstone, *Scoggan 10268* (C, S). SASKATCHEWAN: Carleton House without collector, (GH): without locality, *Drummond*, type of *E. Planchonii* Casp. (GH, K). BRITISH COLUMBIA: Mara L., Enderby to Sicamous, *Calder & Savile 11838* (W).

UNITED STATES. MAINE: L. Auburn, Auburn, 1953, *Bean* (NEBC); Benton Falls, Sebasticook R., 1959, *Bean* (NEBC); Lily Pond, Rockport, *C. A. E. Long 906* (NEBC, NY); Rockport, *Long*

(NEBC, NY); calcareous water, Lily Pond, Rockport, *Rossbach 96* (NEBC); Unity Pond, Unity, *Rossbach 97* (NEBC). NEW HAMPSHIRE: Harris Pond, Pelham, Hillsborough Co., *Dupee* (NHA); Partridge Pond, Littleton, Grafton Co., *Sheehan & Krochmal 53* (NHA). VERMONT: Winooski R., Essex Jct., *S. F. Blake 2210* (NEBC, PH); N. Hero, *Brainerd* (P); Herb. *Chapman* (UC); Fern L., Leicester, *Dutton* (CU, MO); Catharine Wells, *Dutton & C. W. Dodge* (NY); L. Bomoseen, W. Ferrisburg, *Eggleston* (GH); Little Otter Cr., Ferrisburg, *Eggleston & Grout* (GH); Ferrisburg, *Eggleston* (F). MASSACHUSETTS: Andover, *J. Blake 2210* (NEBC); Pontoosuc L., Lanesboro, *Churchill* (MO); Tyringham, *H. T. Clark* (BR); L. Garfield, Monterey, *Hoffman* (NEBC); Sheffield, *Hoffman* (NEBC); Fresh Pond, Cambridge, *Morong* (MO); Pontoosuc L., Pittsfield, *Kennedy* (GH); L. Quannapowitt, Wakefield, *Ripley 16138* (GH), *17494* (GH, NEBC); Great Brook, Southwick, *Seymour 257* (MO, NY). RHODE ISLAND: N. Providence, *Olney* (BRU, S), *Curtiss* (G), *Hope* (NY), *Olney* (BRU), *Olney* (S). CONNECTICUT: L. Saltonstall, *Blewitt 1981* (NEBC); Norwalk, *E. H. Eames 5265* (NY); L. Congamond, *Eames 8457* (GH); Boardman's Pond, E. Hartford, *Weatherby 367* (NCSC); Housatonic R., N. Canaan, *Weatherby 2700* (NEBC); E. Haven, *Weatherby 3591* (NCSC); Housatonic R., Huntington, *Harger & Weatherby 3595* (NCSC); Huntington, *Weatherby 3604* (NEBC), *3595* (WEATHERBY HERB.); Branford, *Setchell* (UC); E. Haven Pond, Herb. *Torrey* (NY); *Wright* in part (MO). NEW YORK: Fall Cr., Ithaca, *Bechtel 13364* (CU); New York, *Bicknell 174* (NY); Thousand Is., *Bicknell 177* (NY); Chilton L., *Britton* (NY); New York, *Britton* (G); Kendall, *Burnett* (NY); Harris Bay, L. George, *Burnham 53* (US); Fall Cr., Ithaca, *Clausen 2386* (G); Buffalo, *Clinton* (F, MO, NY); Grand I., Niagara R., *Coville* (US); Cayuga L., *Dudley* (DS); Springport, *A. J. Eames 13362* (CU); Renwick, *Eames & Wiegand 13353, 13353a* (CU); Cayuga L., *Eames & Wiegand 13356* (CU); Mattituck, *Ferguson 3405* (NY): Oakdale, *Ferguson 7879* (NY); Cayuga L., *Fernald & Wiegand 14548* (CU, GH); Watertown, *Fernald, Wiegand & Eames 14125* (CU, GH); Ossawegatchee, *Fernald, Wiegand & Eames 14126* (CU, GH); Clayton, *Fernald, Wiegand & Eames 14127*, in part (CU, GH); Selkirk, *Fernald, Wiegand & Eames 14128* (CU, GH); Watertown, *Gray* (NY); w. N. Y., *Gray* (GH); *Gray* (K, M); Renwick, *R. Hitchcock & A. R. Bechtel 11218* (CU); Pecksport, *House 6561* in part (GH); Pierrepont Pond, Woodville, *House 8223* (NY); Irondequoit Bay, *Killip 1063* (MO); Oswego R., Oswego, *Killip 12533* (US); Jennings Pond, Danby, *Lawrence 831* (S); without locality, 1821, *Mitchell* (G); L. Ontario, *Morong* (MO, NY); Cayuga L., Ithaca, *Morong* (BM, NY); Danby Pond, Danby, *Muenscher 19584* (S); Fall Cr., Ithaca, *Muenscher 13354, 13363* (CU, GH); Oneida L., *Muenscher 14547* (CU); Fall Cr., Ithaca, *Muenscher & Bechtel 50* (O); Cayuga L., Ithaca, *Muenscher & Bechtel 51* (O); Geneva, *Muenscher & Burkholder 16366* (WS); Conesus L., *Muenscher & Burkholder 16367, 16370* (WS); Silver L., Wyoming Co., *Muenscher & Burkholder 16368* (WS), *16369* (GH, WS); Irondequoit Bay, *Muenscher, Wiegand & Wright 15197* (CU); Sodus Center, *Wiegand & Wright 15198* (CU); Thousand Is., *J. I. & G. R. Northrup* (NY); Junius marlbog, Seneca Co., *Ostenfeld* (C); Tioughnioga R., Cortland, *E. L. Palmer 73* (CU); Seneca Falls, Cayuga L., *Palmer & Eames 72* (CU); Grass R., Canton, *Phelps 279* (CU, GH); P Y = (Penn Yan), *Sartwell* (F); Cayuga L., *H. von Schrenk* (MO); Fall Cr. Ithaca, *von Schrenk* (MO); Albany, Herb. *Schinz* (Z, ZT); Bainbridge, *Topping* (US); Oneide by New York, *Torrey* (P); Ithaca, *Trelease* (MO); Fish Cr., Oneida L., *Underwood 3211* (NY); Lake View, L. Ontario, Jefferson Co., *Underwood* (NY); Charlotte am Ontario See, *Weinland 49* (B); North Pond, Sandy Cr., Oswego Co., *Wiegand 13355* (CU); N. Fairhaven, *Wiegand 13358*, in part (CU); McMullen Pond, *Wiegand 13359* (CU); Renwick, *Wiegand 13360* (CU); Fall Cr., Ithaca, *Wiegand 13361*, in part (CU); Spencer, *Wiegand & Fernald 14546* (CU, GH); Cayuga L., Ithaca, *Wiegand & C. C. Thomas 1533* (CU); Wellesley I., St. Lawrence R., *Ward* (US); L. Katrine, Ulster Co., *Wilson* (NY). NEW JERSEY: Foul Rift, Warren Co., *Bartram* (PH); Muscanetcong R., Asbury, Warren Co., *Godfrey 62102* (FSU); Delaware R., Delaware Co., *Mackenzie 7233* (NY); New Brunswick, *Mackenzie 7258* (NY); Green Pond, Warren Co., *Mackenzie 7732* (NY); Raritan R., New Brunswick, *Mackenzie* (NY); Rockaway, *Mackenzie* (NY, S); Stillwater, *Mackenzie* (NY); Clifton, *Nash 1* (NY); Morris Co., *Rusby* (MO); Sussex Co., *Rusby* (BRU); Budd's L., Sussex Co., *Small* (C, F); Pensauken Cr., *Trudell* (NY); Foul Rift, *Van Pelt* (PH); Cooper's Ferry, opp. Kensington, without collector (PH). PENNSYLVANIA: Ingham Sprs., Bucks Co., *Bassett* (S); W. Chester, *W. D[arlington]* (K, LD); Peach Bottom, *Eby* (MO); Sellersville, *Fretz* (UC); without locality, Herb. *Guthnik* (BERN); Flinton, *Jennings* (CU, MO); Churchtown, *Long* (PH); Bloomsburg, *Meredith* (PH); Bethlehem, *Moser* (L, NY); Lancaster, *Mühlenberg* (M); without locality, *Mühlenberg* (S); Philadelphia, *Pickering* (PH); Erie, *Porter 91* (PH); Pot Rock, Easton, *Porter* (PH); Saucon Cr., Friedensville, *Pretz 4183* (PH); Allentown, *Pretz 4784* (PH); Cedar Cr., Griesemersville, *Pretz 6962* (PH); Centre Valley Sta., *Pretz 11212* (PH, WS); Juniata R., *Rothrock* (F); without locality, *L. B. de Schweinitz*, in part (BR); Bethlehem, *Schweinitz*, in part (PH); Harrisburg, *Small* (F); Telford, *Strohm* (PH); Bethlehem, without collector, in part (BR). DELAWARE: Delaware City, *Commons* (GH, PH); Wilmington, *Tatnall* (MO). MARYLAND: Susquehannah, Herb. *Buckley* (MO); C. & P. Canal, near Lock 12, *Killip 32129* (P); Ipesutic I., *J. D. Smith* (US). DISTRICT OF COLUMBIA: Rob's Pt., Potomac R., *Coville 120* (US); Washington, *Vasey* (US), *Ward* (US). WEST VIRGINIA: Booth Cr., Uffington, Monongalia Co., *Davis 205* (NCU); Kanawha Co., *Holton* (F); Wallace Switch, *Small* (NY). VIRGINIA: without locality, *Beyrich* (B); Big Walker Cr., Poplar Hill, Giles Co., *Kral 13971*

(FSU); V. P. I. grounds, Montgomery Co., *Massey* (NCU); Hunting Cr., *McAtee 2281* (US); Waynesborough, *Murrill* (NY); Four-Mile Run, *Shull 467* (US); New R., Goodwin Ferry, *Thorne 17862* (FSU); Four Mile Run, near Alexandria, *Tidestrom 94* (P); The Dyke, Potomac R., *Tidestrom 7185* (US). NORTH CAROLINA: shallow pond, Perquimans Co., 1932, *Glasson* (DUKE); University L., Chapel Hill, *Hueske* (NCU); Snyder's L., Blowing Rock, Watauga Co., *Radford 4950* (NCU); pools, State Fish Hatchery, Marion, McDowell Co., *Radford 5279* (NCU). MICHIGAN: Detroit, *Bigelow* (MO); R. Rosin, Monroe, *Chandler* (US); Wolf L., *Chase 1711* (US); Arenac Co., *Dodge* (US); Black R. near Black L., Cheboygan Co. *Ehlers 5902* (S); Ocquecoc L., Presque Isle Co., *Ehlers 6256* (S); Douglas L., Cheboygan Co., *Ehlers 6280* (S); Hook Pt., Mich. Biol. Sta., Cheboygan Co., *Gates 14143* (S); Douglas L., *F. C. & M. T. Gates 10592* (F, MO); Sault St. Marie, *Gillman* (GH); Fort Gratiot, *Gillman* (GH); Sailor's Encampment, *E. T. & S. A. Harper* (B); Liver-Light Lakes, *Metcalf 2222* (C, CP); Manistee, *Morong* (GH, NY); Kewenah Pt., L. Superior, *Robbins;* Whitmore L., *Stearns 305* (C, CP, G, GH, K, LD, NCSC, NY, O, ZT); Reed's L., Grand Rapids, *C. F. Wheeler 7663* (CS); Swan Cr., Old Fort, *Wight 41* (US); Lower Scott L., Lee, *Wight 73* (US); Ann Arbor, *Winchell 7760* (MO); Sault Ste. Marie, no collector (PH). OHIO: Cincinnati, *J. Clark* (BM); unio itiner., *Frank* (G, K, P); Clear Cr., Hamilton Co., *J. F. James* (DS, US); Sandusky, *Moseley* (F), *R. C. O. & E. B. W.* (Deam Herb.); Put-in-Bay, *Pieters* (US); East Harbor, *Pieters* (US); Braceville, *A. N. Reed & Webb 929* (GH); without locality, *J. L. R.* (P); Newark, *E. B. Williamson* (Deam Herb.). INDIANA: Wolf L., *Chase 1711* (C, F, MO, O); L. Maxinkuckee, *H. W. Clark 1* (US), *1593* (US); Rochester, *Deam 11765* (Deam Herb.); L. James, Steuben Co., *Deam 20245* (Deam Herb.); Princeton, *Deam 25520* (Deam Herb.); Pendleton, *Deam 25599* (Deam Herb.); Deshee R., Decker, *Deam 29224* (Deam Herb.); Waldron, *Deam 30087* (Deam Herb.); Knox, *Deam 42177* (Deam Herb.); Harrison, *Deam* (Deam Herb.); L. Maxinkuckee, *Evermann 1070* (US); 5-Mile Pond, Terre Haute, *Evermann* (F, US): Wolf L., *Greenman* (MO); Tippecanoe R., Talma, Fulton Co., *N. C. Henderson 61-471* (FSU); Bedford, *Kriebel 3479* (GH); E. Chicago, *Lansing 1767* (F); L. Maxinkuckee, *Scovell & H. W. Clark 1070* (DS, F); Mishawaka, *E. B. U.* (F); Whitings, no collector (PH). KENTUCKY: Reelfoot L., *Alexander 323* (US); Kentucky R., *Peter* (PH); without locality, Herb. *C. W. Short.* ALABAMA: Lightsey's Pond, Centerville, *R. M. Harper 3287* (NY, PH, US). WISCONSIN: Lauderdale, *R. Bebb 1531* (F); Prairie du Chien, *Fassett 5049* (Glück Herb., Heidelberg); Kawaquesagon, Minocqua, *Fassett 5328* (Glück. Herb.); Beloit, *Fassett 5691* (Glück Herb.); St. Croix Falls, *Fassett 7378, 7379* (WIS); Nemakagon R., Cable, *Fassett 7380* (WIS); L. Wiehe, Eliot, *Fassett 7381* (WIS); Tomahawk R., *Fassett* (Glück Herb.); Trempealeau, *Fassett & Wilson 5050, 5051*

(Glück Herb.); Bear L., Barron Co., *Goessl 6907* (B); Nobleton, Washburn Co., *Goessl 7471* (B); Cameron, Barron Co., *Goessl 8785* (B); Milwaukee, *Hasse 2531* (PH); Whitewater, *Kleeberger* (CAS); without locality, *Lapham* (MO); Prairie du Chien, *H. H. Smith 7422* (B). ILLINOIS: Mound Cr., Ogle Co., *M. S. Bebb* (PH); Ogle Co., *Bebb* (F); Peoria, *Brendel* (P); "Canes," *De Selm 717* (F); Grass L., Lake Co., *Gates 1758.4* (Deam Herb.); Oregon, *Waite* (US). MINNESOTA: Prior's L., Scott Co., *Ballard* (NY); Clearwater Co., *Buell 1650* (NCSC); E. Twin Pond, Itasca Park, Clearwater Co., *Buell 1651* (NCSC); Ft. Snelling, *Campbell* (F, MO); L. Winona, *Holzinger* (NY, US); L. of the Woods, *MacMillan & Sheldon 572* (CU, GH), *3334* (NY); Ft. Snelling, *Mearns 804* (US); Squaw L., Cass Co., *Metcalf 2364* (GH); N. W. Territory, *Nicollet 415* (PH); Thompson, *Sandberg 563* (WS); Hennepin Co., *Sandberg* (F, UC, US); Center City, *B. C. Taylor* (O). IOWA: Fayette Co., *Fink 552* (US); Spirit L., Dickinson Co., *Anderson* (C, G, GH, L, LD, NCSC, S, W); Clinton Co., *Butler 27* (MO, P); Des Moines R., Emmet Co., *Cratty* (NY); L. Okoboji, *Wolden* (GB); Pilot Knob State Park, Hancock Co., *Thorne 14595* (NCSC); Cheever L., Estherville, Emmet Co., *Thorne* (NCSC); E. Okoboji L., Dickinson Co., *Wylie*, type of *E. iowensis* Wylie (GH, NY). MISSOURI: Neosho, *Bush* (MO); St. Louis, *Engelmann* (NY); Phillips Spr., Van Buren Co., *Redfearn 5742* (FSU); Mill Spr., Wayne Co., *Russell: Trelease* (MO). ARKANSAS: Mammoth Spr., *Trelease* (MO). NORTH DAKOTA: L. Metigoshe, *(C. E.) Lee* (RM); Minot, *Lunell* (Deam Herb., DS, NY, RM, US); Jim L., Pingree, *Mabbott 321* (US); Fargo, *Waldron* (MO). NEBRASKA: Loup Fork, *Hayden 1553, 1554* (MO); without locality, *Hayden* (NY); Jackson L., N. Platte, *Kiener 17514* (G); Kingsley Dam, Keith Co., *Kiener 15537* (G); Fremont, *Williams 373* (US). MONTANA: Lindberg L., Swan R., Missoula Co., *C. L. Hitchcock & Muhlick 13712* (S); S. Pablo Reservoir, Lake Co., *Hotchkiss 6349* (US). IDAHO: L. Pend d'Oreille, *Leiberg 9* (C). WYOMING: Fish Hatchery, *Nelson 1429* (RM), *5374* (BM, GH, MO, NY, RM, US). COLORADO: Alamosa, *Biltmore Herb. 105a*, Colo. Exped. *1-897* (US); Rio Grande, Alamosa, *Shear 3746* (NY). UTAH: Panguitch L., *Jones 6018* (US); Fish L., *Locke 4* (US). NEVADA: (formerly in Utah), Carson R., Ragtown, *Remy* (B, P). WASHINGTON: Seattle, *Bardell* (MO); Green L., Seattle, *Congdon* (MO); Seattle, *Eyerdam* (G); Clover Cr., Pierce Co., *Eyerdam 1221* (G, S); 98th st., (Seattle), *Eyerdam 6627* (G); Lake Chelan, *Gorman* (US, WS); Green L., Seattle, *Piper* (WS); Fish L., Spokane Co., *Preston 860* (WS); Little Spokane R., Dartford, *St. John 3438* (DS, K, WS), *St. John & Warren 3423* (WS); Falcon Valley, *Suksdorf 87* (O); Calispell L., Pend Oreille Co., *Yocom* (W); Seattle, *Zeller* (MO). OREGON: Harriman Lodge Sta., *Abrams 9719* (DS, MO); Crater L., *Coombs* (CAS); Sprague R., Bly, *Coville & Leiberg 318* (US); DesChutes R., Bend, *Peck 4250* in part (W, WS). CALIFORNIA: Big Meadows, *Austin 573* (MO, US); Feather R., *Austin 1179* (US); Plumas Co., *Austin* (NY);

Egg L., *Baker* (UC); Sisson, *Eastwood 1268* (CAS); Folsum, Sacramento Co., *Johannsen 652* (FSU); Mt. Eady, *Krautter* (BM); Sisson, *Krautter* (K); Walker Cr., Klamath R., Siskiyou Co., *Lee 1239* (G, K); San Dimas Canyon, San Gabriel Mts., "of very doubtful indigeniety," *L. Wheeler 2325* (DS, CAS, LD); Mendocino Co., *Vasey* (US).

Discussion: Caspary in his treatment of the Hydrilleen (1858) included a detailed monograph of *Elodea,* in which he accepted 10 species. He treated *E. canadensis* Rich. in Michx. in great detail. It is noted that he describes plants with a floral morphology quite different from those of the present concept. In *E. canadensis* he included plants that were hermaphroditic, others dioecious, others polygamous (fide Torrey, and fide Gray). His "hermaphroditic" plants were Michaux's type specimens of *E. canadensis* (hermaphroditic fide Rich. in Michx.); and Moser's and Schweinitz's collections from Bethlehem, Pa. which are the true *E. Schweinitzii* and are genuinely hermaphroditic. His dioecious plants were *E. Nuttallii,* and *Anacharis Alsinastrum* which was based on pistillate plants of *E. canadensis* when established in England, and *Udora occidentalis* (Pursh) Koch, in part, which is a synonym of *E. canadensis.* In addition Caspary accepted as a species *E. Planchonii* Casp. which is merely the staminate plant of *E. canadensis.* He also made and accepted *E. latifolia,* based on broad leaved, sterile material of *E. canadensis.* He accepted *E. Schweinitzii* (Planch.) Casp., though he had some doubt about it. He had seen the holotype but its flowers were mutilated and he could not confirm its characters, so he accepted it, with confidence in the description by Planchon. However, he cited four good specimens of this species as hermaphroditic specimens of *E. canadensis.* In sum, Caspary did not have a good understanding of *E. canadensis,* as he made three species out of it, while reducing to the synonymy of *E. canadensis* itself two other excellent species. *E. guyannensis* Rich. was maintained by Caspary, though there are no actual differences to separate it from the earlier *E. granatensis* Humb. & Bonpl.

The floral morphology of *Elodea canadensis* is in need of discussion, as it has often been misinterpreted. In the original diagnosis of the monotypic genus Richard in Michaux included among other details, the following: that the three stamens, with thick filaments, bore terminal, cordate anthers. In part 1 of this monograph (1962: 34-36) it is shown that of the existing 8 good, open flowers on the holotypic sheets in Paris and the isotypic sheet in Geneva, all are pistillate, with 3 acicular staminodia, all without anthers. The type locality was "in rivulis Canadae," and the label adds, "environs de Montreal." The species still grows commonly there, and the pistillate plants from the type locality have subsequently been described in detail by Victorin (1931: 15-19). Their pistillate flowers are identical in structure with those of the holotype collection, and with all other normal flowers of all other collections of wild, indigenous specimens from Canada and the United States. Their flowers are dioecious, as the functionally pistillate ones have 3 bifid stigmas and 3 acicular staminodia, but no anthers. These pistillate plants were the kind that in 1836 escaped from cultivation in Ireland, and with remarkable rapidity spread to aquatic habitats of most of Europe.

Rydberg (1908: 458-459) stated that "Caspary, who saw the original Michauxian material at Paris, stated that the two flowers found there were hermaphrodite as described." The present writer in 1935 found Michaux's holotype in Paris to consist of five sheets, and in Geneva one isotypic sheet, the holotype with a total of eight good flowers, but none of them with anthers. Caspary (1858: 462) stated that he examined two of Michaux's specimens. For one he quoted from the label, "Triandr.;" for the other he said, "mit schlechter blüthe." So, Rydberg notwithstanding, Caspary did not say that he saw two flowers of the type material and that they were hermaphrodite. It is clear that the existing abundant holotypic material has only pistillate flowers with 3 staminodia.

The staminate plants and flowers of this species were not at first recognized as of the species *Elodea canadensis*. They were described as *E. Planchonii* Casp. (1857: 47), based upon "Suskatschawan, *Drummondio;* Canada, *Cleghornio.*" The former specimen, Saskatchewan, *Drummond* (K), which has good staminate flowers, is here chosen as lectotype. These staminate flowers are strikingly different from the pistillate flowers, but are produced from the same sort of spathe which has a peduncle-like base and a bidentate ellipsoid apex. The sepals are larger, 3.5-5 mm. long; so also are the petals, being 5 mm. long. The 9 stamens consist of 6 lower outer ones and 3 inner ones raised on a common stalk. On the holotype and on most of the staminate plants the leaves of successive nodes are more widely spaced, narrower, and thinner, than on the pistillate plants of *E. canadensis.* Since their description as *E. Planchonii* in 1857, these staminate plants have by most botanists been accepted as a distinct species, but by a few as a variety, *Anacharis canadensis* var. *Planchonii* (Casp.) Victorin.

The first good evidence that *Elodea Planchonii* really represented only the staminate plants of *E. canadensis* came from the studies of Wiegand and Eames (1926: 55). They reported that these staminate plants grew together with the pistillate *E. canadensis* and they classed them as the two sexes of a single species. Several of their collections of flowering staminate plants had broad, firm, imbricate leaves, indistinguishable from those of genuine, pistillate *E. canadensis.*

The collection from New Jersey, Morris Co., July 1879, H. H. Rusby, has the leaves as narrow as in *Elodea linearis,* but the staminate flowers as in *E. Planchonii.* The specimen from Quebec, Longueuil, Aout 1920, *Marie-Victorin 11256* (US); and that from North Dakota, Jim Lake, Pingree, Aug. 14, 1917, *D. C. Mabbott 321* (US) have the typical staminate flowers but the leaves as short and broad and imbricate as in the pistillate *E. canadensis.*

In 1926 to confirm the observations of Wiegand and Eames, the writer followed Dr. W. C. Muenscher, and at Ithaca, New York, waded in the estuary of a stream flowing into the south end of Cayuga Lake. There, flowering pistillate *E. canadensis* and flowering staminate *E. Planchonii* were growing in 3-4 feet of water in both adjacent and intermingling luxuriant colonies. At first glance they seemed different in herbage. That is, of course, to be expected between plants of different species, but it is also possible between the two sexes of a dioecious species. An extended survey in this large colony showed that besides the different looking plants, there were also plants with intermediate and ones with identical foliage characters. We agreed that there were no constant differences or usable distinctions in the foliage of the male and the female plants.

Though the male flowers are much the more conspicuous, they have seldom been collected. However, their total range in North America falls within that of *Elodea canadensis,* and at almost every locality for the staminate, the pistillate is also known to occur. From these considerations it seems clear that the staminate *E. Planchonii* is not a distinct taxon, but is merely the staminate sex of the wide ranging *E. canadensis.*

Staminate plants of *Elodea canadensis* have rarely been found in Europe. A second botanical collector with the famous name D. Douglas found and published (1880: 227-229) on the occurrence of these plants at the Braid Hills, Edinburgh, Scotland. In the Kew herbarium there are three of his sheets from the above locality, collected in Aug. 1881. They are vigorous shoots with oblong leaves 4-5 mm. wide, and with normal, 9-anthered staminate flowers. No later collections of this plant have been seen or reported. It did not rapidly spread over Europe, instead it apparently died out. There seems to be no documentary evidence of its advent in Scotland. It may have been privately imported from North America by some individual for aquarium culture. Then it may have been wholly or in part discarded by a stream or pond, where it then became established.

The other possible origin of these staminate plants in Scotland is that a flowering pistillate plant may have set some parthenogenetic seed. Some of these seeds could have grown into staminate plants. If this happened, it has been a rare occurrence. The other possible method of advent, the direct importation of staminate plants, seems the more probable explanation of its occurrence in Scotland.

The description of the fruit given by Victorin (1931: 19) is rather different from the writer's. His description when translated is, "capsules 10-15 mm. long, ovoid, acuminate and with a persistent style; seeds 1-2, rarely more, lance-ovoid." It would seem that he included the style when measuring the capsule. The details and measurements here presented by the writer came from study of a specimen from North Dakota, Lake Metigoshe, July 9, 1891, *Lee* (RM).

In the southeastern states of the U. S. A., *Elodea canadensis* has been considered absent. Here is accepted as that species a sterile collection from Centerville, Alabama, *Harper 3287*. The leaves are broad and imbricate, and so typical that no hesitation is felt in accepting this record. In the Kew herbarium there is another specimen labeled Alabama, Schweinitz. He was a Pennsylvanian botanist who collected intensively around Bethlehem, Pa., but is not known to have collected in Alabama. The flowers are small and resemble those of *E. canadensis*, but the herbage looks like that of *E. Schweinitzii*, a species found only near Bethlehem, Pa. It seems best to leave this specimen undetermined and to question its locality.

Elodea canadensis has been recorded as occurring in Texas by Coulter (1894: 421); and as *Anacharis canadensis* by Cory and Parks (1937: 14). Having seen no specimens of this or other indigenous species from that state, inquiries were made. V. L. Cory replied on Dec. 16, 1940, "I regret to inform you that the inclusion of *Anacharis canadensis* in our Catalogue was apparently based on the report given in Coulter's Botany of Western Texas. As for myself, I have not seen this plant in Texas, nor have I seen any material of it collected by anyone else in this State." Prof. B. C. Tharp, curator of the herbarium of the University of Texas, replied on Jan. 14, 1941, that concerning, "specimens of *Elodea*, I regret to say that I do not find any specimens in the herbarium."

Recent collections in the herbarium of the Texas Agricultural and Mechanical College, from Brazos, Robertson, Hays, and Leon Counties prove to be not *Elodea*, but the introduced *Egeria densa*. Thus, it appears that no indigenous species of *Elodea* occur in Texas, or in South Carolina, Georgia, Florida, or Louisiana.

There is a collection of *Elodea canadensis* from Mexico. Its data is Morelia, Laguno, in aqua, 2,000 m. alt., 1.9.1911, *Arsène* (B). This locality is 130 miles slightly north of west of Mexico City, and is remote from the known range of the species. To an inquiry, Dr. F. Miranda of the Universidad Nacional Autónoma de México replied on 23 Nov. 1962, "No conazio ejemplares verdaderamente indígenas de ninguna especie de *Elodea* (o *Egeria*) en México. *Elodea densa* es frecuente en estanques de jardines públicos o cultivada en acuarios de esta ciudad." It can be safely concluded that the collection of *E. canadensis* from Morelia represents a plant cultivated or adventive in that area.

One other locality record needs discussion. In the Berlin herbarium there is a specimen of *E. canadensis* labeled as from Labrador. It was determined as *Anacharis Alsinastrum* which is a synonym of *E. canadensis*. It is marked "ex Mus. Parisiensis," but the bottom of the label is cut away so that the collector's name is shown only by the remaining tops of a few taller letters. Later the originals were found in the museum in Paris, three similar sheets of *E. canadensis*, and one of *E. Nuttallii*. They all have the printed label form: Amerique du Nord, M. Lamarre-Picquot, and on it in handwriting is the locality Labrador. He was sent in 1848 to North America to collect economic plants for the Ministère de l'Agriculture. From his report (1849) we learn his itinerary. He landed on the 24th of June 1848 at New York. He journeyed up the Hudson River to Lake Erie, Detroit, across Michigan, and Indiana to Chicago, Galena, Saint-Paul, Mendota at the junction of the R. Saint-Pierre with the R. Mississippi, to Lac-qui-Parle, Mendota, Saint-Paul, Buffalo, Erie Canal, Albany, and he sailed from New York on Oct. 3, 1848 to Europe. As edible plants he brought back to France *Psoralea esculenta* Pursh and *Apios americana* Medic. (*A. tuberosa*).

His specimens of *Elodea* are genuine, but his locality Labrador is incredible. On his voyage he nowhere approached Labrador. No species of *Elodea* is known within many hundreds of miles of Labrador. The present writer explored the full length of the southern coast of the Labrador Peninsula, and wrote his doctor's thesis on its flora. Others have explored the eastern and other sections of Labrador. This record of *Elodea* from that area is rejected as an undoubted error.

There is a specimen of *Elodea* from Nicolett's North-Western Expedition, ponds up Rivière aux Serpent near Oanus River, July 10, 1883, *Charles A. Geyer* (US), that was omitted in the enumeration of specimens. The plant is *E. canadensis*, but the locality is obscure to the writer and to the present staff of the Missouri Botanical Garden. However, Dr. J. M. Greenman noted on the sheet that it was "probably from Nebraska."

In the British Museum of Natural History is a specimen of *Elodea canadensis*, with the data: Hawaiian Ids., *Udora**, the asterisk indicating a new species, then follows a specific epithet meaning broad-leaved. The epithet is not quoted here, as this would constitute the publishing of a *nomen nudum*. The locality Wahoo is in T. Nuttall's writing, then in another hand is added, Herb. Nuttall. The label is like Nuttall's other labels for plants that he collected on Wahoo (Oahu I., Hawaiian Is.). A confusion is suspected here, since *Elodea* is not indigenous to the Hawaiian Islands, is not established there now, nor does it ever seem to have been. The sheet bears three small, but genuine, branches of *E. canadensis*, but the locality stated seems to be in error.

In 1836, *Elodea canadensis* was found introduced in Ireland, and in 1842 in Scotland, and in 1847 in England. It spread to continental Europe and soon became abundant and a pest in the watercourses of much of the continent. As the plants were pistillate only, its spread was due to vegetative fragmentation.

The species spreads rapidly by its own means, and man has doubtless been responsible for its arrival on distant continents or regions. It is now established in Europe, Asia, Africa, Australia, and New Zealand. From these areas it is abundantly represented in herbaria, but there seems no good reason for listing these records in this monograph. There is also a very extensive literature reporting its occurrence as an exotic in the above named areas. Also, there are many articles on its anatomy, cytology, genetics, and physiology, but they are not pertinent here.

J. K. Santos (1923, and 1924) published two studies upon the genus *Elodea,* issued as Contributions 302 and 317 of the Hull Botanical Laboratory. They are both largely cytological studies on the cell division in the formation of the pollen grains. However, being studies of the sexuality of *Elodea* plants, they touch in several places on the characters used by taxonomists for the differentiation of the species of this genus. In the first article Santos deals particularly with *E. gigantea* which he inadvertently published as a new species, *Elodea gigantea* Santos. Evidently this is a synonym of the cultivated *Egeria densa* Planch. He states (1923: 44) that *E. canadensis* "is strictly dioecious." His second paper deals principally with what he calls *E. canadensis.* His material came from Wolf Lake, Indiana. He again describes it as dioecious, saying (1924: 353), "both male and female plants are abundant." His papers do not record his means of determination of the species. By correspondence it is clear that Gray's Manual was the only source consulted. On page 85 of the 7th edition, this gives *Elodea canadensis* as the only species in northeastern North America. As synonymy it gives *Anacharis* Planch., and *Philotria* Britton. Britton & Brown's Illustrated Flora (ed. 1913) gives four species for the same area, and in the key leading to *Philotria* (*Elodea*) *canadensis* says "staminate flowers unknown." Also there are given references to the monographs by Planchon, Caspary, and Rydberg. Santos gives a bibliography of 36 titles in his first paper, and one of 53 in his second. In neither does he include any of these four monographs dealing with the classification of *Elodea,* or give any indication that he had consulted them. If he had, he could not have determined his plants all as *E. canadensis.*

No voucher specimens of the *Elodea* studied by Santos were preserved, which makes it more difficult to verify his determinations, but both *E. canadensis* and *E. Nuttallii* are known to occur in Wolf Lake, Indiana, the source of the specimens investigated by Santos.

In his final discussion of the determination of sex, Santos says (1924: 368) any experimental studies should be accompanied with a critical cytological investigation. The effect of the environmental condition should not be looked upon from the external character of the individual only, but also in its effect upon the structure of the cell. One apparently may get some changes in form, but in reality the changes may be produced by changes in the chromatin." On this the writer would comment, any such experimental study should be preceded by a critical and accurate identification of the species studied.

20. **Elodea linearis** (Rydb.) comb. nov. *Philotria linearis* Rydb., Bull. Torrey Bot. Club **35** (1908) 464; *Anacharis linearis* (Rydb.) Victorin, Contrib. Lab. Bot., Univ. Montréal **18** (1931) 41. Fig. 3 d-f, 5.

Diagnosis of Holotype: Submerged aquatic; stems slender, dicho- than 1 mm. wide, in whorls of 3, linear, acute, finely serrulate; tomously branched; middle and upper leaves 5-12 mm. long, less staminate spathes borne in the upper axils, about 1 cm. long, the lower half 3-5 mm. long, narrowed and peduncle-like, the upper inflated ovate or obovate, the apex like a gaping mouth, with 2 salient teeth 3-4 mm. long; staminate flowers peduncled by the slender, thread-like, elongating hypanthium; sepals 2.5-4 mm. long, 1.5-2 mm. broad, obovate, or oval, dark striate; petals 4.5 mm. long, 0.5 mm. broad, linear lanceolate, white and filmy; stamens 9 and equal, 2 mm. long, all attached at the summit of the hypanthium: anthers oblong; pistillate plants and flowers unknown.

Holotype: Tennessee, swamps bordering on Cumberland River, vicinity of Nashville, *A. Gattinger* (NY). Type examined! Isotypes (DS, MO, NY, US).

Discussion: Several of the characters mentioned by Dr. Rydberg in the original description do not hold after examination of the holotype and the isotypes. Instead of being entire, the leaves are finely serrulate as in the other species of this genus. The peduncle-like base of the spathe reaches 5 mm. in length. The inflated apex of the spathe is ovate

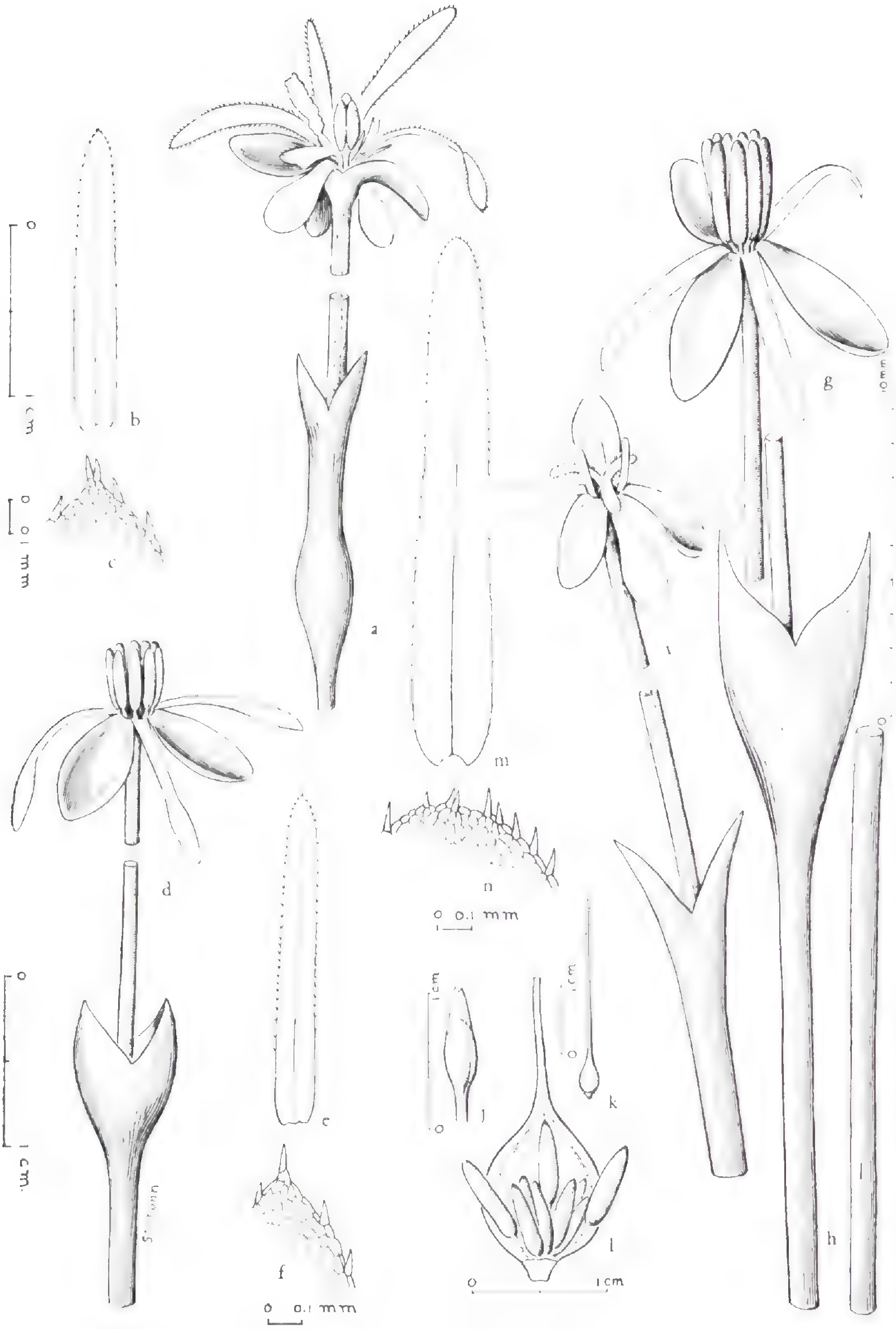

Fig. 3. *a, Elodea Schweinitzii* (Planch.) Casp., perfect flower, from holotype, × 5; *b,* leaf, × 5; *c,* leaf apex of same, × 50; *d, Elodea linearis* (Rydb.) St. John, staminate flower, from holotype × 5; *e,* leaf, × 5; *f,* leaf apex of same, × 50; *g, Elodea longivaginata* St. John, staminate flower, from C. S. Crandall 2,528, × 5; *h,* staminate spathe of same, × 5; *i,* pistillate flower of holotype, × 5; *j,* staminate bud, from Crandall 2,528; *k,* fruit, from Crandall & Cowen 6,720, × 1; *l,* opened capsule and seeds of same, × 2; *m,* leaf, from C. S. Crandall, 2,423, × 5; *n,* leaf apex of same, × 50.

when young, but appears obovate when mature and opened. The sepals reach 3 or 4 mm. in length. The petals instead of being oblong, are clawed and narrowly linear lanceolate. The specimen from Center City, Minnesota, 1892, B. C. Taylor, the writer considers to be *E. Nuttallii,* and not the pistillate plant of *E. linearis.*

Elodea linearis is a member of the section *Elodea.* In many ways it closely resembles staminate *E. canadensis,* but it differs in having the leaves less than 1 mm. wide, and in having the stamens equal in length and equally attached on the hypanthium; while the latter species has the leaves 1-4 mm. broad, and the 3 inner stamens raised on a joint stalk.

Here is presented a copy of a note on the specimen, Tennessee, Nashville, Sept. 1875, A Gattinger (NY). This is apparently the same collection as that distributed with a printed label and made the type of *P. linearis* Rydb. It has several staminate flowers still in the spathes, but more mature than those described by Rydberg. The 3 central anthers are slightly the longer, but attached as shown in our illustration. The flower examined had only one petal, it being short and bearing a single anther sac containing pollen, attached along one edge of the petal.

The following note is in a pocket on the sheet. It is in T. Morong's handwriting, but is evidently a copy of field observations, probably Gattinger's. "*Anacharis Canadensis* Planch. Male flowers apt. in the spathe, undeveloped. There seem to be about 9 stamens (as Wood says) which are contained in a hyaline sack, and this in a spathe; the spathe on a pedicel ¼′ or ½′ long, opening in a bifid mouth, and suffering the stamens with their sack to escape, when mature. These stamens rise to the surface, on which they float, and there fertilize the pistillate flowers, which rise to the surface on a long and very slender tube. The pistillate flowers are also furnished with stamens, and these in the time of maturity seem to have an abundance of pollen, as I have often seen when collecting the plant in August."

"Why Wood and Gray should both call these staminate flowers 'minute', I do not understand, as the sack is at least

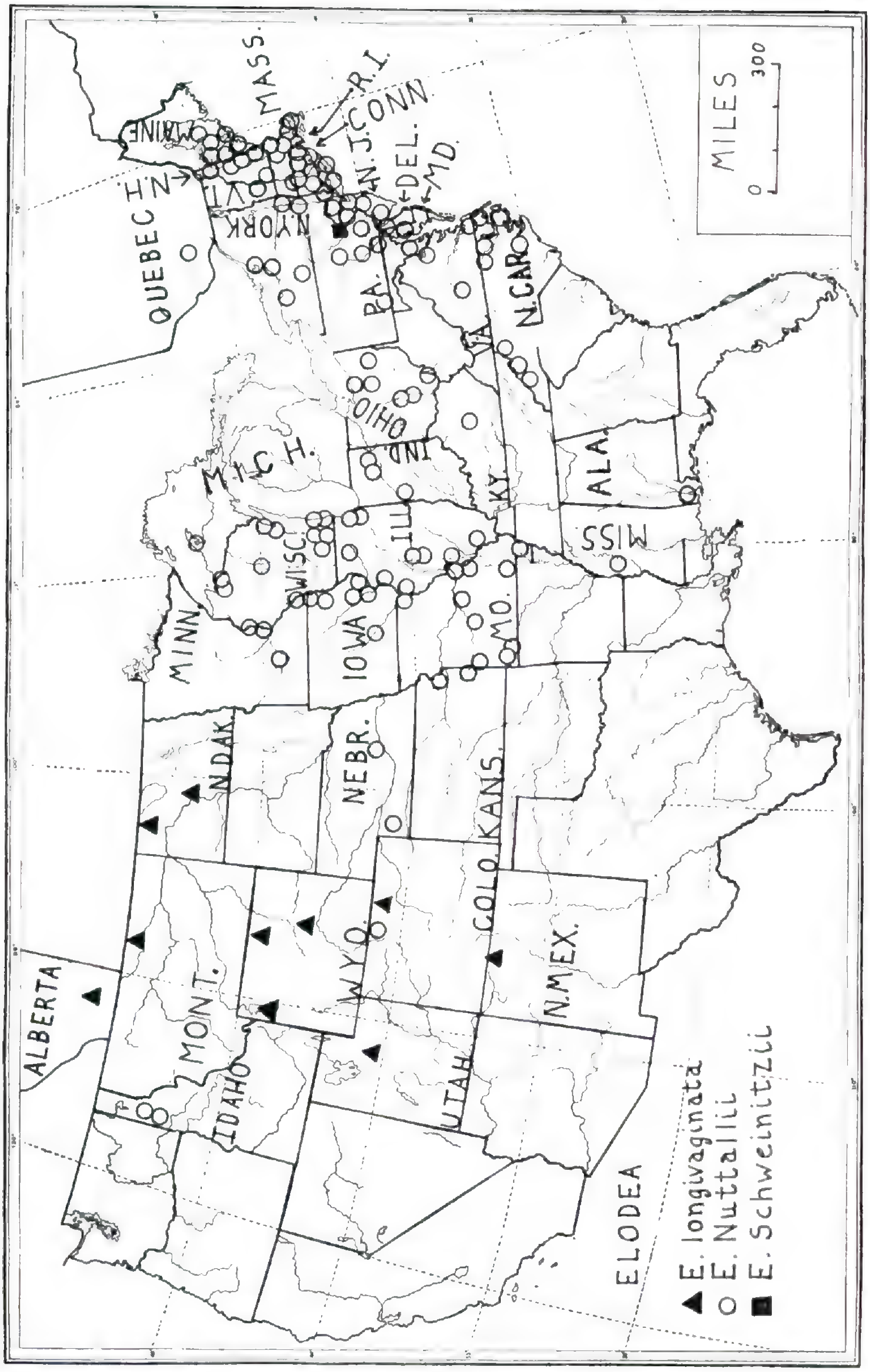

Fig. 4. Map of the distribution of *Elodea longivaginat* St. John; *E. Nuttallii* (Planch.) St. John; and *E. Schweinitzii* (Planch.) Casp.

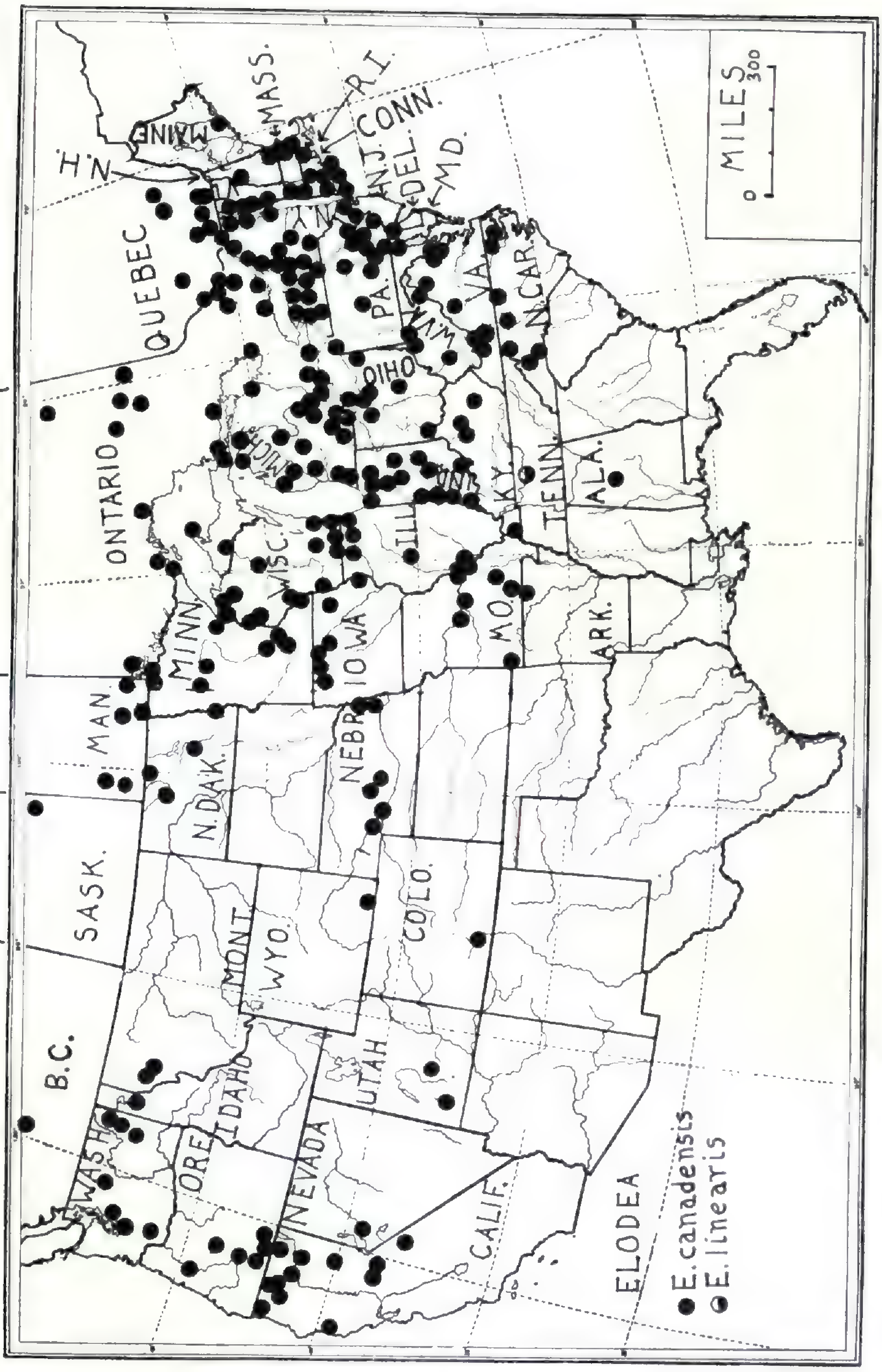

Fig. 5. Map of the distribution of *Elodea canadensis* Rich. in Michx.; and *E. linearis* (Rydb.) St. John.

1″ long & 1″ wide, & the spathe on a pedicel 3″ or 4″ lines long, fully as large as the fertile flowers."

"The staminate flowers seem to be without corolla, so far as I can make out. This does not appear to be the theory of the books, but from this specimen I judge it to be so."

These notes seem to contain partly material derived from the books by Wood, and by Gray, and partly actual field observations by Gattinger. Characteristics of more than one species are included. The sessile staminate flowers which are liberated and float to the surface are known only in *E. Nuttallii.* He recorded seeing perfect flowers, but none of his numerous specimens have any such, and no other species with bisexual flowers is known in the area.

21. (5 of part 1.) **Elodea longivaginata** St. John, Research Studies, Washington State Univ. **30** (1962) 38-40, fig. 2, e-j, 4, c-d, 5. Fig. 3 g-n, 4.

Description of all specimens examined: Submerged aquatic, rooting in the mud; stems elongate, slender, sparsely dichotomously branched; leaves opposite, linear, obtuse or acute, finely serrate near the tip, the middle and upper ones 5-24 mm. long, 0.5-2 mm. wide, bright green and flaccid, scarcely imbricate; apparently the lower leaves do not differ from the middle and upper ones, at least this is so down to the 21st. leafy node; staminate spathe 20-150 mm. long, ovoid, inflated near the tip, before opening with two small apical teeth, the inflated portion 8-10 mm. long, 2.5-4 mm. broad, finally with two large salient teeth at the open mouth-like apex; staminate flowers peduncled on the elongating, thread-like hypanthium which is up to 30 cm. in length; sepals 3.5-5 mm. long, 1.9-2.5 mm. wide, elliptic, dark-striate especially near the tip; petals 5 mm. long, 0.6 mm. wide, white, delicate, linear; stamens 9, all attached at the summit of the hypanthium, 3.1 mm. long, linear-cylindric; pistillate spathe 30-70 mm. long, linear-cylindric, slightly larger near the tip, the apex with 2 salient teeth, the base split by the ripening capsule; pistillate flowers stalked by the thread-like base of the hypanthium which elongates even to several decimeters, bearing the flower to the surface of the water; sepals 2.8 mm. long, 1.3 mm. wide, elliptic, dark-striate especially near the tip; petals 4 mm. long, 1.3 mm. wide, white, delicate, spatulate; staminodia 3, strap-shaped; style slender equaling the hypanthium; stigmas 3, oblong, undivided, only half the length of the sepals; ovary commonly setting fruit and becoming large and conspicuous, ovoid; capsule 10 mm. long, 3 mm. in diameter; seeds 6 mm. long, cylindric, surrounded by jelly, one attached on each parietal placenta, 6 attached basally.

CANADA. ALBERTA: in a lake at the northern edge of the Milk River Ridge, where the Lethbridge Trail leaves the summit, [holotype], July 20, 1895, *J. Macoun 13725* (CAN)!

UNITED STATES. NORTH DAKOTA: slough 7 miles e. of Bismarck, *Metcalf 358* (US); Ward L., Kenmare, Burke Co., *Metcalf 569* (CU). MONTANA: n. e. of Loring, Reservoir 158, Phillips Co., *Hotchkiss 6348* (US). WYOMING: Seven Mile L., Albany Co., *Gooding 597* (G, P); Teapot Dome, Reservoir, Casper, *Porter 6259* (UPS); L. De Smet, Johnson Co., *Porter 6285* (UPS); Two-Ocean L., Teton Co., *Porter 6365* (UPS). COLORADO: Lee's L., Fort Collins, 5,000 ft. alt., *Crandall & Cowen 6720* or *Crandall 6720* (CS); Lee's L., *Crandall 2528* in part (WS), *Crandall 2423* (B, CS, F, GH, LD, NY, P, PH, RM, US, WS); Fort Collins, *Cowen* (MO, UC); Lee's L., ex Herb. State Agric. Col. *2421* (NY, PH, US, WS). UTAH: drift, s. end, Strawberry Reservoir, Wasatch Co., *Hotchkiss 4933* (US). NEW MEXICO: L. La Jara, Jicarilla, Apache Reservation near Dulce, *Standley 8274* (US). Rocky Mts., 1868, *G. Vasey* (US).

(TO BE CONTINUED)

CORRECTION

In volume 65, p. 241 (1963) of Rhodora I reported *Habenaria conopsea* (L.) Benth. as having been collected by the late W. C. Coker in "Abisco," Labrador. Dr. A. E. Porsild has kindly called my attention to the geographical error of placing Abisko, Lapland in Labrador, and I have since learned from Dr. H. R. Totten that, in 1921, Dr. Coker was truly in Lapland. I must apologize for the bad labeling and my poor geography that resulted in this erroneous report. This species is now dubiously known from North America only in Connecticut.

D. S. CORRELL, TEXAS RESEARCH FOUNDATION, RENNER, TEXAS

A NEW SPECIES OF LAGENOPHORA (COMPOSITAE) FROM GUATEMALA[1]

JOHN H. BEAMAN AND D. C. D. DE JONG

Lagenophora cuchumatanica Beaman & De Jong, sp. nov.

Herba perennis humilis cum 1-4 caulibus adscendentibus vel decumbentibus usque ad 20 cm longis, usque ad capitula foliosis vel cum pedunculis usque ad 6.5 cm longis; folia basalia cum petiolis 0.7-3.3 cm longis, lamina ovata-elliptica ad orbiculata, margine crenato-dentata, ciliata; folia caulina media oblanceolata vel spatulata, pauci-serrata; folia caulina superiora oblanceolata, sessilia, margine 1-4-serrata, folia suprema subulata, integra; capitula parva, terminalia, solitaria; involucra campanulata, 4.0-5.0 mm alta, 6.0-7.0 mm lata; phyllaria 3-seriata, herbacea, oblongo-lanceolata ad anguste-lanceolata, apice ciliato-fimbriata; flores radii 10-20, 1-seriata, ligula reflexa, viridi-alba, 2.0-2.2 mm longis, apice 2-dentata vel 3-denticulata; flores disci 8-14, corollae viridi-flavae cum lobis patentibus circa 0.7 mm longis; achaenia radii et disci obovata, 3.2-4.0 mm longa, 1.0-1.5 mm lata, glabra, brunnea, margine crassi-nervata, apice annulari glanduloso; pappus nullus.

Low perennial herb from a short, erect or oblique rhizome with fibrous lateral roots; stems 1-4, simple, to 20 cm long, rarely longer, ascending but more commonly decumbent, green to reddish, grooved, flattened or subterete, pilose with short to long, spreading to appressed often purple-based multicellular hairs, leafy throughout or with peduncles gradually elongating in age to 6.5 cm, rarely longer, the summits of the stems somewhat enlarged and densely pubescent below the heads; basal and cauline leaves pubescent with multicellular hairs, the margins ciliate and faintly revolute; basal leaves few (less than 10), the petioles 0.7-3.3 cm long, densely pilose with spreading hairs, less so toward the sheathing base, the lamina ovate-elliptic to orbicular, 0.9-1.8 cm long, 0.7-1.4 cm wide, the margins crenate-dentate with 3-5 pairs of teeth with callous-tipped apices, pubescent below with appressed to spreading hairs, minutely white-dotted and glabrate to appressed-pubescent above with scattered hairs often in rows near and paralleling the margins; lower cauline leaves similar, smaller, soon shriveling; middle and upper cauline leaves sparsely appressed-pubescent below, glabrate above, minutely white-dotted only toward the apex; middle cauline leaves oblanceolate to spatulate,

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[1]Supported by grants G-9045 and G-23187 from the National Science Foundation. We are indebted to Dr. Mladen Kabalin, Michigan State University Science Librarian, for editing the Latin diagnosis. The U. S. National Herbarium loaned an isotype of *Lagenophora andina* Badillo for comparison with the new species.

serrate with a few callous-tipped teeth; upper cauline leaves oblanceolate with broad, sessile bases and margins with 1-4 small teeth, the uppermost subulate, entire; heads terminal, solitary, rarely more than 1 per stem, often subtended by a single phyllary-like bract; involucre campanulate, 4.0-5.0 mm high, 6.0-7.0 mm wide; phyllaries imbricated in about 3 series, distinct to the base, essentially herbaceous but with very narrow scarious margins and prominent midribs, often carinate near the base, shiny, glabrate to sparsely pilose on the back, the margins sparsely long-ciliate toward the base, the apices ciliate-fringed with often purple, sometimes sub-glandular hairs; outer phyllaries lance-oblong, 3.0-3.8 mm long, about 0.6-0.7 mm wide, minutely white-dotted near the obtuse apex, the middle phyllaries similar in outline and texture, 3.5-4.2 mm long, about 0.9 mm wide, the inner phyllaries thin, narrowly lanceolate, acute, about as long as the outer; receptacle 1.5-2.0 mm across, somewhat concave, naked, with whitish achenial attachment points; ray florets 10-20, pistillate, in one series, the tube ca. 0.1 mm long, its abaxial surface with short, thick glands, the ligule reflexed, 2.0-2.2 mm long, with 2-dentate or 3-denticulate apex, greenish-white, turning purple in age; disk florets 8-14, perfect, the limb greenish-yellow, campanulate, 1.9-2.4 mm long, 5-lobed with spreading, apically thickened lobes ca. 0.7 mm long, turning purple in age; style branches of the disk about 0.6 mm long, pubescent on the outside with short, blunt collecting hairs, glabrous within, the ovate stylar appendages about as long as the stigmatic lines; stamens with minute, blunt apical appendages and rounded anther bases; achenes of disk and ray similar, obovate, those toward the periphery increasingly oblique, compressed, with thick-nerved margins, the faces with minute ridges near the base, shiny, glabrous. brown (greenish-purple when immature), 3.2-4.0 mm long, 1.0-1.5 mm wide, the apices produced into a sticky glandular ring, this 0.4 mm high in the ray, 0.2 mm high in the disk; pappus absent. Plate 1309.

GUATEMALA. HUEHUETENANGO: Sierra de los Cuchumatanes, between Chemal and Tojiah at Km 319.5 on Ruta Nacional 9 N, ca. 3,365 m alt, among low forbs in *Pinus rudis* forest, frequent in a local area, 29 July 1960, *Beaman 3756* (MSC 172203 holotype; F, GH, K, TEX, UC, US, isotypes); same locality as type, 26 Aug 1961, *De Jong 1145* (MSC); Sierra de los Cuchumatanes, between Km 322 and 323, Ruta Nacional 9 N, ca. 3,200 m alt, 27 Aug 1961, *De Jong 1147* (MSC). TOTONICAPAN: on the Tecum Uman Ridge at Km 154 on Ruta Nacional No. 1, ca. 20 km east of Totonicapan, ca. 3,340 m alt, in pine forest, 14 Aug 1960, *Beaman 4170* (MSC).

The genus *Lagenophora* includes upwards of 20 species distributed from Malaysia and the south Asian coast southward around the Pacific rim through Australia, Tasmania, and New Zealand into southern South America, the Antarctic Islands, and north into the high mountains of Venezuela and Central America. Three species also have been described from Hawaii. Discovery of a species in Guatemala extends the Central American range of the genus northward from Panama. South Pacific distribution patterns of this type have been recognized since Hooker's (1853) classical account of the relationships of the flora of New Zealand. Several of the genera noted by Hooker (eg. *Drimys*, *Colobanthus*, *Acaena*, and *Oreomyrrhis*) have ranges which closely parallel that of *Lagenophora*.

Members of the South Pacific element such as *Lagenophora* which range into tropical latitudes in the western hemisphere occur as isolated populations at high altitudes. In Central America their distribution always must have been discontinuous because the area has not been traversed by a high-mountain system in Cenozoic time (Schuchert, 1935). Long-distance dispersal seems to provide the most plausible explanation for the presence of *Lagenophora* in Guatemala (and probably also in Panama, Venezuela, and Hawaii). The sticky glandular achenial apices may have facilitated its dispersal. Although no data on the breeding system of *Lagenophora* are available, one might suspect self-compatibility on the basis of the inconspicuous heads and ray corollas (Plate 1309). If it is self-compatible, this could also be a key factor in its distribution. As Baker (1955) has noted, autogamy makes possible the establishment of a new population from a single propagule. A strong correlation between wide disjunction and self-compatibility has been demonstrated by Raven (1963) for amphitropical species. The distribution of other groups like *Lagenophora* which cross the tropics on high mountains similarly may be related to autogamy and long-distance dispersal.

The two mountains upon which *Lagenophora cuchumatanica* has been found have different geological histories. The Sierra de los Cuchumatanes is made up chiefly of limestones which Schuchert (1935) suggests are of Cretaceous age. The Tecum Uman Ridge is composed of Tertiary rhyolitic lava domes (Williams, 1960). Both areas are of

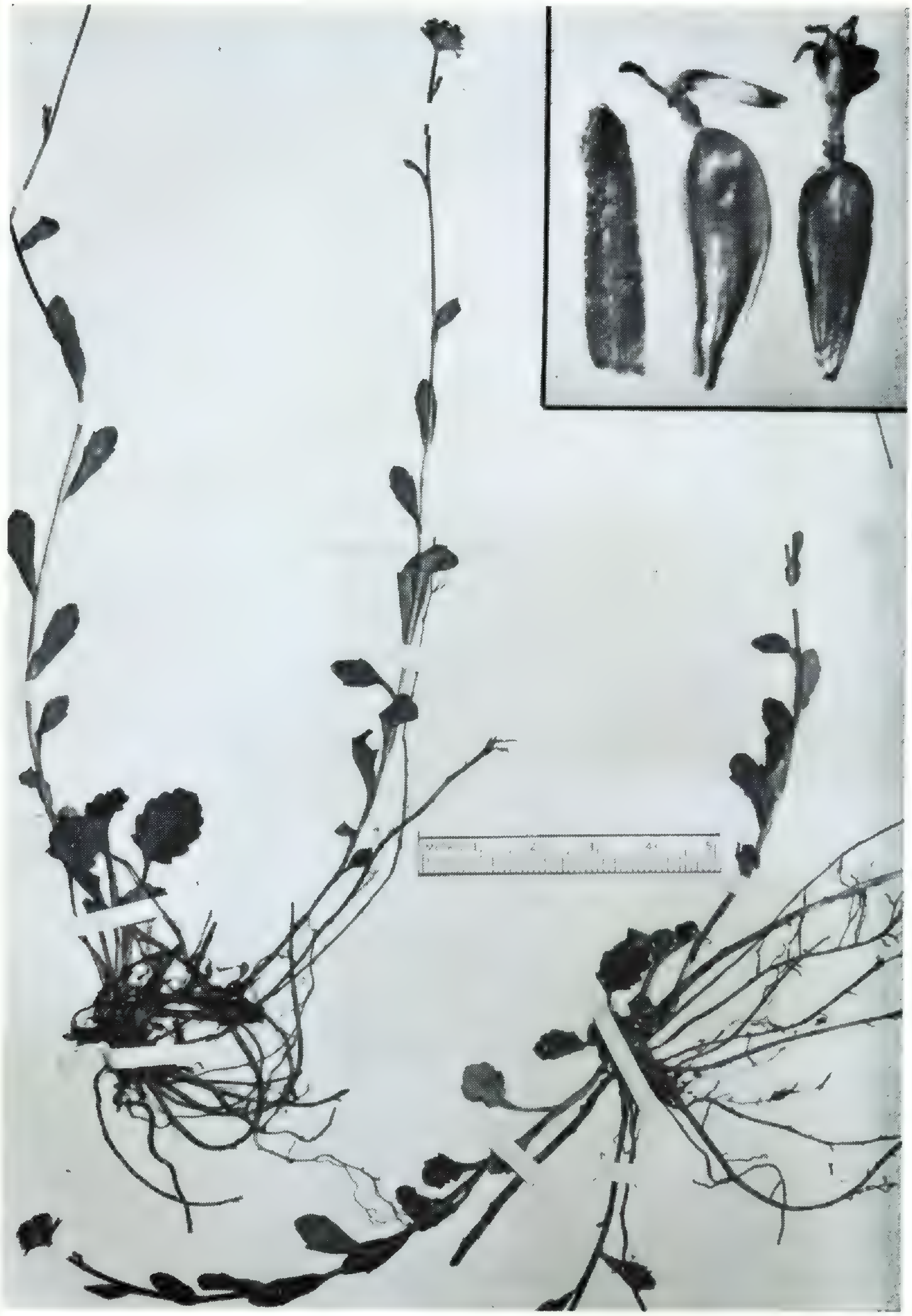

Plate 1309. Portion of the holotype of *Lagenophora cuchumatanica*. Insert, from left to right, shows outer phyllary, ray floret with reflexed ligule, and disk floret (× 8.3).

considerably greater geological age and have much richer high-altitude floras than the neighboring Quaternary volcanic cones. Although the geology differs, the habitats of the two populations are similar. Both localities are on nearly level terrain, in pine forests which are interspersed with large meadows (llanos), and have many other species in common.

Slight morphological differences are evident between specimens from the Sierra de los Cuchumatanes and the single plant *(Beaman 4170)* from the Tecum Uman Ridge. The middle cauline leaves of the latter are conspicuously spatulate with 4-5 marginal teeth whereas the Cuchumatanes specimens have oblanceolate middle cauline leaves with 3-4 teeth.

This species, *Lagenophora cuchumatanica,* is closely related to the Venezuelan *L. andina* Badillo. From Badillo's (1947) description and illustrations we thought that the two taxa might be conspecific, but an examination of isotype material of that species revealed several important differences which are summarized in Table I. These two species also are related to *L. panamensis* Blake, but the latter has a heavier caudex, more elongate basal and cauline leaves, larger heads, and more numerous rays. As noted by Blake (1939) *L. panamensis* seems to be closer to the Hawaiian *L. mauiensis* than to the southern South American species which are scapose or nearly so. The Central and northern South American species seem to have more characters in common among themselves than with other members of the genus.

The genus *Lagenophora* was included in the subtribe Bellidinae of the Astereae by Hoffmann (1894). In a reevaluation of this group, De Jong (1964) concludes that it is artificial and suggests that its members be assigned to other subtribes of the Astereae. He considers *Lagenophora,* along with the related *Myriactis, Rhynchospermum,* and *Solenogyne,* to belong to the Grangeinae.

DEPARTMENT OF BOTANY AND PLANT PATHOLOGY, MICHIGAN STATE UNIVERSITY, EAST LANSING
DEPARTMENT OF BOTANY, MIAMI UNIVERSITY, OXFORD, OHIO.

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Table I. Characters which distinguish *Lagenophora cuchumatanica* from *L. andina.*

L. cuchumatanica	*L. andina (Steyermark 57501,* US*)*
1. Basal leaves pilose below, glabrous above except for pilose rows near the margins.	1. Basal leaves hirsute above and below.
2. Basal leaves broadly ovate to orbicular, blades 1.2-1.5 cm long.	2. Basal leaves obovate, blades 2.0-3.0 cm long.
3. Cauline leaves, at least the lower, spatulate.	3. Cauline leaves oblanceolate to subspatulate.
4. Stems unbranched.	4. Stems with 1-2 lateral branches above.
5. Ray florets in 1 series, ca. 10-20.	5. Ray florets in 2 series, ca. 35-45.
6. Tube of the ray ca. 0.1 mm long.	6. Tube of the ray ca. 0.5 mm long.
7. Immature achenes (for comparison with *L. andina*) ca. 3 mm long.	7. Immature achenes ca. 2 mm long.

GENOTYPIC VARIATION IN THE PHACELIA HIRSUTA COMPLEX[1]

George W. Gillett

The *Phacelia hirsuta* complex is here defined to include *P. gilioides* Brand as well as *P. hirsuta* Nutt., and intermediate populations. Field and laboratory studies of these were carried out in conjunction with a biosystematic investigation of 10 species in the Cosmanthus group. The initial paper of this study (Gillett, in press) includes introductory comments and basic literature citations.

Both *Phacelia hirsuta* and *P. gilioides* are outcrossers and have 9 pairs of chromosomes. Experimental F_1 and F_2 hybrids have been produced. Each of these species is intersterile with the other 8 species of the Cosmanthus group. The *P. hirsuta* complex is separated from the other Cosmanthus phacelias by differences either in seed structure or in chromosome number (Gillett, op. cit.). The *P. hirsuta* complex has a distinct geographical status so that the combined genetical, cytological, morphological, and geographical information portrays this complex as a distinct evolutionary line.

The purpose of this paper is to show the variability of certain genotypic character differences between *Phacelia hirsuta* and *P. gilioides* and through these more clearly to portray their relationship.

These two species and their intergrades occur in an area extending nearly 700 miles north and south in the region between the eastern margin of the Great Plains and the Mississippi River. The more northern populations of central Missouri and southeastern Kansas are usually closer to the description of *P. gilioides*, while the southern populations usually fall within the circumscription of *P. hirsuta*. However, many populations in Arkansas, eastern Oklahoma, and southern Missouri cannot readily be assigned to either species.

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[1]Aided by a grant from the National Science Foundation.

Phacelia gilioides is usually found on sparsely vegetated habitats in clearings of deciduous forests and frequently occurs on rocky barrens or limestone outcrops. On the other hand, *P. hirsuta* is usually found in more densely vegetated habitats in close association with grasses and weeds on stony to fine-textured soils of woodland clearings and roadsides. However, populations of the complex occur on a broad spectrum of habitats between these weakly-defined extremes.

The two species differ by several flower characters including corolla shape and color. However, because of the desirability of using herbarium specimens for the study of variability, only those characters readily apparent in dried material were studied. Those selected were: 1) the margin of the corolla lobes; 2) the width of the sepals; and, 3) the orientation of the cauline hairs (spreading to appressed). These are illustrated in Fig. 1.

A useful summary comparison of *Phacelia gilioides* and *P. hirsuta* is given in the following table:

Phacelia gilioides	*Phacelia hirsuta*
Corolla tube rotate at anthesis.	Corolla tube open-campanulate at anthesis.
Tube with distinct to faint purple mark on each lateral vein, or marks lacking.	Tube with distinct purple mark on each lateral vein, or these merging across the mid-vein.
Petal margins fimbriate.	Petal margins entire.
Sepals from ½ to ¾ mm broad.	Sepals from ¾ to 2½ mm broad.
Appressed cauline hairs.	Spreading cauline hairs.

The variability in each of the last three characters of the above table was determined either by direct measurement or by comparison. Voucher specimens were prepared from the parents employed in crosses and from one of the experimental F_1 hybrids and were used for scoring herbarium specimens. Three classes of expression were recorded for each character and these were plotted on the distribution map of Fig. 2. The expressions classified for each character included the two extremes, each with a representation of near-extremes, and an intermediate generally comparable to the expression in F_1 hybrids, but including some near-

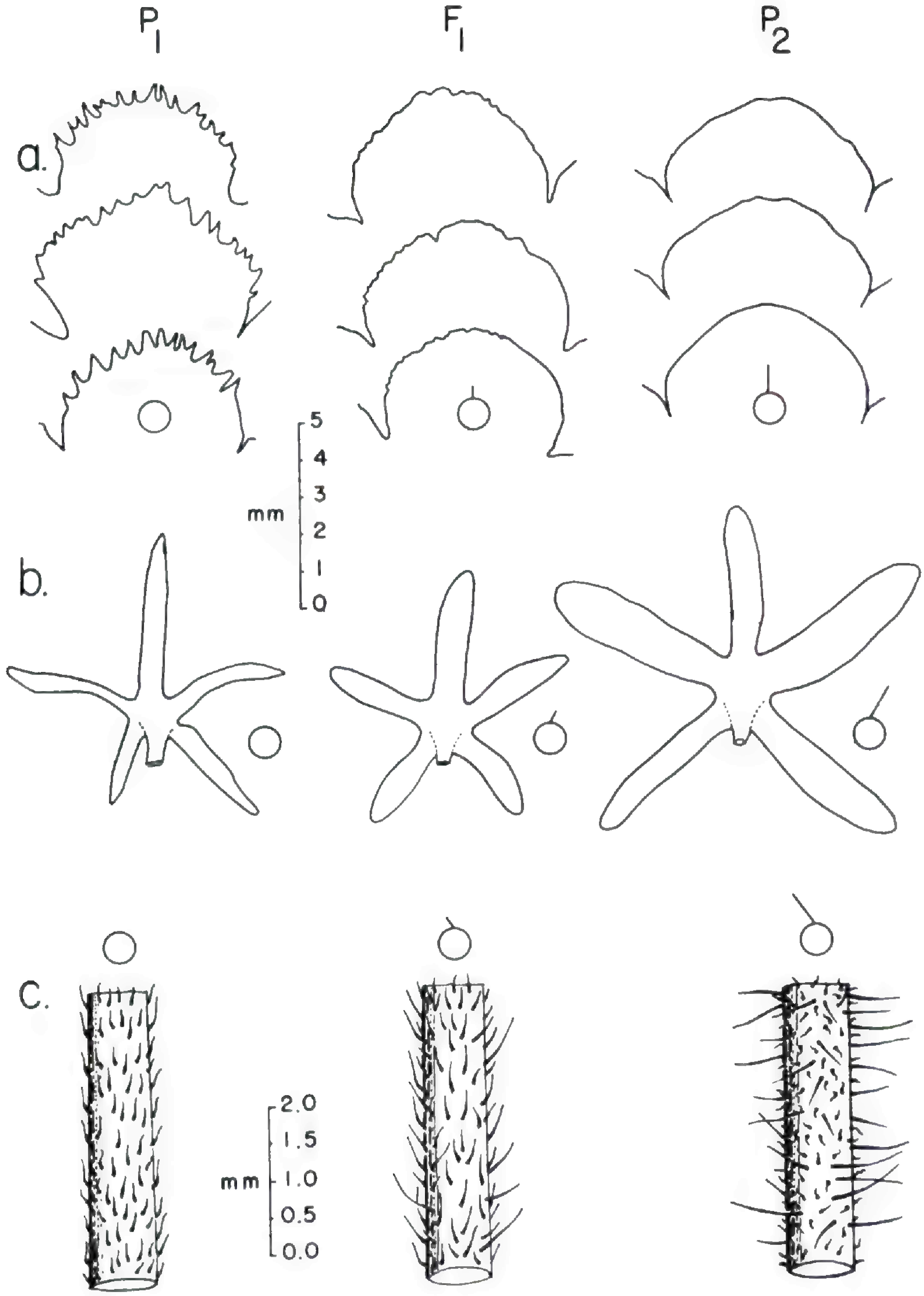

Fig. 1. Corolla margins (a), sepals (b), and cauline pubescence (c), expressed in *P. gilioides* (P_1), *Gillett 1260; P. hirsuta* (P_2), *Gillett 1215;* and experimental F_1 hybrid (center). Map symbols are below the corollas, to the right of the sepals, and above the stems.

intermediates on either side of this central expression. In other words, all three characters are metrical with several degrees of expression for each. These three categories are represented in map (Fig. 2) symbols as follows: the *Phacelia gilioides* extreme by the open circle; the intermediate category, similar to the expression in F_1 hybrids, by a line 1 mm long; and the *P. hirsuta* extreme by a line 2 mm long. The left-hand ray portrays cauline pubescence, the vertical ray corolla margin, and the right-hand ray sepal width. The three recognized classes of expression permitted a crude graphical portrayal of the variability for a particular character over the entire range of the complex. The scoring was accomplished by the procedures enumerated below.

COROLLA LOBES: This character was scored by direct comparison. The fimbriate margins with well-defined teeth characterize one extreme. This expression occurs in central and southeastern Missouri. The intermediate expression is found from the northern limit of the complex to northeastern Oklahoma and central Arkansas. The other extreme, the entire corolla margin, occurs in populations from southwestern Missouri to Texas and Louisiana.

SEPAL WIDTH: This character was measured by the ocular micrometer of a stereoscopic microscope. Normally, 11 sepals were measured on a given plant, these representing 5 mature flowers. The mean value was taken as the expression of central tendency. The narrow extreme (sepals .5 - .75 mm broad) is closely restricted to central and southeastern Missouri. However, the intermediate expression (sepals .75 - 1.00 mm broad) and the other extreme (sepals 1.0 - 2.5 mm broad) have remarkably wide distributions, each extending over almost the entire range of the complex.

CAULINE PUBESCENCE: This character was scored by direct comparison. The pubescence was recorded from the central axis of the plant, just below the mature inflorescence. One extreme is characterized by relatively short hairs that are abruptly bent at the base and have an appressed-ascending orientation with the stem. This expression is found in populations of central and southeastern Missouri, and in

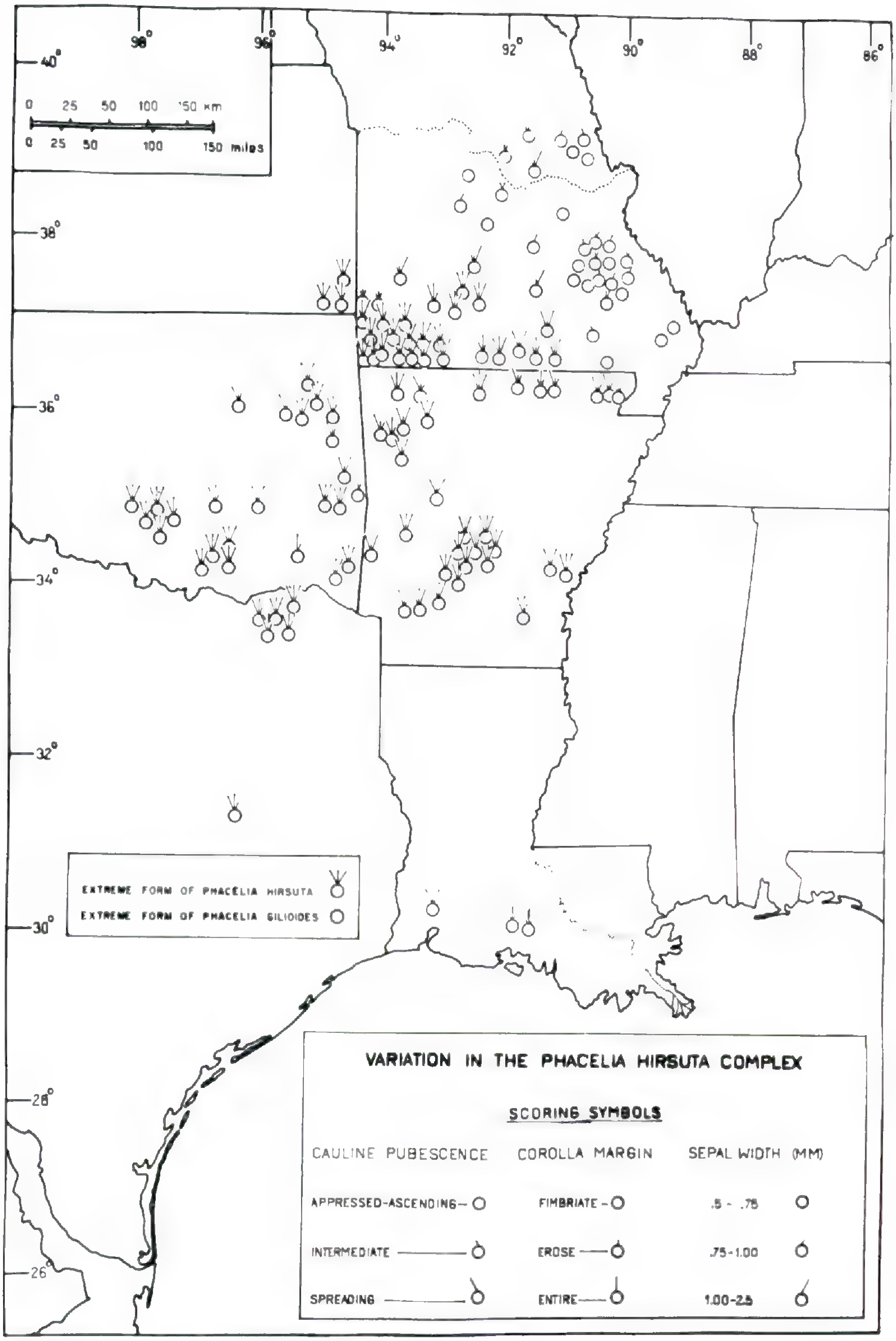

Fig. 2. Map showing distribution of variation in the *Phacelia hirsuta* complex.

isolated populations of eastern Oklahoma. The other extreme is typified by a pubescence of relatively long, spreading hairs and occurs in populations of south-central Missouri to Texas and Louisiana. However, the intermediate expression of cauline pubescence occurs in populations of central and southwestern Missouri, over a narrower range than either of the extremes.

The variation portrayed by this complex is suggestive of introgressive hybridization (Anderson, 1953; Stebbins, 1950), with the more northern *P. gilioides* and the southern *P. hirsuta* converging in southwestern Missouri and northern Arkansas, and subsequent bidirectional gene flow into both of the outbreeding parental stocks.

The variation outlined above is suggestive of that found in the *Phacelia sericea* complex (Gillett, 1961). In both cases it is impossible to make clear-cut taxonomic distinctions because of hybridization and the independent segregation of the genes that regulate character differences. The geographical variation in the *P. hirsuta* complex is so extensive that one feels obliged to recognize that the majority of populations of either species carry some genes of the other. It seems necessary, therefore, to distinguish these species in terms of relative differences imposed by relative gene frequencies rather than to take refuge behind the time-worn cliché "separated only with great difficulty" which implies that the taxa involved are indeed quite separable, but only with remarkable intuition. In this material it seems preferable to follow the suggestion of Dobzhansky (1951) and emphasize the geography of the genes rather than to impose a taxonomic distinction based on arbitrary judgment or hypothetical statistical differences, both of which tend to conceal the problem rather than to elucidate it.

DEPARTMENT OF BOTANY, UNIVERSITY OF HAWAII

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EULOPHIA ECRISTATA AND EPIDENDRUM CONOPSEUM IN MISSISSIPPI

According to the latest authority available to me (Native Orchids of North America North of Mexico, Donovan Stewart Correll, 1950) the present known range of *Eulophia ecristata* (Fernald) Ames is extremely disjunct with stations in North Carolina, Florida and Louisiana. I recall collecting it some fifteen years ago in Georgia. It was almost a certainty that sooner or later it would turn up in the intervening territory. This past summer while collecting in a low lying, grassy savanna within the western limits of the town of Picayune I found a small colony of three plants. Close associates were various species of *Panicum* and *Paspalum* while nearby were such genera as *Stokesia, Eupatorium, Gerardia, Chondrophora, Solidago*, and *Helianthus*. The *Eulophia* was in bloom on Aug. 21st. A few days later I found a single specimen about eight miles to the northwest in open, grassy pineland. A specimen has been deposited at the University of Mississippi.

Curiously enough almost the same pattern applies to the range of *Epidendrum conopseum* R. Br. This past winter I noticed its leaves about ten feet up on the trunk of *Nyssa* in a wooded overflow swamp two miles west of Picayune. About the middle of July, in company with Dr. Thomas M. Pullen, it was collected in flower.

F. H. SARGENT
PICAYUNE, MISSISSIPPI

DETERMINATION OF THE DEVELOPMENTAL PATTERN OF ANGIOSPERMOUS LEAVES[1]

EDWARD L. DAVIS

In studies on the development of fruits in curcubits, Sinnott (1936) has shown the consequence of differential growth rates in two dimensions on the ultimate fruit form. Where the relative rate of growth of width and length remains constant throughout maturation, but width is increasing more, or less, rapidly than length, there will be major differences between the form of small and large fruits. The resulting difference in ultimate form may serve to mask what is a high degree of genetic uniformity. Under these circumstances, a single variable, the duration of growth, can produce marked differences in appearance. Comparable conditions certainly operate in respect to leaf development (Hammond 1941, Stephens 1944, Whaley and Whaley 1942). In the taxonomic analysis of species populations of angiospermous plants collected over a wide geographical range, and under different conditions of photoperiod and growing season, there is a wealth of potential information to be obtained from the developmental pattern of leaves. Unfortunately, most methods of studying leaf development require extensive periodic measurements, or anatomical sections. In order to reduce the time required for accumulation of such growth information, we have been experimenting in our laboratory with 3-amino triazole as a rapid method of showing the developmental pattern of leaves. Three-amino triazole (3-AT) interferes with the synthesis of chlorophyll in leaves (Pyfrom et al. 1957, Jukes 1963) but not with pre-existing chlorophyll molecules, and as a consequence, marks newly developed parts of the leaf through the absence of chlorophyll. From the interpretation of leaves caught at various stages of development at the time of application of 3-AT, the pattern of development — basipetal, acropetal or diffuse, — can readily be deter-

[1]This research was supported, in part, by a grant from the National Science Foundation, NSF-GB1270.

mined. Moreover, by treating some leaves early in development, and others at later stages, it is possible to see the way in which leaf shape is changing, much more readily than through a comparison of unmarked leaves.

For many plants so far examined, an aqueous solution of 3-AT at concentrations of 0.13 grams per liter can be applied by spray or dropper directly to the apex of the plant without significantly altering the leaf size or form. The developmental pattern for a leaf of tomato, *Lycopersicon esculentum* Mill. variety Marglobe is shown in Fig. 1a. The pattern of development, which is basipetal both for the entire compound leaf, and for each lobe, is shown by the development of chlorophyll-free areas within the leaf. In a more detailed treatment of tomato, Breil (1963), Briel and Davis (1964) has shown that the pattern illustrated by 3-AT fits the developmental pattern as determined from anatomical studies and mitotic counts.

Daily measurement of growing leaves of plants of *Tiarella cordifolia* L., from New England and North Carolina, show the maximum length to maximum width ratio to remain almost constant at a value of 1 during the eight day period of principal leaf growth. During that period of growth, differences in leaf form, although minor, become accentuated. *Tiarella* plants from North Carolina show increased crenations on the leaf margin. Figure 1b shows a leaf in which 3-AT was applied early in development, and the effect on chlorophyll synthesis was wearing off in the final stages of leaf expansion. Consequently, chlorophyll appears only in the margin, which was the last part of the leaf to develop. Fig. 1c represents a drawing of a similar leaf, with the chlorophyll containing parts of the leaf in black. *Tiarella* plants from New England tend to stop expansion prior to this last phase of leaf growth, which occurs only in pockets at the margin of the leaf, and consequently show less pronounced crenations.

Equally as important as determining where leaf form does change during enlargement is establishing leaf characteristics which are constant throughout development. Figure 1d shows a photograph of a much dissected leaf of *Humulus*

PLATE 1310

Fig. 1. (a) Leaf of tomato treated with 3-AT; chlorophyll deficient areas at the base of lower lobes. (b) Treated leaf of *Tiarella*, chlorophyll containing areas at leaf margin. (c) Diagram of treated leaf of *Tiarella*, black areas corresponding to chlorophyll containing zones. (d) Treated leaf of *Humulus lupulus* from Rocky Mountains; central and right lobes showing normal growth; lateral lobes on left developed assymetrically and later than usual as indicated by absence of chlorophyll.

lupulus L. from the Rocky Mountains, treated with 3-AT at the mid-point in its development. The developmental sequence of the hop leaf is shown to be basipetal with the lobes maturing first, followed by the "palm" of the leaf. The form of the leaf has taxonomic significance for several hop varieties have been distinguished by the relative size of the lobes of the leaf. Daily measurements of the length of the lobes of the expanding leaf during a thirteen day period, from the time the leaves are first large enough to measure to completed expansion, show the ratio of the central lobe to the adjacent lateral lobe to be nearly constant within the range of 1.1 to 1.2 (Fig. 2), and its taxonomic use is independent of leaf age. This same information can be obtained more readily by measuring treated leaves at different stages

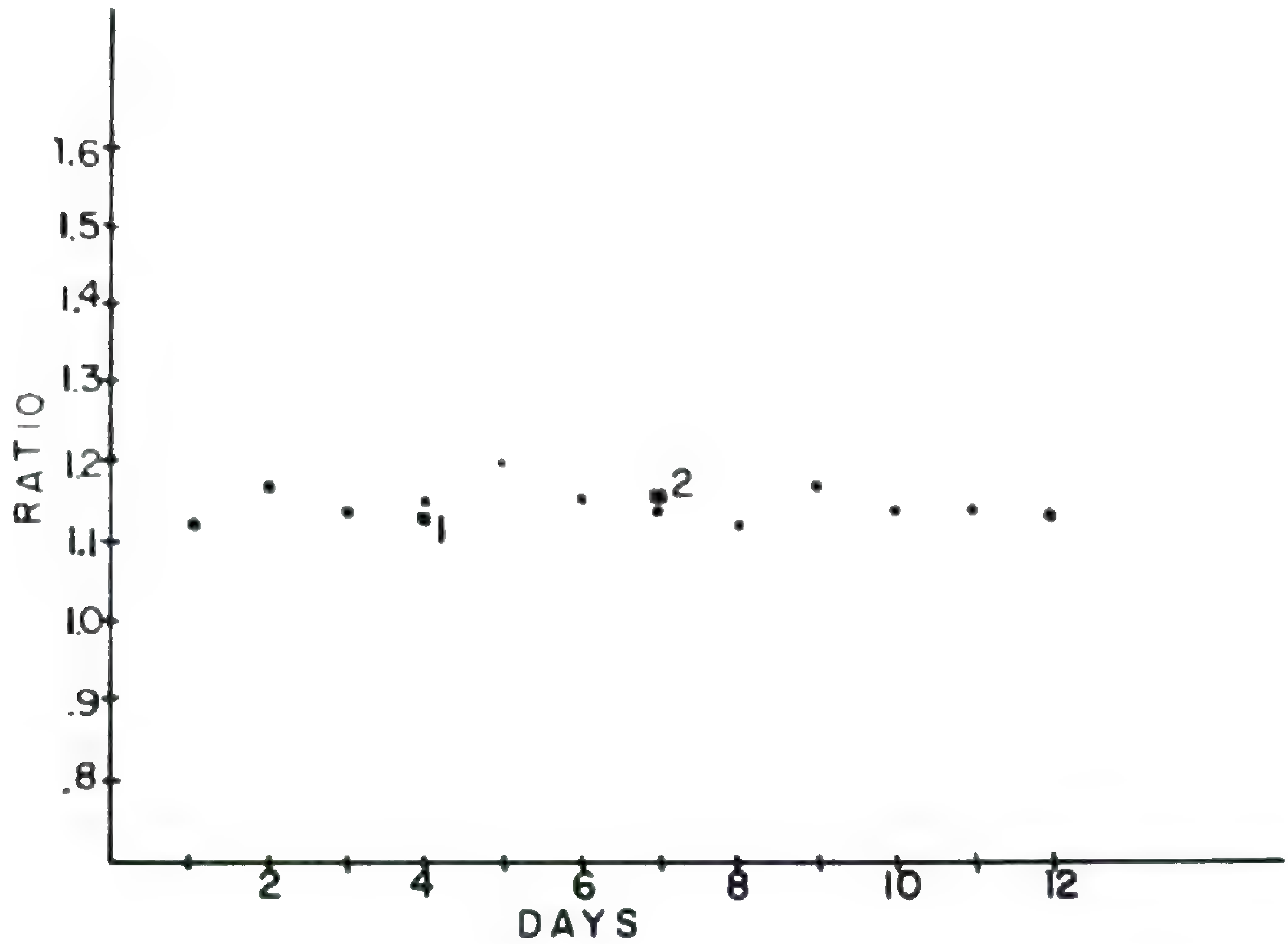

Fig. 2. Ratios of the length of the central lobe to the length of the adjacent lateral lobe plotted on the graph are for a single hop leaf, although ten leaves were measured in the experiment with comparable results, since the ratios are compared to a paired leaf treated with 3-AT. (1) ratio of green tissue at the time of treatment (prior to 3-AT effect) and (2) ratio of chlorophyll deficient tissue at time of leaf collection.

of expansion and determining on each leaf the ratio of the chlorophyll containing zones of the central and adjacent lobes, and making the same determination for the chlorophyll-deficient zones on these lobes. Where the expansion rate (as in hops) is uniform, calculations of the ratio of the tissues in each lobe formed before, or after, treatment for leaves at different stages of development give the same value. Fig. 2 also shows the ratios, determined by measuring green and colorless zones on a paired treated leaf at the time of treatment and at the time the leaf was collected 3 days later.

A comparison of the ratio during expansion of the central lobe to the second lateral lobe shows a marked decline as the leaf enlarges, as would be predicted from the treated leaves (cf. Fig. 1d) which show the basal part of the leaf to develop much later than the apical central portion. Thus with 3-AT it is possible to determine very rapidly those ratios for the leaf which may be independent of the duration or extent of leaf expansion.

It is not yet clear at what cellular stage 3-AT affects chlorophyll synthesis in developing leaves. Experiments are presently underway using tritiated thymidine to determine if only dividing cells, or both expanding and dividing cells are affected. Whatever the case, the use of an easily applied marker in leaf development, which permits a rapid recognition of newly expanding parts of the leaf blade, should make it possible to include more developmental information in taxonomic studies of plant populations.

DEPARTMENT OF BOTANY, UNIVERSITY OF MASSACHUSETTS, AMHERST

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Errata for Rhodora Volume 66

p. 218 line 33 for *Fucus vesiculous* read *Fucus vesiculosus*
p. 223 in note at bottom, for *Pantoneura barii* read *Pantoneura bearii*
p. 234 line 20 for *P. plocamiodes* read *P. plocamioides*
p. 309 line 37 for *Basia* read *Bahia*
p. 312 line 9 for *Diosopyros* read *Diospyros*
p. 353 Fig. 7 is Plate 1306
p. 405 Fig. 1 is Plate 1307

NATURAL AND ARTIFICIAL HYBRIDS OF CACALIA ATRIPLICIFOLIA AND C. MUHLENBERGII

James R. Coleman

In the summer of 1961, the author undertook, at the suggestion of Dr. Charles B. Heiser, Jr., an investigation of those species of *Cacalia* found in Indiana. This involves four species: *C. atriplicifolia* L., *C. muhlenbergii* (Sch. Bip.) Fern., *C. suaveolens* L. and *C. tuberosa* Nutt.

The two species *Cacalia atriplicifolia* and *C. muhlenbergii* are morphologically rather similar, differing primarily in the following characters:

C. atriplicifolia	*C. muhlenbergii*
1. Stems glaucous	1. Stems not glaucous
2. Stems terete	2. Stems grooved and angular
3. Leaves white beneath	3. Leaves green beneath
4. Basal leaves triangular-ovate	4. Basal leaves reniform
5. Leaves essentially glabrous	5. Leaves pubescent

Whereas *Cacalia muhlenbergii* occurs primarily in rich, shaded woods *C. atriplicifolia* occurs primarily in dry, open woods.

The author found one locality (Cedar Bluff, Monroe Co., Ind.) at which populations of the two species were growing within 200 feet of one another. The area is a rich woods penetrated by an abandoned road. *Cacalia muhlenbergii* was growing primarily in the shaded areas to the sides of the road, and *C. atriplicifolia* was growing in the clearing of the road. One plant, occurring at the edge of the *C. atriplicifolia* population toward the *C. muhlenbergii* population, showed intermediacy for the characters separating the species. However, the stalk was broken off before sexual maturity was reached thereby preventing an examination of meiosis and pollen stainability.

The rootstock of the putative hybrid was transferred into the greenhouse at Indiana University as were mature plants of the parental species. Crosses were made between *Cacalia atriplicifolia* and *C. muhlenbergii* with the former as the female parent. Of the 165 florets crossed, 7.5% developed seeds.

The putative hybrid seeds were planted in the spring of 1962 and placed out-of-doors for a two week cold treatment. They were then transferred to the greenhouse where they germinated and appeared healthy but did not produce flowering stalks. The putative natural hybrid behaved similarly. The plants remained in the greenhouse until the fall of 1963 without flowering.

In the fall of 1963 the putative natural hybrid and two putative artificial hybrids were transferred to the experimental garden at Indiana University. All three flowered in the summer of 1964. Pollen stainability with cotton blue (based on 200 grains) was 2.0% for the natural hybrid and 3.0% and 9.5% for the artificial hybrids. The lack of seed-set observed in these hybrids accounts for the failure to detect hybridization in the Cedar Bluff populations.

An examination of meiosis, using acetocarmine squash methods, revealed both bivalents and univalents (Fig. 1). However, since the bivalents have a tendency to dissociate even in the parental species, the exact number of true univalents could not be accurately determined. Laggards were observed at anaphase (Fig. 2) as were "tetrads" with micronuclei.

The chromosome count of *Cacalia muhlenbergii* has been reported as $2n=50$ (Afzelius in Darlington and Wylie, 1955), of *C. atriplicifolia* as $n=25$ (Jackson, 1962) and *C. suaveolens* as $2n=40$ (Afzelius in Darlington and Wylie, 1955). Counts by the author confirm these reports. An examination of *C. tuberosa* revealed $n=27$ (Fig. 3) (voucher: Cabin Creek Bog, ca. 6 mi. n. of Modoc, Randolph Co., Ind. *Coleman 101* IND). Other numbers reported for the genus are $2n=52$ (2 species) and $2n=60$ (4 species) (Darlington and Wylie, 1955 and Takeshita, 1961).

DEPARTMENT OF BOTANY, INDIANA UNIVERSITY, BLOOMINGTON
Present address, INSTITUTO DE BOTÂNICA, SAO PAULO, BRAZIL

Fig. 1. Diakinesis of natural hybrid showing bivalents and univalents.

Fig. 2. Anaphase 1 of artificial hybrid showing laggards.

Fig. 3. Diakinesis of *Cacalia tuberosa*, $n=27$.

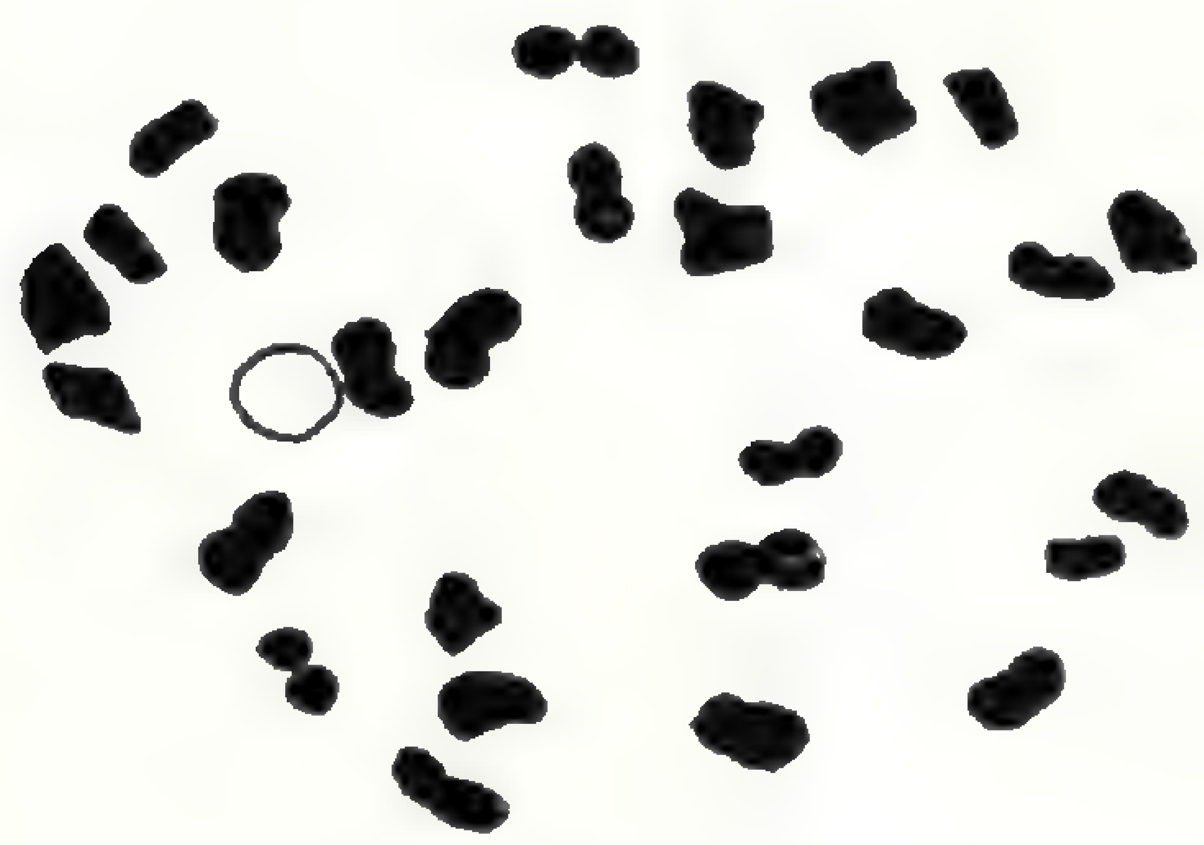

Fig.3

Fig.2

Fig.1

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NOTES ON VARIETIES OF BIDENS CONNATA AND A HYBRID WITH B. CERNUA

EARL EDWARD SHERFF

Some years ago I cited (Brittonia **11**:190. 1959) *Bidens connata* var. *gracilipes* Fern. as growing on the east shore of Eagle Lake, Kalamazoo County, Michigan. Later, I listed various additional localities for the same variety (*Bidens connata* var. *gracilipes* Fern. in Western Michigan, Rhodora 63:145. 1961). Still later (*ibid.* 64:23-28. 1962), under the caption, "Further notes on the distribution of Bidens connata vars. pinnata and gracilipes," I discussed the two varieties, giving an extended list of *exsiccatae* of var. *pinnata* for Wisconsin (pp. 24 & 25), also a list of additional ones of var. *gracilipes* for Western Michigan (pp. 27 & 28) and Wisconsin (p. 26).

Recently, through the kindness of Dr. Gerald B. Ownbey, Professor of Botany and Curator of the Herbarium at the University of Minnesota, I was permitted to examine the entire collection of Minnesota specimens of *Bidens* in that herbarium. A careful search was made for the possible occurrence of var. *gracilipes* in Minnesota. Only five collections of the variety were found, all from the north or eastern part of the state: *Olga Lakela 1860*, ("leaves on mainstem divided" *fide Lakela*), Oatka Beach Addition, Bay Front, Duluth, Minnesota, Sept. 15, 1936 (MIN); *Lakela 6202*, St. Louis River estuary at New Duluth, Minn., Sept. 9, 1945 (MIN); *Lakela 19270*, shore swamp of Black Bay of Rainy Lake, Koochiching County, Minn., Aug. 16, 1955 (MIN); *Carl O. Rosendahl 6503*, shores of Deming Lake, Itasca Park, Minn., Sept. 8, 1933 (MIN); *J. H. Sandberg*, wet places, Hennepin County, Minn., August, 1889 (MIN).

So far as known at present, *Bidens connata* var. *pinnata* is found growing only in Minnesota and Wisconsin, as previously stated by me (N. Amer. Fl. ser. II: pt. 2: 91. 1955). To the list of *exsiccatae* of *Bidens connata* var. *pinnata* cited for Wisconsin, may be added the following found in the Herbarium of the University of Minnesota: all from localities in Minnesota:

F. K. Butters & C. O. Rosendahl 6555, annual, shores of island, Form Island Lake, Aitkin County, Minn., Sept. 6, 1934; *C. L. Herrick*, Minneapolis, Minn., July, 1878; *Olga Lakela 1858*, in shallow water on bog shore, Oatka Beach Addition, Duluth, Minn., Sept. 7, 1936 ("leaves pinnate on the main stem"); *Lakela 4869*, roadside swamp south of Cloquet, Carlton County, Minn., Sept. 5, 1941; *Lakela 5905*, in shallow pond on Minnesota Point, Duluth, Minn., Sept. 10, 1944; *Lakela 6231*, swamp along St. Louis River at New Duluth, Minn., Sept. 15, 1945 (2 sheets examined); *Bruce R. Ledin*, edge of Hill Point Bog across from Schoolcraft Island, Itasca Park, Minn., Aug. 25, 1938; *John W. Moore 24920*, growing along the north shore of Loon Lake, Blue Earth County, Minn., Sept. 30, 1959; *C. O. Rosendahl 6134*, in dried-up pond near Pine Tree Lake, Washington County, Minn., Sept. 17, 1929.

During the examination of Minnesota specimens of *Bidens connata* and its known varieties, however, two additional sheets of material were discovered, one of them bearing an obviously new variety of *B. connata* and the other bearing what I construed to be a hitherto undescribed hybrid. The new variety is set forth here:

Bidens connata var. **saint-vincentii** var. nov. — Herba annua ±4 dm. alta, glabra, pallida, suberecte ramosa, ramis tenuibus angulatis striatisque tantum circ. 1 mm. crassis. Folia principalia (pro unica planta visa) tripartita, petiolata petiolo tenui 2.5-3 cm. longo, foliolis membranaceis ovatis ovato-lanceolatisve apice acutis basi plus minusve petiolulatis marginibus subintegris saepius acriter paucidentatis lateralibus 1-2.5 cm. longis terminali (petiolulo excluso) 1.5-4.5 cm. longo; alia folia saepius simplicia, minora, interdum integra. Involucri bracteae exteriores 4-8, lineari-spathulatae, adscendentes, usque ad circ. 3.5 cm. longae et 5 mm. latae, apice acutae, marginibus pauciter antrorso-spinulosae alibi glaberrimae. Achaenia biaristata, corpore atra vel subatra, 7-11.5 mm. longa et 1.5-3.5 mm. lata, plana vel valde obcompressa, anguste lineari-cuneata, faciebus striata et remote subremoteve erecte adpresseque setulosa, marginibus de apice usque ad basim erecte setosa; aristis circ. 2.5-4 mm. longis suberectis, acriter retrorso-hamosis.

Annual herb ±4 dm. tall, glabrous, pale-green, suberectly branched, the branches delicate, angulate and striate, only about 1 mm. thick. Principal leaves (seen only for a single plant) tripartite, petioled with a slender petiole 2.5-3 cm. long; the leaflets membranaceous, ovate or ovate-lanceolate, apically acute, at base more or less petiolulate, the margins subentire more often sharply few-dentate, lateral ones 1-2.5 cm. long, terminal one (petiolule excluded) 1.5-4.5 cm. long; secondary leaves more often simple, smaller, at times entire. Outer involucral bracts (phyllaries) 4-8, linear-spatulate, ascending, up to about 3.5 cm. long and 5 mm. wide, apically acute, at margins scantily antrorse-spinulose elsewhere very glabrous. Achenes biaristate, their body black or blackish, 7-11.5 mm. long and 1.5-3.5 mm. wide, flat or strongly obcompressed, narrowly linear-cuneate, on the faces striate and remotely or subremotely erectly and appressedly setulose, edges erectly setose all the way from apex to base; aristae about 2.5-4 mm. long, suberect, sharply and retrorsely barbed.

Holotype: *John W. Moore & John H. McAndrews 24810*, growing on the river bank at St. Vincent, Kittson County, northwesternmost Minnesota, Sept. 17, 1959 (MIN., herb. no. *574691*).

The general habit of the foliage and fruiting heads, also the striate achenial surfaces, place this plant with the *Bidens connata* Muhl. complex. Indeed, the collectors had determined the type as "*Bidens connata* Muhl."

In my previously published key to the varieties of *Bidens connata* (North Amer. Flora ser. II: pt 2: 89. 1955), var. *saint-vincentii* will deserve a special line as a fourth line of the key, to read: Achenial aristae normally 2 .... var. *saint-vincentii*.

The type, a moderately small specimen, doubtless selected in the field for ease of preserving, probably is somewhat atypic as to foliage characters of large, well developed plants. More specimens should be studied in the type locality.

In the entire species, *Bidens connata*, consisting as it does of eight hitherto-known varieties (including the var. *connata*), no achenes have been known to be as here, constantly biaristate. The usual number of aristae is four, though in var. *submutica* Fassett they may be "none or rarely one or two."

The above-mentioned undescribed hybrid may be set forth as:

A putative hybrid of *Bidens cernua* L. and *B. connata* Muhl.

Under her no. *2356*, Miss Olga Lakela distributed as *Bidens cernua* L. a remarkably slender-leaved annual herb which she had collected at Duluth, Minnesota: *Lakela 2356*, in shallow water on Oatka Beach Addition, Duluth, Minnesota, "leaves very narrow, bracts long," Sept. 6, 1937 (MIN). The plant examined by me is on herbarium sheet no. *338394*. It is of slender, erect habit with slender suberect branches; the leaves are all simple, exceedingly narrow (even graminiform) and 4-12 cm. long by 1.5-7 mm. wide, very long-attenuate at both ends, the tip very acute, surfaces glabrate, margins entire or each ±2-5-dentulate with slender, small and at times inflexed teeth, otherwise glabrate except for almost microscopic *spinulae*. The heads are radiate, about 2.5-3 cm. wide when expanded at anthesis, the disk (excluding the outer phyllaries) about 1.5 cm. wide; ray florets about 1.2-1.4 cm. long, ray yellow, linear-oblong and about 3-4 mm. wide. Outer phyllaries about 8, linear or linear-spatulate, ±1.5 cm. long, about 3- or 5-striate, glabrous except for minutely spinulose edges.

The achenes are of the type found on *Bidens cernua* but are grossly undeveloped, almost abortive, seemingly suggestive of hybridity. As the general aspect of the plant is unlike that of any *Bidens cernua* material ever heretofore seen by me, and as specimens of *B. connata* var. *pinnata* Wats. and *B. connata* var. *gracilipes* Fern. were collected by the same collector in the same small locality just a year earlier (*vide Lakela 1858* and *1860, supra*), I have concluded *Lakela 2356* to be designated best as a putative hybrid between *B. cernua* L. and some variety, perhaps var. *gracilipes* Fern. or var. *pinnata* Wats., of *B. connata* Muhl. Years ago I wrote (The Genus *Bidens*. Bot. Ser. Field Mus. Nat. Hist. **16**: 262, footnote 1. 1937): *Bidens connata* appears to hybridize very rarely in nature. I have seen two sheets of material (Herb. W. C. Ferguson) collected by W. C. Ferguson, Plattsdale, Long Island, New York, Sept. 20, 1919, which appeared clearly to be of hybrid origin — *B. connata* × *B. cernua.* The leaves were tripartite as in typical *B. connata;* the heads were radiate and much like those of *B. cernua.*

CHICAGO NATURAL HISTORY MUSEUM, CHICAGO 5, ILLINOIS

A REVISION OF THE NORTH AMERICAN SPECIES OF HELIANTHEMUM (CISTACEAE)

H. S. Daoud and Robert L. Wilbur*

The genus *Helianthemum s.l.* is composed of approximately one hundred species found in both the New and the Old World. The species are particularly abundant about the Mediterranean Sea and in North America. The American species, as well as those of the rest of the world, were most recently revised in their entirety by Grosser (Engler's Pflanzenreich 14. (IV. 193.) 1903). Several regional treatments for the North American species have been since published but no comprehensive account of the genus in North America has appeared. Since Grosser's monograph, several additional American species have been proposed.

The generic dismemberment of *Helianthemum* has continued to be a source of considerable disagreement. This study, however, was not intended to evaluate the generic relationship of the American species with those of the Old World but to review the North American representatives. The troublesome question of generic limits deserves careful reappraisal but ought to be undertaken where collections of the entire generic complex are readily available. Twenty North American species of *Helianthemum* are recognized in this account.

Our geographical area 'North America' includes the West Indies and Central America. This treatment therefore includes all the species in the New World except the three known from South America. These were excluded primarily because too little material was readily available to make their study feasible. One species, *H. brasiliense* (Lam.) Pers., is known from the eastern side of that continent,

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occurring in Brazil, Uruguay and Argentina, while two others, *H. hirsutissimum* Presl and *H. spartioides* Presl, are found in Chile. The last mentioned species is of particular interest since its relationship is reported to be with the Californian *H. scoparium* Nutt.

HISTORY OF THE GENUS IN NORTH AMERICA

Although the names *Helianthemum* and *Cistus* were in use earlier, Tournefort (Inst. Rei Herb. 1700.) recognized two genera on the basis of their capsule differences: *Helianthemum* having but one locule and *Cistus* with 5(6-10) locules.

Linnaeus (Sp. Pl. 523-529. 1753 and Gen. Pl. 234. 1754.) did not accept Tournefort's *Helianthemum.* Instead he combined it with *Cistus*, which he placed in the first order (Monogynia) of his thirteenth class (Polyandria). He recognized 28 species of *Cistus* including one New World species, *Cistus canadensis.* Two years earlier, Linnaeus described *Lechea major* which he later included in Species Plantarum in the class and order Triandria Monogynia. Blake (Rhodora **20**: 49-50. 1918), found the type of *Lechea major* to be conspecific with *Cistus canadensis.*

Nomenclaturally, the genus is attributed to Miller (Gard. Dict. Arb. 1754.), whose Fourth Edition, although pre-Linnean in character, is still an acceptable source of generic names.

Rafinesque (Car. Nuov. Gen. Sp. Sicil. 73. 1810.) proposed the generic name *Xolantha* to replace *Helianthemum* since the latter could be confused with *Helianthus* (Compositae). Later Rafinesque (Chlor. Aetn. 9. 1815.) proposed the generic name *Anthelis* as another substitute for *Helianthemum.*

Dunal (DC. Prodr. 1: 266-284. 1824.) recognized 112 species of *Helianthemum* and divided the genus into three "series" and nine sections primarily on the bases of differences of stigma, style and stamens.

Dunal's section *Lecheoides* contained only the seven species of *Helianthemum* adequately known to him from the New World *(H. corymbosum, H. rosmarinifolium, H.*

glomeratum, H. ramuliflorum, H. canadense, H. brasiliense, and *H. carolinianum).* It would seem that the American occurrence of these species and their alternate cauline leaves were their principal claim to separate sectional ranking.

Sweet (Cistineae. 1825-30.) adopted Dunal's classification and listed four more species with the seven American species which Dunal had assigned to his section *Lecheoides.* Three of these *(H. obcordatum, H. tripetalum* and *H. astylum)* Dunal previously had listed as unsatisfactorily known to him and they were known no better by Sweet. The fourth species, *H. polygalaefolium* Sweet, is generally considered a synonym of *H. brasiliense.* Sweet indicated that several New World species produced petaliferous flowers in the summer and apetalous flowers in the autumn, a feature he expected was characteristic of all American species.

Spach (Ann. Sci. Nat. 2nd ser. **6**: 357-375. 1836.) recognized sixteen genera in the Cistaceae. The known species of *Helianthemum s.l.* were placed in eight of these genera. Five of these eight genera were restricted to the Old World. The other three, *Crocanthemum, Heteromeris* and *Taeniostema,* all newly described, occurred only in the New World. The primary points in Spach's account of the New World genera are as follows:

Crocanthemum: flowers all petaliferous. (*C. carolinianum* (Walt.) Spach and *C. brasiliense* (Lam.) Spach were both definitely included and *Helianthemum polygalaefolium* Sweet was indicated as a possible addition.)

Heteromeris: both petaliferous and apetalous flowers present. (Included in this genus were taxa which are today known as *Helianthemum glomeratum, H. canadense, H. corymbosum* and *H. rosmarinifolium* but which were in several cases provided by Spach with new epithets under *Heteromeris.*)

Taeniostema: flowers all apetalous. (The only species included was *T. micranthum* to which he appended *Helianthemum glomeratum* as a questionable synonym.)

A fundamental weakness of his last two genera was the inclusion of different floral states of *H. glomeratum* within both taxa. Most American authors who accept generic status for the American species have taken up the generic name *Crocanthemum.* Although this genus was originally characterized by the constant petaliferous condition of its flowers, a feature not strictly true of either of the species originally included and certainly correct for only a minority of the species included by those who have accepted the genus, this in itself would not bar the employment of the name for the American segregate.

The subgenus *Horanthes* was proposed by Rafinesque (New Fl. N. Am. 3: 30 + 31. 1838.) as a substitute for Dunal's section *Lecheoides* since, in his opinion, the latter too closely resembled the generic name *Lechea.* Later in the same year he elevated (Sylva Tell. 132 + 133. 1838.) *Horanthes* to generic status along with four other segregates from the Old World: *Stegitris, Fumana, Xolanthes* (=*Xolantha*), and *Psistina.*

Willkomm (Icon. et Descr. Pl. 2: 8-12. 1856.) proposed a new classification for Cistaceae dividing it into eleven genera. He accepted Spach's genera, *Crocanthemum, Heteromeris* and *Taeniostema,* to which both workers had assigned all the known New World species. *Crocanthemum* and five Old World genera comprised his Tribe Normales possessing only chasmogamous flowers while *Heteromeris* and *Taeniostemma* (=*Taeniostema*) were placed in his Tribe Abnormes since they possessed cleistogamous flowers.

Bentham (Gen. Pl. 1: 113 + 114. 1862.) maintained the genus in the broader sense, indicating that the characters used in separating the species of *Helianthemum* into supposed genera by Spach and others were minor and inconstant.

The Synoptical Flora (Gray's Syn. Fl. 1(1): 189-191. 1895.) accepted nine species of *Helianthemum* in the United States which were arranged in three groups. The first group contained the "Atlantic species, with dimorphous flowers" (*H. canadense, H. majus* (=*H. Bicknellii*), *H. capitatum* (=*H. rosmarinifolium*), and *H. corymbosum*). The second included the "S. Atlantic species with homomorphous flowers" *(H. arenicola, H. Nashii,* and *H. carolinianum)*. Barnhart (Bull. Torrey Club **27**: 589-592. 1900.) pointed out that *H. arenicola* and *H. Nashii* were apparently placed among the species with homomorphous flowers on the basis of their original description since both possess cleistogamous as well as petaliferous flowers. Gray's third group consisted of the "Pacific species: flowers homomorphous" *(H. scoparium* and *H. Greenei)*.

Reiche (Nat. Pflanzenfam. III. 6: 304-306. 1895.), employing *Helianthemum* in the broad sense, treated all of Dunal's sections as subgenera except *Macularia* which was omitted. All the New World species were placed in the subgenus *Lecheoides* (Dunal) Reiche.

Grosser (Pflanzenreich 14 (IV. 193.) 1-161. 1903.) assigned all known species of *Helianthemum s.l.* to three genera: *Halimium, Tuberaria,* and *Helianthemum. Tuberaria* and *Helianthemum,* both confined to the Old World, supposedly resemble one another in possessing either no style or one that is bent or curved and often elongate as well, somewhat swollen funiculi and only petaliferous (chasmogamous) flowers. *Halimium* (Dun.) Wilk., found according to Grosser's concept both in the Old and New World, was reported to differ from them in its short, straight style, filiform funiculi and often apetalous (cleistogamous) flowers in addition to the petaliferous. There were also differences reported for the embryos of the three genera.

Grosser recognized three sections in *Halimium*. Section *Spartioides*, containing the Californian endemics, *H. scoparium* and *H. occidentale* (=*Helianthemum Greenei*), and the Chilean *H. spartioides,* was characterized primarily by its supposed broom-like habit. The Old World section *Euhalimium* was distinguished principally by possessing only chasmogamous flowers while the American section *Lecheoides* often has cleistogamous as well as chasmogamous flowers.

Britton (Ill. Fl. N. U.S. 2: 539-541. 1913.) transferred the three species of *Helianthemum* then recognized within the range of the Illustrated Flora to Spach's *Crocanthemum*. In the same year Bicknell (Bull. Torrey Club **40**: 613-616.

1913.) accepted this generic segregate. However, Fernald (Rhodora **19**: 58-60. 1917.) rejected the idea of separating the New World species into the endemic, segregate genus *Crocanthemum.*

Ponzo (Nuovo Gior. Bot. Ital. 28: 157-173. 1921.) basing his classification on anatomical and morphological features, included the seven New World species known to him in Spach's genus *Heteromeris.*

Standley (Contr. U.S. Nat. Herb. 23: 832-834. 1923.), following Grosser, treated all nine Mexican species of *Helianthemum* known to him in the genus *Halimium.*

Janchen (österr. Bot. Zeitschr. **71**: 266-270. 1922.) followed Britton and Bicknell in accepting the segregation of the New World species in Spach's genus *Crocanthemum.* He indicated that these species have alternate, pinnately nerved leaves while the Old World species of *Halimium* have opposite, three nerved leaves. Janchen (Engler & Prantl's Nat. Pflanzenfam. 2 Aufl. 21: 289-313. 1925.) included all the species of *Helianthemum (sensu lat.)* in four genera: the New World *Crocanthemum* and three genera from the Old World. The species of *Crocanthemum* were aligned in two sections, *Spartioides* and *Lecheoides*, which were previously recognized by Grosser (Engler & Prantl's Nat. Pflanzenfam. 14. IV. 193. 33. 1903.) as sections of *Halimium.*

Barnhart (in Small's Man. Se. Fl. 878-880. 1933.) followed Britton, Bicknell, and Janchen in accepting *Crocanthemum.* He also arranged the nine species genus into three informally designated groups.

Schreiber (Madrono 5: 81-85. 1939.) studied the genus *Helianthemum* in California, accepting the two previously recognized species and three varieties, and proposed a new species, *H. suffrutescens.*

Fernald (Rhodora 43: 609-616. 1941.) for the second time questioned the status of the segregate genus *Crocanthemum* and the way it was applied to the species of the New World. He indicated that the characteristics proposed by various authors as a basis for the segregation of the New World species into a single genus were inconstant.

MORPHOLOGY

The HABIT of all American species is perennial. The genus contains herbaceous, suffruticose and fruticose growth forms. The ten species found in the eastern half of the United States, Canada, and the West Indies are typically herbaceous while the two Californian species are suffruticose. The Baja Californian species, *H. nutans*, is definitely shrubby although low and divergent. Three Mexican and Central American species *(H. Pringlei, H. Coulteri* and *H. patens)* may be either herbaceous or suffruticose, while the remaining Mexican and Central American species are all suffruticose. The habit of the species is of minimal value in identification.

PUBESCENCE varies greatly in both quality and quantity on different parts of the plant. All the American species are typically pubescent although occasional specimens of *H. patens* are completely glabrous. The basic types of pubescence found among the North American species are (1) stellate hairs, the predominant type varying greatly in both length and density; (2) simple hairs, longer than the stellate hairs but less abundant and usually intermixed with them; (3) glandular hairs, very rare but typically found on the calyces of *H. dumosum* and always on the inflorescence as well as the upper part of the stem in *H. Greenei* and occasionally on the calyces of *H. carolinianum*, *H. Coulteri* and *H. canadense*. They are conspicuous only in *H. Greenei*.

Aside from habit and pubescence, few features of the STEM are taxonomically useful. Usually the stem is pubescent although in some species it is glabrate, or in a few specimens of *H. patens* completely glabrous. Among the species of the southeastern United States, *H. carolinianum* alone has stems sparsely covered with elongate, hyaline stellate pubescence. Among the Mexican species, the stems of *H. chihuahuense* and sometimes those of *H. Pringlei* are villous. *Helianthemum propinquum* characteristically arises from a creeping subterranean rootstock, and this distinguishes it from the closely related *H. Bicknellii* which like most American species possesses a woody caudex.

The LEAVES are simple, pinnately but often obscurely veined, estipulate, and alternate. STIPULES have been reported in certain species (e.g. *Crocanthemum stipulatum* Janch.) but these are the result of a mistaken interpretation of fasciculate axillary leaves. A few species possess basal leaves in rosettes or crowded at the base of the plant but these differ in no essential way from the lower cauline leaves. These have been reported as opposite but actually are alternate and separated by very short internodes. The presence of basal leaves is often characteristic of *H. carolinianum* and *H. georgianum*. Occasionally, however, *H. rosmarinifolium* or a few other species also have basal leaves.

PETIOLES are present in a majority of the species. A few species may be either epetiolate or with a petiole up to 3 mm. long. Sometimes no definite distinction can be made between the blade and petiole. This renders the presence or absence of the petiole of negligible taxonomic value.

The shape of the BLADES varies from linear to broadly obovate. Although the shape is characteristic for some species, it varies greatly in others. Also there is the expected gradual decrease in size and change in shape of the lamina from the base of the plant upward. The shape of the leaf-blade, therefore, is of limited aid in distinguishing the species and has been employed only as a supplementary character.

The PUBESCENCE of the leaves is essentially of two types: (1) the predominant stellate hairs which vary greatly in both length and quantity, and (2) the relatively uncommon simple hairs which are longer, less abundant and usually intermixed with the stellate type. (Simple foliar trichomes occur on the upper leaf surface of *H. canadense*, *H. dumosum*, and sometimes *H. Coulteri*, both surfaces of *H. chihuahuense* and sometimes also on *H. Pringlei*, and only on the leaf margin of *H. nutans*). The leaves of all species examined are typically pubescent, but those of *H. scoparium* and *H. Greenei* sometimes are glabrate and occasionally those of *H. patens* are completely glabrous.

The pubescence on both surfaces of the leaves is similar in quantity and quality in some species (*H. Greenei*, *H. scoparium*, *H. Pringlei*, *H. chihuahuense*, *H. patens*, *H.*

argenteum, and *H. nutans)* and in these species the secondary veins are not elevated below. In other species *(H. canadense, H. dumosum, H. Bicknellii, H. propinquum, H. carolinianum, H. rosmarinifolium, H. georgianum, H. corymbosum, H. concolor,* and usually *H. Coulteri*) the quality and the quantity of the pubescence are remarkably dissimilar on both surfaces of the leaves, and in these the secondary veins are prominently elevated beneath. Both leaf surfaces of *H. glomeratum* possess similar pubescence but its venation varies from obscure to prominent. *Helianthemum arenicola* has obscure secondary veins on the lower surface of the leaf but the pubescence differs somewhat (largely in color) on the two sides. The secondary veins of *H. Nashii* vary from obscure to prominent, and the pubescence differs on the two surfaces.

Among the species with prominent secondary venation beneath only *H. carolinianum* and *H. concolor* have leaves sparsely stellate-pubescent while the remaining prominently veined species are so densely stellate-tomentose that the lower surfaces of their leaves are not visible.

In spite of the indicated variability, the pubescence and the secondary veins are taxonomically helpful in distinguishing the species.

The MARGINS of the leaves of *H. carolinianum* are subdenticulate while those of the remainder of the species are entire. The margins of some species are characteristically revolute.

The INFLORESCENCES of the American species are remarkably diverse as to type, position, and structure. It may consist of: (1) all chasmogamous flowers varying from solitary (as in *H. canadense*) to numerous (as in *H. Greenei*); (2) many chasmogamous flowers and few cleistogamous ones as in *H. Coulteri*; (3) few chasmogamous flowers and many cleistogamous ones as in *H. corymbosum;* and (4) all cleistogamous flowers, varying from a solitary flower as in *H. argenteum* to numerous as in *H. glomeratum.*

A few species *(H. scoparium, H. Pringlei, H. Coulteri)* have unusually variable inflorescences. Other species *(H. canadense, H. dumosum, H. Bicknellii, H. propinquum,* and to a much lesser extent *H. chihuahuense)* have two types of inflorescence which mature at different times in the growing season and in different positions on the plant, resulting in great variability in aspect. However, the inflorescence is characteristic for most species and hence has proved to be a useful diagnostic feature.

The BRACTS of *H. corymbosum* are obtusely spatulate-linear while those of the remaining species are acutely linear or lanceolate.

The PEDICELS of the chasmogamous flowers range from shorter than to about five times longer than the calyx. As a taxonomic character, the pedicel has been greatly over-emphasized and its variability minimized. The cleistogamous flowers may be sessile or pedicellate.

The FLOWERS are either chasmogamous (pollination apparently effected after expansion of the floral envelope) or cleistogamous (with pollination occurring within the closed perianth). When these two kinds of flowers are borne on the same plant, the CHASMOGAMOUS flowers are earlier and usually longer pedicellate. They are characterized also by a larger calyx, five fugacious petals, more numerous stamens (10 or more), and by larger fruits which usually contain more numerous seeds. Their anthers are usually longer than wide and dehisce along their entire length. The CLEISTOGAMOUS flowers lack petals and are borne later (but may fruit earlier) and possess shorter pedicels, a smaller calyx, and fewer stamens (3-8). The anthers of the cleistogamous flowers are as long as wide or shorter and dehisce only by a break in the wall adjacent to the stigma to which they adhere.

Four species *(H. Greenei, H. scoparium, H. nutans,* and *H. patens)* possess only petaliferous flowers. Cleistogamous flowers are very rare in *H. carolinianum,* while all of the remaining species are dimorphic, possessing both chasmogamous and cleistogamous flowers. The Mexican *H. glomeratum* is the only species in which some of its members apparently produce only cleistogamous flowers.

The CALYX is composed of five sepals in two dissimilar series: two narrower and usually shorter outer sepals and three inner sepals. The inner three constitute the prominent calyx. The outer and the inner sepals are united near the base in some species (e.g. *H. Bicknellii, H. scoparium*), while in others the fusion extends half or two thirds of their length (e.g. *H. propinquum* and *H. Coulteri*).

The calyces are characteristically pubescent in all species, although they are sometimes glabrate in *H. scoparium,* or occasionally even completely glabrous in *H. patens.* The calyces of some species are covered with stellate pubescence of varying quality and density, while the calycine stellate pubescence of other species is intermixed with simple hairs and/or glandular hairs.

The CHASMOGAMOUS OUTER SEPALS are variable in shape, length, and degree of fusion with the inner ones. They are useful in distinguishing species especially when combined with other characteristics. The southeastern *H. corymbosum* alone has spatulate outer sepals with the apices obtuse or nearly so, while the other species have linear or lanceolate sepals with acute apices. The amount of the fusion between the inner and the outer sepals and the length of the free portion of the outer ones are of significance in distinguishing the closely related *H. Bicknellii* and *H. propinquum.*

The CHASMOGAMOUS INNER SEPALS are typically ovate or ovate-lanceolate with acute to acuminate apices except in *H. Nashii* whose inner sepals are asymmetrically oblique. The length of the inner sepals is exceedingly variable even within the same species and hence offers no serviceable diagnostic character.

The CLEISTOGAMOUS OUTER SEPALS are mostly linear and attached near the base of the inner ones. In contrast the free portion of the outer sepals of *H. canadense* and *H. propinquum* is a rudimentary knob about twice as long as wide and fused to the middle edge of the inner sepals.

The CLEISTOGAMOUS INNER SEPALS vary but little, being either ovate or ovate-lanceolate, with acute to acuminate apices. Two unrelated species, *H. Nashii* and *H. canadense,* are unusual in possessing sepals asymmetrically oblique at their apices. In most of the species the cleistogamous flowers are so small that most measurements were made at the fruiting stage.

The COROLLA is present in the chasmogamous flowers and is fugacious. Cleistogamous flowers lack petals. The petals are essentially yellow but those of *H. Pringlei* are sometimes tipped or margined with purple. The shape of the petals is more or less uniform among the species and usually longer than the calyx at anthesis. The variation in petal size within a species is great. For example, the range is between 2.4-5.0 mm. long in *H. patens,* and 8-16 mm. long in *H. carolinianum.*

ANTHER-DEHISCENCE is one of the best ways to distinguish chasmogamous from cleistogamous flowers. This is especially true in fruiting specimens when the petals and some of the stamens have fallen which alone in the past have been relied upon to distinguish the two types of flowers. In the chasmogamous flowers stamen-number varies between 10-50. The small-flowered species, such as *H. argenteum,* have 10-15 stamens, while the larger-flowered species, like *H. carolinianum,* have 20-50. The length of the filament as well as that of the anthers is quite variable. The anthers of the chasmogamous stamens, which neither cohere to each other nor adhere to the stigma at anthesis, are oblong to linear, (1-) 1.5-2 times longer than wide and dehisce throughout their entire length. In the cleistogamous flowers, the number of the stamens is also variable (3-8). Their anthers are coherent to one another and adherent to the stigma at anthesis and even in fruit for most species. These anthers dehisce by the rupture of their walls adherent to the stigma.

There is such great variation in the size of the PISTIL and its parts that their size is of no taxonomic use. However the stellate-pubescent ovaries of *H. Nashii* and *H. arenicola* are most helpful in distinguishing them from all other species.

The chasmogamous pistils are larger than the cleistogamous ones in the same species. The ovaries of the chasmogamous flowers are ovoid or nearly so and unilocular with few to many ovules. The styles of these flowers vary in length from wanting or nearly so in *H. Coulteri* to nearly as long as the ovary in *H. glomeratum* but never exceeding 1 mm. in length. The styles of the chasmogamous flowers, when present, are always erect and straight in American species and their stigmas are capitate and vary greatly in diameter.

The cleistogamous pistils are so small that they usually have not been measured. However, their ovaries are ovoid and similar to the chasmogamous pistils of the same species in carpel-number and pubescence. Their styles are very short and are much exceeded in height by the ovaries of the same flower.

The CAPSULES of both chasmogamous and cleistogamous flowers are loculicidally dehiscent. Previously the capsules of all species of *Helianthemum* were thought to be 3-valved. However *H. Nashii* characteristically is 2-valved. Only two species, *H. Nashii* and *H. arenicola,* possess stellate-pubescent capsules while those of the other American species are glabrous.

The variation in size and shape of the chasmogamous capsules is so great as to be taxonomically useless. The capsules are shorter than the calyx (or rarely slightly longer in *H. Pringlei*). The chasmogamous capsules typically persist throughout the growing season, but in both *H. Bicknellii* and *H. propinquum* they usually fall immediately after maturation.

The largest capsules, often containing more than one hundred seeds, are found in *H. carolinianum* and the smallest capsules, with only 1-3 (-6) seeds, occur in *H. rosmarinifolium.* Chasmogamous capsules are apparently produced by all species, although many specimens bear only cleistogamous capsules.

The cleistogamous capsules vary in shape and size but are always shorter than the calyx. The largest cleistogamous capsules, containing up to 22 seeds are borne by *H. Coulteri* and the smallest capsules, with only one or rarely two seeds, are found in *H. rosmarinifolium.* Four species of course lack cleistogamous capsules. No cleistogamous capsules were seen in *H. carolinianum,* which is not surprising since less than one per cent of the specimens studied had cleistogamous flowers. The number of the cleistogamous seeds per capsule is reasonably constant and hence helpful in identification.

Except for the number and size, the SEEDS produced by both chasmogamous and cleistogamous fruits in the same species are similar.

The seeds of twelve of the species studied are covered with a thin membrane, which is separable after the seeds are moistened with water for a few seconds. Such a membrane is usually yellowish or sometimes spotted with brown, but in *H. nutans* and *H. argenteum* white papillae occur.

The seeds of the remaining species *(H. canadense, H. dumosum, H. carolinianum, H. Coulteri, H. Bicknellii, H. propinquum, H. Nashii* and *H. arenicola)* do not have a readily separable membrane. The seeds of *H. canadense, H. dumosum,* and *H. carolinianum* are papillate. The seeds of *H. Coulteri* are mostly papillate but in plants from Central America are often reticulate. Those of *H. Bicknellii* and *H. propinquum* are usually reticulate, while the seeds of *H. Nashii* and *H. arenicola* are pebbled to papillate. The sculpturing of the seed coats often provides useful diagnostic features.

The seeds of most of the species have a somewhat transparent endosperm especially if examined when moist and after removal of the membrane. The embryos are curved, possess linear cotyledons, and are enveloped by the endosperm. They can easily be excised by rupturing soaked seeds.

EVOLUTIONARY RELATIONSHIPS

The American species of *Helianthemum* show numerous morphological trends which probably are best interpreted as evolutionary tendencies. Speculation as to evolution is of necessity highly subjective when facts are few but still it would seem desirable to record our feelings as to relationships. We are aware of the shortcomings of such a proposed "phylogenetic tree" as is presented in figure 1, but offer it in hopes that it will stimulate other investigations in this genus and thereby supplement the all too scanty morphological data. The more obvious evolutionary tendencies are thought to be the development of cleistogamous flowers, the appearance of a hygroscopic testa and changes in inflorescence-type. There also seem to be established trends for decrease both in the size of floral parts and fruit accompanied by reduction in the number of seeds per capsule. In one species the carpel number has been reduced to two.

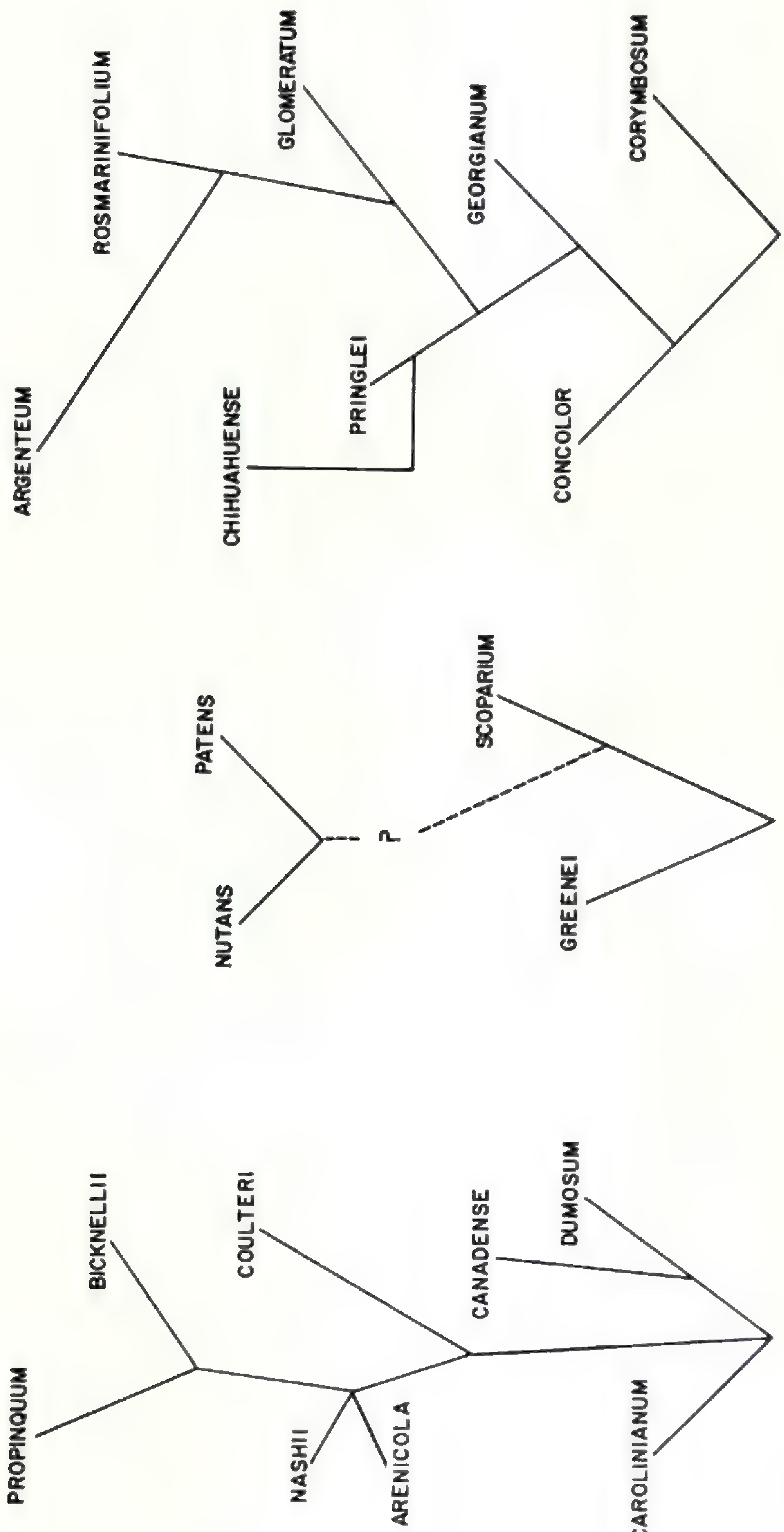

Fig. 1. Possible relationship of the North American species of *Helianthemum*.

The supposedly more primitive species are presumed to possess only petaliferous, chasmogamous flowers. The presence of cleistogamous flowers is therefore considered an evolutionary advance. The four species lacking cleistogamous flowers are quite diverse and perhaps not closely related. There is no evidence that they are derived from taxa that once had cleistogamous flowers. Although possessing only chasmogamous flowers, it is felt that they still are evolutionarily more advanced than members (e.g. *H. canadense* and *H. dumosum*) that have cleistogamous flowers. The presence of a hygroscopic testa in these species would suggest a possible relationship with the supposed more advanced alliance. It is of course generally accepted that evolutionary progression does not proceed uniformly in all structures of any given taxon.

Three principal evolutionary lines perhaps exist within the North American species. The four species which lack cleistogamous flowers possibly represent one line but their great diversity might be an indication that they are an unnatural assemblage of primitive species. Among the species which develop cleistogamous flowers two lines are apparent. The supposedly most advanced of the three lines consists of those species with a hygroscopic seed coat. The members of the presumed most primitive alliance have seeds lacking this hygroscopic testa. It has not appeared wise to recognize formally the three suggested evolutionary lines as taxonomic series or sections since each is characterized by only one feature. It is felt that formally designated taxa ought to have more than one feature indicating their common origin. Since the arrangement presented here is admittedly tentative, there seems to be no urgency in formal designations.

Eight species were recognized in the more primitive line characterized by papillate, pebbled or reticulate seeds lacking the hygroscopic seed coat. *Helianthemum carolinianum* is considered the most primitive American species for the following reasons: (1) the rarity of cleistogamous flowers; (2) the most primitive type of inflorescence (a scorpioid cyme) in this line; (3) the largest capsule which produces the greatest number of seeds; (4) the most numerous stamens. Barnhart (Bull. Torrey Club 27: 592. 1900.) has, however, indicated that this taxon seems to him "like a heteromorphous species which has lost its apetalous form of flowers" and he suspected that "if its origins could be traced, to find it had heteromorphous ancestors."

Both *H. dumosum* and *H. canadense* are apparently very closely related and have been even treated as one species until this century. The chasmogamous calyces of these two species approach those of *H. carolinianum* in size. *Helianthemum dumosum* is here considered more primitive than *H. canadense* since it possesses both fewer and larger cleistogamous capsules containing more numerous seeds. Its chasmogamous flowers are usually larger than those of *H. canadense*. In addition the cleistogamous outer sepals of *H. canadense* are more reduced, being almost rudimentary. Also there is no sharp differentiation between the late chasmogamous flowers and the cleistogamous ones in *H. dumosum*. The fact that the range of *H. dumosum* is very restricted and confined entirely to a glaciated region in contrast to the widespread *H. canadense*, however, might argue for another interpretation.

The unusually variable *H. Coulteri* often possesses a chasmogamous calyx nearly as large as those of *H. canadense* and *H. dumosum*. Its relationship to those two species is perhaps indicated by the frequent intermixture of stellate pubescence and pilose hairs on the chasmogamous calyx. Also the leaves sometimes resemble those two northern species in having the upper surface both stellate- pubescent and pilose. *Helianthemum Coulteri* is judged as more advanced than either *H. canadense* or *H. dumosum*, in spite of its fewer but larger cleistogamous flowers.

The southeastern *H. arenicola* and *H. Nashii* are unique among the American species in possessing stellate-pubescent ovaries and capsules. Of the two, *H. arenicola* is considered the more primitive since it has larger chasmogamous flowers, more seeds in each cleistogamous capsule and the characteristic 3-valved capsule rather than two which *H. Nashii* alone possesses in the genus. It is suggested that these two species are more advanced than the preceding members of this line because they have smaller chasmogamous flowers and fruit and fewer seeds/chasmogamous capsule. Also their outer sepals are narrower and shorter than the earlier-mentioned and supposedly more primitive species.

The two closely related species, *H. Bicknellii* and *H. propinquum*, are perhaps more advanced than the other rough-seeded species since their numerous cleistogamous capsules are smaller and contain fewer seeds. *Helianthemum propinquum* is possibly more advanced than *H. Bicknellii* since it has fewer chasmogamous flowers and a much smaller free portion of the outer sepals. *Helianthemum propinquum* has smaller cleistogamous outer sepals and generally smaller cleistogamous capsules. Although *H. propinquum* is ranked as the most advanced species in this evolutionary line, it is thought to be more primitive than some members of the other supposed phylads.

The four Mexican and Californian species lacking cleistogamous flowers *(H. Greenei, H. scoparium, H. nutans* and *H. patens)* perhaps represent an independent line but are so dissimilar that placing them together may be unwarranted. Among them *H. Greenei*, a narrow endemic to the Channel Islands of California, is treated as the most primitive because of its broader, lanceolate outer sepals. The more widespread and variable *H. scoparium* is related to *H. Greenei* but has narrow, linear, outer sepals. The remaining strictly chasmogamous species, *H. nutans* and *H. patens*, possess a different habit and are believed to be more advanced, as indicated by reduction in number of flowers and size of leaf. By similar reasoning *H. patens* would be considered more advanced than *H. nutans* since its flowers are smaller with fewer stamens and fewer seeds/capsule. In addition the herbaceous habit of *H. patens* contrasted with the fruticose habit of *H. nutans* might be considered as an evolutionary advance. These four species possess a hygroscopic testa which also characterizes the supposedly more advanced evolutionary line with cleistogamous flowers.

The most primitive member of the line with a hygroscopic seed-coat is possibly *H. corymbosum*. Its more foliaceous outer sepals and bracts may indicate its relative primitiveness. It also is the only species in this line possessing the prominent and persistent funiculi and placentae which are found also in the three supposedly more primitive species of the non-hygroscopic seeded alliance. It is suggested that *H. concolor* is another primitive species. It possesses the largest leaves and the longest outer sepals of any member of the hygroscopic-seeded alliance. It is treated here as more advanced than *H. corymbosum* because of its much narrower outer sepals and bracts and fewer seeds in each of the cleistogamous capsules.

The next more advanced species within this line are perhaps *H. georgianum* and *H. Pringlei.* These two species have a supposedly reduced and hence more advanced inflorescence-type (a racemose cyme), and their outer sepals are reduced in size. *Helianthemum georgianum* may be more primitive than *H. Pringlei* as it has more numerous seeds in its cleistogamous capsule.

It is felt that *H. chihuahuense* is more advanced than the two preceding species since its chasmogamous and cleistogamous flowers are borne separately and in different positions on the plant. In addition the number of the cleistogamous flowers has been often reduced to a single flower in the leaf axil which seems to be clearly derived from the many-flowered clusters borne terminally on short axillary branches. *Helianthemum glomeratum* is thought to be more advanced than *H. chihuahuense* since the number of chasmogamous flowers is reduced to a usually solitary flower borne at the end of the branches and branchlets. Also chasmogamous flowers are occasionally lacking and the size of the cleistogamous capsule is reduced with only 1-3 seeds in each capsule. When chasmogamous flowers are present in *H. glomeratum,* they are to be found terminating both branches and branchlets while in both *H. rosmarinifolium* and *H. argenteum* the solitary chasmogamous flowers are to be found only at the tips of the major branches. Also in these two species the number of seeds/cleistogamous capsule is never more than one or two. In addition the cleistogamous capsules of both species are more reduced than in any other species. However, *H. argenteum* is considered even more advanced than *H. rosmarinifolium* and also perhaps the most advanced species of the North

American species of *Helianthemum* since (1) the chasmogamous flowers have been reduced to one at the tips of the major branches; (2) the more primitive condition of clustered cleistogamous flowers has been reduced to but one (or rarely two together) in the leaf axils; (3) the cleistogamous capsules are the smallest of all the species studied; and (4) the leaf-size is greatly reduced.

The primitive and advanced features are summarized below:

More than 7000 herbarium specimens were examined of the *Helianthemum* collections of 53 herbaria to whose curators we are most indebted. These herbaria are indicated by their abbreviations following Lanjouw & Stafleu (Regnum Vegetabile, ed. 4. **15:** 1959.): A, ARIZ, BUS, CHRB, COLO, CU, DS, DUKE, F, FLAS, FSU, GA, GH, IA, ILL, IND, ISC, JEPS, KANU, KY, MICH, MIN, MISSA, MO, MSC, NCSC, NCU, ND, NO, NY, OKL, OKLA, OS, PENN, PH, POM, PUR, RSA, SBBG, SBM, SD, SMU, TENN, TEX, UARK, UC, UMO, US, SCAR (=University of South Carolina), USF, VDB, WIS, WVA.

PRIMITIVE	ADVANCED
1. Possession of only chasmogamous flowers.	1. Possession of both chasmogamous and cleistogamous flowers or of cleistogamous flowers only.
2. Few but large cleistogamous flowers.	2. More numerous but smaller cleistogamous flowers.
3. Floral parts large.	3. Floral parts relatively small.
a. Outer sepals of chasmogamous flowers spatulate (and relatively large).	a. Outer sepals of chasmogamous flowers linear (and small).
b. Outer sepals of cleistogamous flowers large.	b. Outer sepals of cleistogamous flowers much smaller, often reduced to knob-like rudiments.
c. Stigma large.	c. Stigma small.
4. Fruits large and many-seeded.	4. Fruits small and few-seeded.
5. Numerous stamens in the chasmogamous flowers.	5. Fewer stamens in the chasmogamous flowers.
6. Carpels 3.	6. Carpels 2.
7. Non-hygroscopic testa.	7. Hygroscopic testa.

to be continued

AN EARLIER NAME FOR LUDWIGIA NATANS (ONAGRACEAE)

Peter H. Raven

John Reinhold Forster's "Flora Americae Septentrionalis, or a Catalogue of the Plants of North America . . . . ," published in London in 1771, has in general been neglected. It is an enumeration in the form of a list with English names, localities, references, and occasionally economic notes on the plants known from North America up to that time, arranged according to the Linnaean system. It is not an original work but rather a compilation based on the published works of other students. Thus, Forster himself evidently considered its greatest utility to serve as a kind of index to the important early works of Kalm, Gronovius, Sloane, and Catesby.

Forster did, however, propose new binomials for a few species described in the second edition of Gronovius' Flora Virginica (1762), a work which did not adopt Linnaeus' binomial system of nomenclature. One such is Gronovius' "Ludwigia caule repente, foliis obverse ovatis petiolatis" (p. 20), for which Forster (1771, p. 6) proposed "Ludwigia repens? N. S.," quoting Gronovius' description in full. It is often possible to typify Gronovius' names with collections made by Clayton. Clayton's specimen of this particular species, in the herbarium of the British Museum (Natural History), is *Ludwigia palustris* (L.) Ell. It cannot be taken as a type, however, as the description ("floribus . . . dilute luteis tetrapetalis fugacissimis . . .") can refer only to the species currently known as *Ludwigia natans* Ell. (1821). Clayton's mention of petals probably accounts for Linnaeus' not identifying this species with his *Isnardia palustris* [= *Ludwigia palustris* (L.) Ell.], as subsequent authors have incorrectly done (cf. Fernald, Rhodora 37: 175-177. 1935). Thus, the partial synonymy for this species is as follows:

Ludwigia repens Forst., Fl. Amer. Sept. 6, 1771.

Ludwigia natans Ell., Sketch Bot. S. C. & Ga. 1: 581. 1821.

Ludwigia repens Forst. is listed in the *Index Kewensis* (2: 123. 1895), but the page reference is given incorrectly as "22." Five other new species are proposed by Forster in his work. Two on p. 7 are published under the genus "*Menandra*" and are therefore invalid, "*Menandra*" itself never having been published. A third proposed species, "*Rhamnus volubilis,*" p. 11, is a *nomen nudum*. The remaining two, *Potamogeton rotundifolium* and *P. oblongifolium*, p. 7, are validly published and should, therefore, be taken up by the *Index Kewensis* and similar works. Gronovius' brief descriptions (Fl. Virg., ed. 2, 23. 1771) might make it possible for them to be identified. Unfortunately, there is apparently no existing herbarium material that can be identified with these names.

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DIVISION OF SYSTEMATIC BIOLOGY, STANFORD UNIVERSITY, STANFORD, CALIFORNIA

MOUNTAIN FLOWERS OF NEW ENGLAND[1]

This is an important illustrated and convenient guide to the alpine plants of New England and New York.

The excellent illustrated series of articles by Stuart K. Harris, *Plants of the Presidential Range*, that appeared in Appalachia at intervals during the years 1940-1949 provided the principal basis for the present book. The area covered being somewhat larger in the present work, it has been necessary to define the boundaries of the alpine area very carefully; also, it was necessary to provide a complete and accurately selected list of species and to be as precise as possible about habitats. In these matters, the help of Frederic Steele has been particularly valuable.

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[1]Mountain Flowers of New England, by Stuart K. Harris, Jean Langenheim, Frederic L. Steele, and Miriam Underhill. Appalachian Mountain Club, Boston, Mass. 150 pp. April 1964. $4.50.

The thirty-two plates in color at the end of the book are unusually well done and represent an admirable selection of the flora. Of these, twenty-eight are photographs of vascular plants illustrating some 129 species. Selected examples of mosses and lichens are depicted on three plates, while the final page shows six scenic habitats in the mountains of Maine and New Hampshire. This important photographic contribution was made by Miriam Underhill.

The text on lichens and mosses was contributed by Jean Langenheim. With these groups there was no attempt made to be exhaustive, but a good beginning can be made by the amateur using the book and referring to the illustrations.

The book is compact (4.5 × 7.5 in.), and with its profuse drawings, color photographs, readable descriptions, keys and glossary, will help materially to educate the mountain climber.

A few suggestions for improvements in future printings or editions are perhaps in order. A comment from one of the authors refers to the desirability of providing information about dates of flowering. For example, certain species do not flower as late as July in most years, while others do not commence flowering until July. This information could be given in a special table or added to the discussion for any particular species. It seems to this reviewer that the four authors should be given more prominence by placing their names on the title page. The introduction seems to be an unusual place to have to look to locate the authors' names.

A. R. Hodgdon, UNIVERSITY OF NEW HAMPSHIRE

A SECOND CHARACTER DISTINGUISHING HETEROTHECA S. STR. FROM CHRYSOPSIS (COMPOSITAE: ASTEREAE)

Vernon L. Harms

The sole criterion of the absence of pappus bristles in the ray florets of *Heterotheca* Cass. and their presence in *Chrysopsis* has been used traditionally to separate the respective genera. An examination of numerous specimens of all included entities has revealed another character which also seems consistently to separate the two groups if the earlier cauline leaves have been retained on the specimens. The lowermost leaves of most *Chrysopsis* and of all *Heterotheca* s. str. species are distinctly petiolate and the upper ones sessile. In *Chrysopsis* there is simply a progressive reduction of the petiole length with no enlargement of petiole bases from the lower to upper leaves (Fig. 4-8). But in *Heterotheca* s. str., the sequence from the lower petiolate to the upper sessile leaves is characterized by progressively more expanded petiole bases in successive leaves, resulting in a gradual proximal to distal lamination of the petiole (Fig. 1-3). The radical and very lowermost cauline leaves have long petioles without expanded bases. The leaves just above these begin to reveal small laminar petiole bases. These petiole bases or auricles become increasingly more expanded and conspicuous in successive leaves to merge eventually with the leaf blade proper obscuring all traces of the petiole.

The peculiar lyrate to panduriform shapes of the middle leaves of this petiole lamination series in *Heterotheca* s. str. (Fig. 1-3) are quite distinctive of the group, never being present in any *Chrysopsis* species. This characteristic leaf sequence is apparent in all *Heterotheca* entities, but of course is not distinguishable on herbarium specimens if none of the lower petiolate leaves have been retained. In large, well-developed *Heterotheca* plants, especially in dense stands, most of the lower leaves may be deciduous and the remaining leaves predominantly of the upper sessile type.

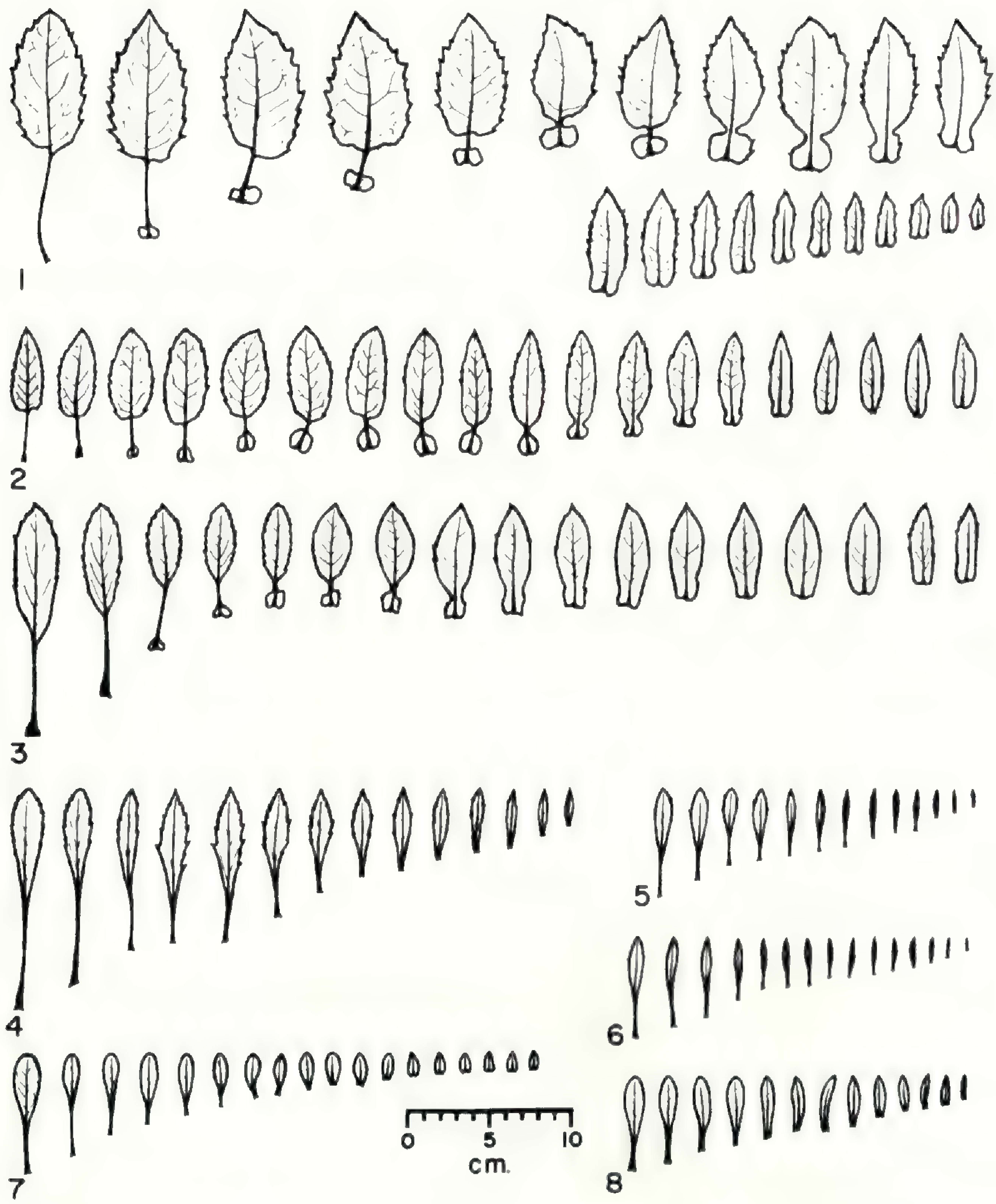

Fig. 1-8. Comparative series of basal to upper leaves in various *Heterotheca* and *Chrysopsis* species. Fig. 1. *Heterotheca latifolia,* Clark County, Ga., G. L. Plummer. Fig. 2. *H. subaxillaris* Tift County, Ga., G. L. Plummer. Fig. 3. *H. psammophila,* Cochise County, Ariz., V. L. Harms 1849. Fig. 4. *Chrysopsis camporum,* St. Louis County, Mo., R. L. McGregor. Fig. 5. *C. berlandieri,* Harvey County, Kans., V. L. Harms 1324. Fig. 6. *C. stenophylla,* Woods County, Okla., V. L. Harms 1995. Fig. 7. *C. fulcrata,* Dona Ana County, N. Mex., V. L. Harms 1839. Fig. 8. *C. villosa,* Jackson County, S. Dak., V. L. Harms 2149.

Yet in the field it is usually possible to find at least some shoots of almost every plant which reveal traces of this very characteristic petiole sequence. Various field botanists have previously noted and used the peculiar basal lobing of the petioles as a field character to help distinguish local *Heterotheca* species. But this attribute has apparently never been recognized as a consistent diagnostic feature characteristic of all *Heterotheca* s. str. species in contrast to those of *Chrysopsis*.

While this second diagnostic character improves the status of *Heterotheca* s. str. as a natural group and might possibly be construed as enhancing the continued generic separation of the two groups, such a conclusion is hardly warranted. Foliage characters just as diverse, if not more so, separate the section *Pityopsis* (*C. graminifolia* and its allies) from the other sections of *Chrysopsis*. Both morphological data (Shinners, 1951, and Wagenknecht, 1960) and cytogenetic evidence (Harms, in press) seem to point to the congeneric status of *Heterotheca* and *Chrysopsis*, in which case the peculiar petiole lamination sequence reported here would constitute another sectional character, along with epappose ray florets, serving to distinguish *Heterotheca* sect. *Heterotheca* from the other sections of an enlarged genus.

DEPARTMENT OF BIOLOGICAL SCIENCES,
UNIVERSITY OF ALASKA, COLLEGE.

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TULOSTOMA BRUMALE PERS. A NEW RECORD FOR NEW ENGLAND

WESLEY N. TIFFNEY AND WESLEY N. TIFFNEY, JR.

In April 1963, we were collecting on Good Harbor Beach, Gloucester, Essex County, Massachusetts. Mr. Arnold Kenniston of Norton drew our attention to an unusual Basidiomycete. Later, we tentatively identified the plant as *Tulostoma brumale* Persoon of the Series Gasteromycetes in the order Sclerodermatales. This is a stalked puffball which produces its fruiting body in the fall as a small sclerotial swelling some two to three centimeters under the surface of the ground (Gaumann and Dodge, 1928). On maturation, it emerges on a slender stipe and sheds its exoperidium, exposing an endoperidium which opens by an apical mouth.

Good Harbor Beach is a public bathing area. Back of the broad, sandy storm beach is a series of low dunes which extend for about 350 yards to a public highway. This broad area of fine sand is a rarity on rocky Cape Ann.

In 1963, thirty-five specimens of *Tulostoma* were collected from the north end of the beach ninety to one-hundred feet inland from the fore-dune. In 1964, thirty-three additional individuals were taken, nine from the previous station and twenty-four from a location sixty to seventy-five feet south of the 1963 site and about seventy-five feet from the fore-dune. The vascular plants associated with *Tulostoma* were as follows: *Agropyron repens* (L.) Beauv. (common), *Ammophila breviligulata* Fernald (fairly common), *Lathyrus japonicus* Willd. var. *glaber* (Sev.) Fernald (fairly common), *Limonium Nashii* Small (rather rare), *Solidago sempervirens* L. (rather rare), *Sedum* sp. (only a few plants), and *Taraxacum officinale* Weber (only a few). Specimens are on deposit at the Herbarium of the University of New Hampshire.

Our collection in Gloucester constitutes a new record for both the genus *Tulostoma* and the family *Tulostomataceae* in New England. The nearest station to our material for the genus is one reported by White (1901) in Ithaca, New York.

The identification of this organism as *Tulostoma brumale* Persoon 1801 posed a considerable problem. We visited the Farlow Herbarium and the Herbarium of the New York Botanical Garden and examined their collections of *Tulostoma*.[1]

We feel from our investigation that many uncertainties exist in the taxonomy of the genus. At present, no studies are available showing possible variation within a single large population. If such studies were systematically made for the genus, it might be possible to reduce to synonomy many existing species. Cunningham (1942) supports this conclusion when he states that of the eighty-five described species of *Tulostoma*, "not more than about thirty are valid." Our present collection is of a size to warrant making a statistical examination of *Tulostoma brumale*.

Coker and Couch (1928) noted that *Tulostoma simulans* Lloyd was found at the same station for nineteen years. This indicates a perennial tendency in at least some species of the genus. Our material from Cape Ann appears to be perennial since it has persisted in the same locality for two years. If our organism can be collected annually, it is our hope to find eventually young specimens in the hypogenous stage and perhaps to verify Schroeter's figures of the basidia and the method of spore production.

There is confusion in the taxonomic history of the genus *Tulostoma* and of the species *T. brumale*. Persoon established *T. brumale* in 1801 (Synopsis methodica fungorum, p. 139). Synonyms for Persoon's species are. *T. imbricatum* Pers. 1794 (N. Mag. Bot. (Rom.)1:86); *T. squamosum* Pers. 1801 (Syn. meth. fung., p. 139); *T. mammosum* Fr. 1829 (Syst. 3:42); and *T. pedunculatum* (L.) Schroet. 1876 (Beitr. Biol. Pflanz. (Cohn) 2:65). There has also been confusion concerning the spelling of

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[1]The authors are very grateful to Dr. Clark T. Rogerson, Curator of Cryptogamic Botany of the New York Botanical Garden, for the time and attention given to us during the two days spent at the herbarium.

the generic name. Persoon established the genus in 1801 and spelled it *Tulostoma.* Sprengel in 1827 (Systema Vegetabilium 4(1) : 524) followed by Fries in 1849 (Summa Vegetabilium Scandivaviae 440), Saccardo in 1888 (Syl. fung. vol. 7) and Long in 1946 (Mycologia 38:77), among others, questioned the etymology of the word and pointed out that the Greek upsilon should be transcribed by the Latin "y", thus spelling the genus *Tylostoma.* We consulted Dr. Donald P. Rogers[2] of the University of Illinois on this matter, and he pointed out that there was "no law on the point and the practice was not invariable." He stated that such names as "*Tulocarpus, Tulodiscus* and *Buxus* or *Mucor*" were equally vulnerable to the same type of logic. Thus, no "inadvertance or error on the part of the author" can be claimed. With this support, we advise the retention of Persoon's spelling of *Tulostoma.*

BIOLOGY DEPT., BOSTON UNIVERSITY, BOSTON, MASSACHUSETTS
BOTANY DEPT., UNIVERSITY OF NEW HAMPSHIRE (Graduate School), DURHAM

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[2]We wish to thank Dr. Rogers for his aid with synonomy of the species and spelling of the generic name.

NEW RECORDS OF ARCTIC SPECIES IN SOUTHEASTERN NEW BRUNSWICK

Three arctic species with southern mainland limits in the mountains of the Gaspe Peninsula, according to Fernald (1950), are *Dryas integrifolia* Vahl., *Salix myrtillifolia* Anderss. and *Solidago multiradiata* Ait. The last named has been reported from St. Paul Island, Nova Scotia, by Perry in 1931.

These three species were found in the vicinity of Hillsborough, Albert County, in south-eastern New Brunswick during 1964 associated with *Anemone parviflora* Michx., *Shepherdia canadensis* (L.) Nutt., and *Potentilla fruticosa* L., new records for this part of the province, and with *Erigeron hyssopifolius* Michx., *Galium triflorum* Michx., *Mitella nuda* L., *Campanula rotundifolia* L., and *Cystopteris bulbifera* (L.) Bernh., all common elsewhere in Albert County.

The habitat is a crumbling cliff of white gypsum, less than half a mile long, 70-80 ft. high, with a north-facing slope of 70-75°. The plateau at the top of the cliff is 300 ft. above sea level and bounded on at least three sides by the steep gypsum cliffs. It is dissected slightly by streams and honeycombed with funnel-shaped sinkholes ranging from 10 to 60 feet in depth and in orifice diameter. The plateau, which has been partially cut over, supports a somewhat stunted forest of *Picea rubens* Sarg., *P. mariana* (Mill.) BSP., *Abies balsamea* (L.) Mill., *Betula lutea*, Michx.f. and *Tsuga canadensis*, (L.) Carr.; there is generally a heavy carpet of herbs, mosses and lichens beneath. Along the streams, for the most part, the same species are present but the forest growth is richer, particularly at the base of the cliffs. None of the newly recorded species are present in the forest although *Salix myrtillifolia* is abundant near the base of the north-facing cliff at the upper edge of the forest. Some of the other species do appear wherever gypsum occurs at the surface and the canopy is open. *Dryas integrifolia*, *Solidago multiradiata* and *Anemone parviflora* appear to be confined to the exposed north-facing cliff, forming, with the other species, mats of up to two square meters in area on the otherwise loose talus.

Other gypsum cliffs in Albert County investigated thus far do not support *Dryas integrifolia, Solidago multiradiata, Anemone parviflora* or *Salix myrtillifolia* although all of the other species are usually present.

The nomenclature employed here follows Fernald (1950). Specimens have been deposited in the Herbarium of the University of New Brunswick, Fredericton, New Brunswick and in the Phanerogamic Herbarium of the Canada Department of Agriculture, Ottawa.

This work is part of project G15, "The distribution of the flora of New Brunswick," supported by the New Brunswick Research and Productivity Council. The help of Dr. Bernard Boivin of the Canada Department of Agriculture, Ottawa, in checking identifications is gratefully acknowledged.

PATRICIA R. ROBERTS, UNIVERSITY OF NEW BRUNSWICK, FREDERICTON, NEW BRUNSWICK.

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COMMON TREES OF PUERTO RICO AND THE VIRGIN ISLANDS[1]

Visitors to the West Indies interested in trees usually come away with much misinformation acquired from chauffeurs and local guides. Even the best "official guides" in the

[1]Common Trees of Puerto Rico and the Virgin Islands. By Elbert L. Little, Jr., and Frank H. Wadsworth. U. S. Department of Agriculture, Agriculture Handbook No. 249, 548 pages, illus. 1964. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. Price $4.25 (cloth).

several botanic gardens often confuse rather than inform the interested tourist. This is particularly true if several islands are visited where different languages and cultural backgrounds have served to give diverse and often overlapping common names to the native and introduced trees. Even a visitor with considerable botanical background finds himself fairly helpless when confronted for the first time with numbers of unfamiliar tropical and subtropical trees and is usually frustrated in identifying any except a handful of well known ornamental and economic species.

The preparation of this guide by the Forest Service and USDA offers at least partial relief to this situation by describing in nontechnical language 250 species of the commoner native and introduced trees of Puerto Rico and the Virgin Islands. Full page line drawings, as near natural size as space permits, of foliage, flowers and fruit face each description and permit identification by this means alone. In addition, several categories and nontechnical listings as well as keys are included to enable even the novice to identify the described trees. A valuable part of each treatment is the listing of common names used in various Carribbean islands and countries. With both English and Spanish editions available this volume will be helpful in the whole Carribbean and Central American area as a great many of the species described occur throughout.

Information is included indicating economic value and ornamental use of the trees described which should make this book valuable to foresters, horticulturists and other residents of the area. Biology teachers from grade school to college level will find this an almost necessary reference book. Both scientific and common names are included in one complete index. A second volume is planned to include several hundred less common and rare tree species (27 feet or over) which will presumably complete the treatment for these islands.

R. B. PIKE, UNIVERSITY OF NEW HAMPSHIRE

DISSECTING EQUIPMENT AND MATERIALS FOR THE STUDY OF MINUTE PLANT STRUCTURES[1]

At one time the agrostologist's favorite bit of dissecting equipment was a carefully cultured fingernail. However handy this might be, it lacked the precision that artificial equipment may possess. Unfortunately, the average botanist's collection of dissecting equipment is ill-suited to the tasks of dissecting small plant structures and rarely is kept in proper condition. Hooked-tip dissecting needles or blunt prods make the ticklish job of manipulating spikelet parts or similar small structures almost impossible. The following suggestions for the fabrication and care of the basic equipment for handling spikelets and similar organs are the outgrowth of many years of working with grass structures.

The common wooden-handled dissecting needle is one of the most useful and most neglected items of the taxonomist's equipment. By culling over a collection of needles, one can select the strongest for conditioning. They should be pointed on a fine carborundum stone to remove burrs and to give the point a 45° taper. A long needle-point is not desirable, lacking the necessary strength. Final sharpening and polishing should be done on the finest grade of oil stone available. The Behr-Manning HF 873 Hard Arkansas Knife Blade is ideal. The tip should be circular in cross section all the way to the point. The proper sharpening of needles is greatly facilitated by the following method of handling: hold the wooden handle of the needle between the ball of the extended thumb and the second finger, which should be hooked back toward the palm of the hand. The tip of the index finger then lies on top of the tip of the needle, and presses it against the stone. With oil on the stone, slide the needle tip forward and backward over the stone. While thus sharpening the point, the handle of the needle should be rotated between the thumb and the second finger. The point produced by this manipulation will be uniformly tapered and as sharp as desired. Needles should not be

[1]Journal Paper #J-4880 of the Iowa Agricultural and Home Economics Experiment Station, Ames, Project 1136.

sharpened by rubbing sideways on the stone, as chatter will ruin the point.

I still treasure a micro-scalpel of pre-war German manufacture, its blade now almost worn away. Since "Ersatz" American-made products available since the war have been very unsatisfactory, we have made our own micro-scalpels by a variety of processes. The most satisfactory tools can be made from the end section of coping-saw blade (.110″ wide × .020″ thick). The handle is an ordinary wooden dissecting needle handle with the needle removed. The base of a two inch section snipped from the saw blade is thrust into the wooden handle. The hole may have to be enlarged with a fine drill, and the blade can be firmly set with plastic glue. If desired, the shank of the blade can be strengthened by wrapping it in thin metal from a juice can. The saw teeth can be filed or ground off and the scapel blade roughly shaped in any desired style with wire nippers, a file or coarse stone. Final sharpening should be done on a fine oil stone. The scalpel blade ordinarily should not be over 3 or 4 mm. long and its edge should be sharpened to a V-profile. Extremely thin edges should be avoided, since they will merely roll, rather than cut.

Dissection of tough or rigid plant structures is facilitated by the application of a few drops of the following solution. It penetrates rapidly, is non-staining, and requires no boiling. It may safely be used on herbarium sheets. We dispense it from a miniature polyethylene squeeze-bottle, provided with a medicine-dropper tip.

Dioctyl sodium sulfosuccinate[2]	1%
distilled water	74%
Methyl alcohol	25%

RICHARD W. POHL
IOWA STATE UNIVERSITY, AMES

[2]Sold commercially as "Aerosol OT".

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Rhodora

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Rhodora

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NEW ENGLAND BOTANICAL CLUB

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STUDIES IN THE FLORA OF BOLIVIA, — III.
CYPERACEAE, PART 1.

ROBERT C. FOSTER

This treatment of the Bolivian *Cyperaceae* is complete except for the genus *Cyperus*, which will constitute Part 2 of the family treatment. Since it is floristic, rather than monographic, synonymy has mostly been limited to names, some based on misidentifications, which were included in my Catalogue of the Ferns and Flowering Plants of Bolivia (Contrib. Gray Herb. no. 184 [1958]), but which now seem properly relegated to synonymy. In a few instances, I have not seen Bolivian material of species, but after the Bolivian specimens cited I have placed in parentheses the name of a previous worker who had seen them.

A generic description is given whenever two or more species of a genus are treated. When only one species of a genus occurs in Bolivia, a combined generico-specific description is given, to prevent unnecessary repetition. It should be emphasized that generic descriptions are based solely on the Bolivian representatives of a genus.

For the most part, the treatment is based on the collections of the Gray Herbarium (GH). I have, however, received supplementary material from the New York Botanical Garden (NY), the United States National Herbarium (US) and the Missouri Botanical Garden (MO). I am much indebted to the curators of these institutions for making their specimens available. Above all, I am most grateful to Dr. Lyman B. Smith for his patience in answering questions and his kindness in searching for material which would be helpful to me.

KEY TO GENERA

a. Flowers unisexual.
  b. Rachilla of pistillate flowers prolonged and conspicuous. .... 14. *Uncinia.*
  b. Rachilla neither prolonged nor conspicuous.
    c. Achene covered by a puberulent membrane or by a perigynium.
      d. Achene enclosed in a puberulent membrane; staminate flower a single stamen. .... 12. *Calyptrocarya.*
      d. Achene enclosed in a perigynium; staminate flower of 3 stamens. .... 15. *Carex.*
    c. Achene not covered by a membrane nor by a perigynium. .... 13. *Scleria.*

a. Flowers perfect (at least some of them).
  e. Leaf-blades absent. .... 7. *Eleocharis.*
  e. Leaf-blades present (sometimes much reduced).
    f. Style-base persistent on the achene.
      g. Style-base a tubercle. .... 9. *Bulbostylis.*
      g. Style-base a beak.
        h. Perianth present (of scales or bristles).
          i. Achene surrounded by a transparent scale or utricle. .... 3. *Ascolepis.*
          i. Achene surrounded by scales or bristles.
            j. Perianth of 3 flattened scales alternating with 3 bristles (or the bristles absent). .... 5. *Fuirena.*
            j. Perianth of bristles only (flattened scales absent). .... 11. *Rhynchospora.*
        h. Perianth absent. .... 11. *Rhynchospora.*
    f. Style-base not persistent on the achene.
      k. Perianth-bristles present. .... 4. *Scirpus.*
      k. Perianth-bristles absent.
        l. Inner scales present in flowers.
          m. Inner scales 2, like a 2-valved utricle. .... 1. *Lipocarpha.*
          m. Inner scale 1, small, between achene and axis of spikelet. .... 2. *Hemicarpha.*
        l. Inner scales absent in flowers.
          n. Spikelets mostly many-flowered.
            o. Spikelet-scales 2-ranked, conduplicate. .... 6. *Cyperus.*
            o. Spikelet-scales spirally arranged.
              p. Style-base thickened or dilated. .... 8. *Fimbristylis.*
              p. Style-base not thickened. .... 4. *Scirpus.*
          n. Spikelets mostly 1-2 (-few)-flowered. .... 10. *Cladium.*

1. LIPOCARPHA R. Br.

Lipocarpha Sellowiana Kunth, Enum. Pl. **2**: 267 (1837). Caespitose perennial to 8 dm. tall. Culms slender, rigid, triangular. Leaves few, basal, shorter than the culms, basal sheaths often reddish or purplish, blades subterete, canaliculate, the apex obtuse. Involucre of 2-3 foliar bracts, the lowermost to 12 cm. long, the others much shorter. Inflorescence of 2 to several sessile, ovoid or subglobose spikes forming a dense capitulum. Glumes imbricate, to 2 mm. long, obovate to cuneate with a broad terminal acumen, many-nerved, striate, subtending axillary perfect flowers of 1-2 stamens and trifid style, these surrounded by a 2-valved utricle with one scale adaxial, the other abaxial, the 2 parts more or less transparent, membranous, many-nerved, elliptic-ovate and more or less concealed by the glumes. Achene to 1.3 mm. long, basally attenuate, obscurely trigonous. SANTA CRUZ: SARA: Buenavista, 450-500 m., *Steinbach* 1902 (GH), 5140 (GH), 6895 bis (GH).

2. HEMICARPHA Nees & Arn.

Hemicarpha micrantha (Vahl) Pax in Engl. & Prantl, Nat. Pflanzenfam. 2(2): 105 (1887). *Scirpus micranthus* of the Catalogue. Dwarf annual with dark fibrous roots. Culms to 9 cm. high, often much shorter, capillary, smooth. Leaves much shorter than culms, capillary, subterete, sheath-orifice oblique. Inflorescence terminal, pseudolateral, of 1-3 spikelets, involucral bract much exceeding spikelets and appearing as a continuation of the culm. Spikelets ovoid to oblong-ovoid, to 2 mm. long; scales brown with light streaks, oblong-ovate, to 1 mm. long, but usually not much exceeding the achene, not carinate; a small translucent scale between the achene and spikelet-axis; perianth-bristles 0; stamens 1; style bifid. Achene narrowly obovoid, briefly apiculate at the abruptly obtuse apex, about 0.5 mm. long, pale brown until full maturity, then dark brown, minutely and evenly papillate in longitudinal rows, style-base not persistent as a tubercle. SANTA CRUZ: SARA: Buenavista, 450 m., *Steinbach* 1919 (GH).

3. ASCOLEPIS Nees

Ascolepis brasiliensis (Kunth) Benth. ex C. B. Clarke in Dur. & Schinz, Conspect. Fl. Afr. 5: 651 (1894). Perennial, from a more or less horizontal slender rhizome, to 6 dm. tall. Culms slender to filiform. Leaves basal, few in a tuft, shorter than the culms, filiform, basally sheathing. Involucre of 1-3 unequal bracts, the longest to 9 cm. long. Inflorescence capitulate, of 1-3 dense, ovoid to globose sessile spikes to 8 mm. long. Spikelets spirally inserted on the rachis of the spike, each consisting of a long-triangular or long-deltoid several-nerved glume to 2 mm. long and less than 1 mm. wide at the base, subtending a flattened, oval, several-nerved scale or utricle to 2.5 mm. long, the apex abruptly acuminate, the wide margins hyaline, this containing the perfect flower of 1-2 stamens and bifid style, the style-base persistent on the oblong, biconvex, basally attenuate achene, the achene-coat shining brown, finely reticulate. SANTA CRUZ: SARA: Buenavista, 450 m., *Steinbach* 6727 (GH).

4. SCIRPUS L.

Annual or perennial, in wet or damp habitats. Plants dwarf to very tall, the culms filiform to broad-trigonous. Leaves with basal sheaths, the blades mostly short and narrow, or greatly reduced. Inflorescence terminal, reduced to 1-many spikelets, pseudolateral in some species. Spikelets few- to several-flowered, the lowest scales empty, flowers perfect, perianth-bristles present or absent; stamens 2-3; style bifid or trifid. Achene plano-convex or trigonous, smooth or somewhat reticulate or scrobiculate.

a. Inflorescence not pseudolateral.
  b. Perianth-bristles 0.
    c. Achene contracted apically into a short neck.
      d. Culms to 2 dm. high; achene trigonous. .... 2. *S. cernuus.*
      d. Culms to 3 cm. high; achene plano-convex. .. 4. *S. boliviensis.*
    c. Achene not contracted apically into a neck, but abruptly rounded-obtuse. .... 5. *S. atacamensis.*
  b. Perianth-bristles present.
    e. Inflorescence sessile; leaves in a rosette; achene pale. .... 8. *S. acaulis.*
    e. Inflorescence not sessile; leaves not in a rosette; achene dark. .... 9. *S. deserticola.*
a. Inflorescence pseudolateral.
  f. Culms to 2.5 dm. tall, 0.5-1 mm. wide; perianth-bristles 0.
    g. Achene pale brown or stramineous, plano-convex. .. 1. *S. rigidus.*
    g. Achene shiny black or deep brownish-black, trigonous. .... 3. *S. inundatus.*
  f. Culms 0.5-2 m. tall, 2-10 mm. wide; perianth-bristles present.
    h. Leaf-blades present; perianth-bristles not plumose.
      i. Inflorescence a single capitulum; spikelet-scales bilobed or emarginate. .... 6. *S. americanus.*
      i. Inflorescence anthelate; spikelet-scales not bilobed nor emarginate. .... 7. *S. asper.*
    h. Leaf-blades rudimentary or absent; perianth-bristles plumose-ciliate. .... 10. *S. californicus.*

1. **Scirpus rigidus** Boeckl. in Linnaea, **36**: 492. (1870). Stiff, rigid perennial, the fasciculate stems to 2.5 dm. tall, more or less angular-terete, striate, glabrous, smooth or scabrid above. Leaves shorter than the culms, mostly less than 1 mm. wide, glabrous, the margins scabridulous, apex obtuse, sheath-orifice oblique and attenuate. Inflorescence usually a solitary pseudolateral spikelet subtended by 2 bracts, the lower foliar, appearing as a continuation of the culm, somewhat exceeding the spikelet. Spikelet to 1 cm. long; scales oval, obtuse, the lowermost broadly carinate and muticous, yellowish or stramineous below and warm brown above; bristles 0; stamens 3; style deeply trifid, not enlarged at the base. Achene to 2.3 mm. long, obovoid, plano-convex (or subtrigonous), apex abruptly rounded-obtuse, shiny

black or brownish-black. LA PAZ: LARECAJA: Caypichuru, 3500-4200 m., *Mandon* 1412 (GH).

2. S. **cernuus** Vahl, Enum. **2:** 245 (1806). Dwarf caespitose annual. Culms to 2 dm. high, but usually shorter, filiform, striate-sulcate, smooth. Leaves mostly shorter than the culms, filiform; sheath-orifice oblique, unilaterally produced as a long, broad, obtuse apiculus. Inflorescence of 1(-3) terminal pseudolateral spikelets, subtended by 2 bracts, the lower appearing as a continuation of the culm, hardly or only somewhat exceeding the spikelet. Spikelets to 1 cm. long, usually shorter; scales carinate, the midrib excurrent as a very short blunt apiculus, the midrib green, margins bright reddish-chestnut; bristles 0; stamens (1-) 3; style trifid. Achene obovoid, trigonous, obtuse, with a short apiculus nearly 1 mm. long, obscurely to plainly reticulate. LA PAZ: LARECAJA: near Millipaya, 3200-3700 m., *Mandon* 1409 (GH); MURILLO: near La Paz, 3300 m., *Bang* 71 (GH).

3. S. **inundatus** (R. Br.) Spreng. Syst. Veg. **1:** 207 (1825). Perennial from a filiform, branched, spreading rhizome. Culms to 2.5 dm. tall, setaceous. Leaves mostly shorter than the culms, to 1 mm. wide, flat; sheath-orifice oblique and the sheath prolonged unilaterally. Inflorescence pseudolateral, of 2-several spikelets aggregated in a capitulum, subtended by 2 bracts, the lower erect, exceeding the head and appearing to be a continuation of the culm; spikelets ovoid, 4-12 mm. long; scales ovate, obtuse or mucronulate, somewhat carinate, the keel green, the borders pale or hyaline; bristles 0; stamens 1-2(-3); style trifid. Achene ellipsoidal, trigonous, the apex acute, to 0.6 mm. long, finely or obscurely reticulate, pale brown or stramineous. LA PAZ: LARECAJA: Cochipata, etc., 3000-3800 m., *Mandon* 1406 (GH); near Acouma, *Mandon* 1407 (GH).

4. S. **boliviensis** M. Barros in Darwiniana, **11:** 764 (1959). Dwarf perennial from an erect branching rhizome. Culms to 3 cm. high, obtusely trigonous. Leaves few (3-5), shorter than the culms, the sheaths loose, 6-7 mm. long, the blades 4-5 mm. long. Inflorescence a single terminal ebracteate spikelet about 3 mm. in diameter; scales broadly ovate, obtuse, fuscous, at least the lowermost mucronulate; bristles 0; stamens 2; style bifid or trifid. Achene about 1.2 mm. long, suborbicular, the apex abruptly obtuse and contracted into a short neck, plano-convex, slightly reticulate, pale-castaneous or fuscous. POTOSÍ: CERCADO: Potosí, *Petersen & Hjerting* 1043b (type-number; not seen).

As no material of this species has been available, this description has been based on the original description and figure.

5. S. **atacamensis** (Phil.) Boeckl. in Linnaea, **36:** 482 (1870). Perennial, caespitose, from a descending rhizome. Culms to 6 cm.

high. Leaves shorter than the culms, rigid, canaliculate, the margins scabrid on the upper portion. Inflorescence usually a single, terminal, few-flowered spikelet about 6-7 mm. long, the subtending bract not foliar but resembling a scale; scales elliptic-ovate, obtuse, stramineous with brown striations; bristles 0; stamens 3; style trifid. Achene to 1.5 mm. long, plano-convex, obovoid, olivaceous to brownish, shining, the apex abruptly rounded-obtuse. Without data: *Bang* 1882 (GH).

The specimen cited resembles *S. rigidus* vegetatively, but the achene is that of *S. atacamensis*.

6. S. **americanus** var. **polyphyllus** (Boeckl.) Beetle in Amer. Journ. Bot. **30**: 399 (1943). *S. americanus* subsp. *polyphyllus* (Boeckl.) T. Koyama in Canad. Journ. Bot. **41**: 1118 (1963). Perennial from a rather stout rhizome. Culms to 8 dm. tall, glaucous, acutely trigonous, the sides flat. Leaves few, mostly sheathing, the produced blades seldom equaling the inflorescence, basally flattened, the apex trigonous, pungent; sheath-orifice oblique. Inflorescence pseudolateral, a capitulum of 1-6 spikelets, subtended by a bract much exceeding the capitulum and appearing as a continuation of the culm. Scales chestnut-brown, the midrib pale, bilobed with a central mucro equal to or shorter than the lobes; bristles 3-6, exceeding the achene, barbs very large; stamens 3; style bifid (occasionally trifid). Achene obovoid, pale to dark brown, to 2.3 mm. long, plano-convex, apically prolonged into a short neck. COCHABAMBA: CERCADO: near Cochabamba, *Bang* 997 (GH). POTOSÍ: CHICHAS: road from Quechisla to Chorolque, 3600 m., *Cárdenas* 36 (GH).

7. S. **asper** Presl, Rel. Haenk. **1**: 194 (1830). Perennial from a rather woody ascending rootstock. Culms to 8 dm. tall, trigonous, the angles scabrid on the upper portion. Leaf-blades long, to 1 cm. wide, often glaucous, the margins scabrid; sheath-orifice truncate to shortly oblique, the margin finely ciliolate. Inflorescence terminal, compound-anthelate, of several to many capitula, subtended by 2-3 foliar involucral bracts, at least the lowermost exceeding the inflorescence and appearing as a continuation of the culm. Spikelets fasciculate (occasionally solitary), oblong, to 1.2 cm. long; scales ovate, broadly carinate, mucronate, reddish-brown, the keel green, the margin ciliate, especially at the apex; bristles 6, of varying lengths, the longest exceeding the achene; stamens 3; style trifid. Achene ovoid to obovoid, trigonous, to 1.2 mm. long, the apex prolonged into a short neck, smooth, pale (almost white) to brownish. LA PAZ: MURILLO: La Paz, 3460 m., *Buchtien* 529 (GH); Cotaña, 2450 m., *Buchtien* 3141 (GH); Capi, *Bang* 765 (GH).

8. S. **acaulis** Boeckl. in Linnaea, **36**: 494 (1870). Acaulescent perennial from a slender creeping rhizome. Leaves numerous in a flattened rosette, the basal sheath large and much dilated, the apex

more or less obtuse, canaliculate, to 2.5 cm. long, narrow. Inflorescence a sessile capitulum of several to many spikelets, about 7 mm. long. Spikelets oblong, many-flowered (about 8); scales densely aggregated, to 6 mm. long, lance-elliptic, the back green, the sides brownish, apex acute; bristles 5-6, whitish; stamens 3; style long, trifid. Achene obovoid, trigonous, to 1.5 mm. long, the apex acuminate, pale in color, smooth. LA PAZ: MUÑECAS: cordillera above Carabuco, 4200 m., *Buchtien* 6388 (US).

9. **S. deserticola** Phil. Fl. Atac. 53 (1860). Dwarf, densely caespitose perennial from creeping, scaly, slender, much-branched rhizomes. Culms to 10 cm. tall, usually shorter. Leaves very short, much shorter than the culms, the membranous sheathing base somewhat enlarged, blades to 2 cm. long, scabrid on the margins. Inflorescence a solitary terminal (not pseudolateral) capitulum about 1 cm. long, of 2-3 (rarely 1) spikelets, the involucral bracts shorter than the capitulum. Spikelets ovoid-oblong; scales ovate or lance-ovate, the margins pale brown, the broad midrib stramineous to greenish, somewhat excurrent; bristles 3-6, the longest exceeding the achene; stamens 3; style trifid. Achene ellipsoid, trigonous, to 1.5 mm. long, brown, the apex prolonged almost like an apiculus, the surface finely reticulate-scrobiculate. LA PAZ: LARECAJA: Lacatia, etc., *Mandon* 1417 (GH). POTOSÍ: CHICHAS: near Chorolque, 3500 m., *Cárdenas* 62 (GH).

10. **S. californicus** (C. A. Mey.) Steud. Nomencl. (ed. 2) 2: 538 (1841). *S. riparius* of the Catalogue. Perennial from a thick horizontal rhizome. Culms to 1.8 m. high, obtusely trigonous, to 1 cm. wide, smooth. Leaves reduced to thin membranous sheaths, the uppermost with rudimentary blades. Inflorescence a large, terminal, compound anthela, subtended by a single large involucral bract to 5 cm. long, appearing as a continuation of the culm, the inflorescence thus pseudolateral. Spikelets solitary at ends of secondary rays, to 1.8 cm. long; scales broadly ovate to obovate, to 4 mm. long, the apex entire or emarginate, ciliate, long-mucronate, brown or reddish-brown, the midrib and mucro green; bristles 3, plumose-ciliate, equaling the achene; stamens 3; style bifid. Achene to 2.25 mm. long, obovoid, plano-convex, the apex produced as a short apiculus, grayish to brownish, finely scrobiculate. TARIJA: ARCE: Bermejo, 1400 m., *Fiebrig* 2311 (GH).

5. FUIRENA Rottb.

Fuirena umbellata Rottb. Descr. & Icon. 70, t. 19, fig. 3 (1773). Perennial from a creeping rhizome. Culms to 8 dm. tall. Leaves cauline, basally long-sheathing, the linear-lanceolate blades to 18 cm. long and 1.2 cm. wide, acute, scabrid above and beneath, the ligule puberulent or shortly pubescent. Inflorescence of terminal and axillary corymbs. Spikelets few- to many-flowered, on villous peduncles and pedicels, oblong-ovoid, acute, in groups of 3-15, to 7 mm. long. Glumes obovate, red-brown, with 3 prominent green dorsal nerves, the upper half pubescent, 2 mm. long, terminated by a short, thick, straight mucro originating shortly below the apex. Perianth of 3 membranous, flattened, stipitate, ovate, aristate, 3-nerved scales, alternating with 3 bristles (or these absent), surrounding 3 stamens and an obovoid trigonous achene crowned with the persistent base of the trifid style. LA PAZ: CAUPOLICÁN: Apolo, *R. S. Williams* 917 (GH); Ixiamas, 330 m., *Cárdenas* (M. E.)* 1950 (GH). SANTA CRUZ: SARA: Buenavista, 500 m., *Steinbach* 5217 (GH).

7. ELEOCHARIS R. Br.

See Svenson in Rhodora, **31**: 121-135, 151-163, 167-191, 199-219, 224-242 (1929); **34**: 193-203, 215-227 (1932); **35**: 377-389 (1934); **39**: 210-231, 236-273 (1937); **41**: 1-19, 43-77, 90-110 (1939).

Annual or perennial leafless aquatics or semi-aquatics. Culms septate or not septate, angled or terete, with bladeless basal sheaths. Inflorescence a single terminal spikelet, few- to many-flowered, the lowest scales empty, the central scales with perfect flowers, the uppermost scales staminate or sterile. Perianth present as hypogynous bristles (rarely absent), the bristles retrorsely barbed or smooth. Stamens 1-3. Style bifid or trifid, glabrous, the bulbous thickened base persistent on the achene as a tubercle. Achene lenticular, biconvex or trigonous.

a. Culms septate.
- b. Culms 1-2 mm. wide; spikelet much wider than the culms. .... 10. *E. nodulosa.*
- b. Culms 5-10 mm. wide; spikelet hardly or not at all wider than the culm.
  - c. Achene 2 mm. long, longitudinally ribbed and pitted, the cells rectangular; style-base broadly pyramidal. .... 2. *E. interstincta.*
  - c. Achene 1.5 mm. long, scrobiculate; style-base lanceolate, half the length of the achene. .... 11. *E. elegans.*

a. Culms not septate.
- d. Sheath oblique at orifice.
  - e. Achene apically narrowed to a neck.
    - f. Neck of achene broadened upward. .... 1. *E. fistulosa.*
    - f. Neck not broadened upward. .... 3. *E. radicans.*
  - e. Achene lacking an apical neck.
    - g. Achene black or deep brownish-black. .... 6. *E. geniculata.*

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*The initials M. E. refer to specimens collected on the Mulford Biological Exploration. The number-series of these collections duplicate other number-series of the same collectors.

g. Achene white, greenish or brownish.
h. Achene obovoid, greenish to brownish, 1.5 mm. long. .... 9. *E. albibracteata.*
h. Achene ovoid, white to brownish, 1 mm. long.
i. Scales lance-ovate, acute, not emarginate at apex. .... 12. *E. minima.*
i. Scales mostly oblong, obtuse, at least some emarginate at apex. .... 13. *E. filiculmis.*
d. Sheath truncate at orifice.
j. Sheath bifid at apex.
k. Achene shiny black. .... 4. *E. maculosa.*
k. Achene greenish-yellow to olivaceous, never black.
l. Achene olivaceous, with a short apical neck. .... 5. *E. Sellowiana.*
l. Achene greenish-yellow, without an apical neck. .... 8. *E. crinalis.*
j. Sheath not bifid at apex. .... 7. *E. Dombeyana.*

1. **Eleocharis fistulosa** (Poir.) Schult. Mant. **2**: 89 (1824). Culms not septate, acutely trigonous, to 6 dm. high, the coarse roots reddish-brown; sheaths thin, membranous, loose, the orifice oblique, acute, pale reddish-brown. Spikelets to 3 (-3.5) cm. long, as wide as the culm, or sometimes a little wider; scales to 4 mm. long, broadly ovate, subacute or obtuse, firm, conspicuously striate, stramineous to gray, the very narrow, thin, white margin erose; stamens 3; style trifid. Achene about 2 mm. long, obovoid, greenish to light brown, with about 20 rows of deep quadrangular to oblong-hexagonal cells, apex narrowed to a neck and broadened upward to the style-base; bristles 6, exceeding the achene. SANTA CRUZ: SARA: Buenavista, 450 m., *Steinbach* 7444 (GH).

2. **E. interstincta** (Vahl) Roem. & Schult. Syst. Veg. **2**: 149 (1817). Culms septate, terete, to 10 dm. high and 5 mm. wide, from a short thick caudex with coarse red-brown or light brown roots; sheaths membranous, the orifice oblique and acute. Spikelet to 4 cm. long, more or less cylindrical, as wide as or a little wider than the culm; scales oblong, obtuse to subacute, striate, stramineous to gray, with a rather broad, thin, white-hyaline, erosulous margin; stamens 3; style bifid or trifid. Achene 2 mm. long, yellow to gray, longitudinally ribbed and pitted, the cells transversely rectangular and prominent, narrowed to a marked apical annulus (but not narrowed into a neck), the style-base broadly pyramidal, dark brown; bristles 6, exceeding the achene, broad. BENI: YACUMA: near Lake Rogagua, 330 m., *Rusby* (M. E.) 1422 (GH). SANTA CRUZ: SARA: Río Curichi, 450 m., *Steinbach* 1917 (GH); Buenavista, 450-500 m., *Steinbach* 7445 (GH), 7043bis (GH), 5216 (GH).

3. **E. radicans** (Poir.) Kunth, Enum. Pl. **2**: 142 (1837). *E. exigua* and *E. costulata* of the Catalogue. Perennial from filiform creeping

rootstocks. Culms to 1 dm. tall, filiform or capillary, not septate, often recurved, somewhat angular; sheath greenish-scarious, the orifice oblique and acute. Spikelet to 3 mm. long, wider than the culm, scales greenish, often with a broad purple margin, striate, lance-oblong to oblanceolate, obtuse to subacute; stamens 2; style trifid. Achene 1 mm. long, obovoid, yellowish-green to nearly white, obscurely trigonous with about 15 elevated longitudinal ribs, the inter-costal areas about 40-trabeculate, the cells narrowly rectangular, the apex constricted into a neck, but not dilated upward into the dark-green acute style-base; bristles 2 (or 0), white. LA PAZ: LARECAJA: Mapiri, *Bang* 1503 (GH); between Cochipata and Millipaya, 3100 m., *Mandon* 1413 (GH).

4. **E. maculosa** (Vahl) Roem. & Schult. Syst. Veg. **2**: 154 (1817). Perennial, with long, slender, scaly, chestnut-brown stolons. Culms to 3.5 dm. long, not septate, more or less quadrangular and canaliculate, smooth, rigid and erect; uppermost sheaths scarious at apex, enlarged, rugose, the orifice truncate, bifid. Spikelet to 1.2 cm. long, much broader than the culm, lanceolate to ovoid; scales broadly ovate, obtuse, firm-textured, shining, purplish-brown, the scarious margin erosulous; stamens 3; style bifid. Achene to 1 mm. long, obovoid, shiny black, the surface minutely striatulate, narrowed apically to a very short neck, this not enlarged below the style-base; style-base dilated at base, half the achene-width, light-brown, the beak subulate; bristles 7-8, unequal, at least some equaling the achene, teeth small, numerous. LA PAZ: CAUPOLICÁN: Apolo, *R. S. Williams* 914 (Svenson).

5. **E. Sellowiana** Kunth, Enum. Pl. **2**: 149 (1837). *E. ocreata* var. *flaccida* of the Catalogue. Annual, with rather pale slender roots. Culms not septate, to 1.5 dm. tall, or occasionally to 3.5 dm., to 2 mm. wide, striate, slightly constricted below the spikelet; sheaths hyaline at the truncate unilaterally bifid apex. Spikelet to 1 cm. long, wider than the culm, ellipsoid; scales oblong, obtuse, stramineous (or somewhat pale yellow-green), with a narrow brown stripe on each side of the scarcely keeled midrib; stamens 3; style bifid. Achene to 1 mm. long, obovoid, lenticular, olivaceous, shiny, puncticulate-striate, the striae sometimes dark or blackish, narrowed abruptly at the apex into a very short neck, style-base shortly conic, yellow-green, less than half the width of the achene; bristles 7-8, white, shorter than the achene. LA PAZ: CAUPOLICÁN: Apolo, *R. S. Williams* 909 (Svenson). SANTA CRUZ: SARA: Curiche de Piedritas, 450 m., *Steinbach* 2870 (GH).

6. **E. geniculata** (L). Roem. & Schult. Syst. Veg. **2**: 150 (1817). *E. capitata* and *E. geniculata* of the Catalogue. Annual (occasionally stoloniferous ?). Culms to 4 dm. high, not septate, more or less terete, sulcate; sheaths basally brown, stramineous above, the orifice oblique and subacute. Spikelets to 0.8 cm. long, ovoid to subglobose, much

wider than the culms; scales suborbicular to ovate, obtuse, yellow to pale brown with a very narrow, poorly defined, hyaline margin; stamens 2-3; style bifid. Achene about 1 mm. long, obovoid, more or less biconvex or obscurely trigonous, not narrowed into an apical neck, shiny, deep brownish-black or black, the style-base mostly depressed, whitish to brownish; bristles 6-8 (or 0), brown, broad-based, the barbs conspicuous. BENI: YACUMA: near Lake Rogagua, *Mulford Exploration* 2519½ (GH). LA PAZ: SUR YUNGAS: cataracts of the Río Bopi, 1000 m., *Rusby* (M. E.) 738 (GH). SANTA CRUZ: SARA: Río Perdix, 450 m., *Steinbach* 7454 (GH).

7. **E. Dombeyana** Kunth, Enum. Pl. **2:** 145 (1837). Perennial from slender, scaly, red-brown rhizomes. Culms to 3 dm. tall, not septate, subterete, sulcate; sheaths basally deep brown, stramineous at the truncate apiculate orifice. Spikelets to 1 cm. long, ovoid to lance-linear, much wider than the culms; scales elliptic to ovate, obtuse, brown, the midrib yellow or green, the margin hyaline (at least on the lowest scales); stamens 3; style trifid. Achene to 1.3 mm. long, obovoid, trigonous, not narrowed to an apical neck, shiny, yellow or brown, the surface faintly reticulate, the style-base elongate, acute (mucroniform); bristles 4, brown, longer or shorter than the achene. LA PAZ: MURILLO: La Paz, *Buchtien* 149 (GH), 8824 (GH), *Bang* 144 (GH). COCHABAMBA: CERCADO: near Cochabamba, *Bang* 996 (GH).

8. **E. crinalis** (Griseb.) C. B. Clarke in Kew Bull. Add. Ser. **8:** 23 (1908). *E. boliviana* and *E. Brehmeriana* of the Catalogue. Perennial. Culms filiform, in remote clumps from a long, slender, scaly rhizome, to 2 dm. high (rarely higher), not septate, sulcate, angled; sheaths reddish or reddish-brown at the base, the apex darker or lighter, orifice truncate and briefly bifid. Spikelets to 6 mm. long, ovate to elliptic, much broader than the culms; scales ovate to lanceolate, mostly obtuse to subacute, not (or hardly) carinate, deep chestnut-brown to reddish, the midrib paler; stamens 3; style trifid. Achene to 1 mm. long, greenish-yellow, ovoid to suborbicular, obscurely trigonous, the 3 angles thickened, longitudinally striatulate, faintly reticulate, style-base acuminate-deltoid, brownish; bristles pale-brown, slender, about equaling the achene. LA PAZ: MURILLO: Cotaña, 2000-2900 m., *Mandon* 1416 in part (GH; type-number of *E. Brehmeriana*), 2450 m., *Buchtien* 3143 (GH); La Paz, 3750 m., *Buchtien* 4482 (GH; type-number of *E. boliviana*). TARIJA: ARCE: Padcaya, 2100 m., *Fiebrig* 2524 (GH).

9. **E. albibracteata** Nees & Meyen ex Kunth, Enum. Pl. **2:** 143 (1837). *E. nubigena* of the Catalogue. *E. albibracteata* var. *nubigena* (C. B. Clarke) M. Barros in Gen. & Sp. Pl. Argent. 4(1): 179 (1947). Perennial from a rather woody spreading rootstock. Culms filiform, mostly less than 1 dm. long; sheath-orifice oblique, acute. Spikelets to 6 mm. long, wider than the culms; scales ovate, dark brown, the

margin hyaline, entire, the midrib green, obtuse to acute; stamens 3; style trifid. Achene to 1.5 mm. long, obovoid, trigonous, the angles thickened and broad, greenish to brownish, faintly striatulate or reticulate, style-base pyramidal to conic, with a basal ridge at junction with the achene; bristles 3-4, slender, exceeding the achene, occasionally shorter. LA PAZ: LARECAJA: Cochipata, etc., 3100-4100 m., *Mandon* 1414 in part (Gray Herbarium sheet mixed with a very dwarf *Carex*); MURILLO: La Paz, 3300 m., *Bang* 71a (GH).

The variety *nubigena* seems to differ from the species only in the orifice of the sheath, and even this character seems somewhat variable.

10. **E. nodulosa** (Roth) Schult. Mant. **2**: 87 (1824). Perennial from a creeping rhizome. Culms to 8 dm. tall, terete, septate, the septations approximate; sheaths long, stramineous, the orifice truncate, unilaterally apiculate. Spikelets to 2.7 cm. long, lance-oblong, wider than the culms; scales suborbicular to ovate, acute to obtuse, brown, the midrib often lighter in color, with a broad hyaline margin and apex; stamens 2; style bifid or trifid. Achene 1 mm. long, obovoid, biconvex, yellowish, brownish or olivaceous, regularly scrobiculate, the brown style-base flattened-deltoid, with a slight elevation at junction with achene; bristles equaling or somewhat exceeding the achene, red-brown. LA PAZ: CAUPOLICÁN: Apolo, *R. S. Williams* 911 (GH); NOR YUNGAS: Hacienda El Choro, Coripata, *Buchtien* 8065 (NY). COCHABAMBA: TOTORA: Pocona, 2500 m., *Steinbach* 8710 (GH). SANTA CRUZ: SARA: Buanavista, 500 m., *Steinbach* 5298 (GH).

11. **E. elegans** (HBK.) Roem. & Schult. Syst. Veg. **2**: 150 (1817). *E. geniculata* of the Catalogue. Coarse perennial from a creeping rootstock. Culms septate, terete, to 1.5 m. high, to 1 cm. wide; sheaths reddish or pale, the orifice truncate and unilaterally briefly apiculate. Spikelets to 3 cm. long, subglobose to lanceolate to cylindrical, about as wide as the culm or a little wider; scales oblong to obovate, 2 mm. long, obtuse, not carinate, the midportion brown, the broad scarious margin pale brown to whitish; stamens 3; style bifid or trifid. Achene obovoid, 1.5 mm. long, biconvex or obscurely trigonous, the apex narrowed into a short neck, yellow to brown, more or less regularly scrobiculate, style-base dark brown, lanceolate, half the length of the achene; bristles exceeding the achene, dark brown. BENI: YACUMA: Lake Rogagua, *Rusby* 1602 (Svenson).

12. **E. minima** Kunth, Enum. Pl. **2**: 139 (1837). Matted caespitose plants with whitish fibrous roots. Culms to 7 cm. tall, capillary, angular-sulcate, sheaths oblique at the orifice. Spikelets to 4 mm. long, much wider than the culms; scales lance-ovate, acute, dark brown, the midrib green, margin broad, hyaline, white; stamens 3; style trifid. Achene to 1 mm. long, ovoid, trigonous, apically narrowed

into a very brief neck, subreticulate to striatulate, whitish to olivaceous to brown, style-base short-pyramidal, gray or brown; bristles mostly whitish, not equaling the achene, obscurely barbed. SANTA CRUZ: SARA: Buenavista, 450-500 m., *Steinbach* 2208 (GH), 5499 (GH).

13. **E. filiculmis** Kunth, Enum. Pl. 2: 144 (1837). *E. sulcata* of the Catalogue. Perennial from an ascending caudex. Culms to 4 dm. tall, not septate, flattened, sulcate, slender, sometimes to 1 mm. wide; sheath purple-brown to stramineous, the orifice oblique. Spikelets to 1 cm. long, ovoid to cylindric, much wider than the culms; scales more or less oblong, obtuse, often emarginate, stramineous to rufescent, the keel lighter, the broad margin scarious; stamens 3; style trifid. Achene 1 mm. long, ovoid, trigonous, shining white, subreticulate or striatulate, style-base pyramidal, almost as wide as the achene, the basal margin overhanging the achene; bristles about 6, white, nearly equaling the achene. COCHABAMBA: MIZQUE: near Vilavila, 2500 m., *Eyerdam* 24970 (GH). SANTA CRUZ: SARA: Dolores, 450 m., *Steinbach* 1900 (GH); Buenavista, 450-500 m., *Steinbach* 5340 (GH), 6946 (GH).

8. FIMBRISTYLIS Vahl

Annual or perennial. Leaves filiform or linear. Inflorescence anthelate, with few to many heads, or reduced to a single terminal head. Spikelets several- to many-flowered, terete or ellipsoid (ovoid in one case), the glumes all, or mostly, floriferous, imbricate, several-ranked. Flowers perfect; perianth absent; stamens 3; style dilated at the base and abruptly constricted above the achene, bifid or trifid, not persistent on the achene; achene basally attenuate, apically short-apiculate, biconvex or trigonous, regularly ribbed and cancellate or tuberculate.

Inflorescence anthelate, with several to many spikelets; achenes not tuberculate.
  Achenes 1 mm. or more in length, strongly ribbed and cancellate. .... 1. *F. annua.*
  Achenes less than 0.5 mm. long, not cancellate, the ribbing obscure. .... 2. *F. aestivalis.*
Inflorescence reduced to a single head; achenes tuberculate, not ribbed. .... 3. *F. monostachya.*

1. **Fimbristylis annua** (All.) Roem. & Schult. Syst. Veg. 2: 95 (1817). Annual, to 8 dm. tall, glabrous, or in some forms the leaf-sheaths and involucral bracts pubescent. Inflorescence anthelate, involucrate, the lower bract as long as or much exceeding the anthela. Spikelets to 9 mm. long, elliptic, acute, the ovate glumes apiculate, not conspicuously keeled. Style bifid, ciliate on at least the upper portion. Achene 1 mm. long, or a little more, obovoid, biconvex, cancellate, with about 6 prominent longitudinal ribs on each face, the intercostal pitting regular and pronounced. YUNGAS: *Bang* 530 (GH). BENI

(?): Río Beni, *Rusby* 71 (GH). LA PAZ: LARECAJA: San Carlos, Mapiri, 600 m., *Buchtien* 304 (GH); NOR YUNGAS: Coripata, 1300 m., *Buchtien* 8066 (NY). SANTA CRUZ: SARA: Buenavista, 450 m., *Steinbach* 7035 (GH), 1071 (GH), 5141 (GH), 5337 (GH), 5466 (NY). BENI: YACUMA: Hacienda Rosario, near Lake Rogagua, 330 m., *Rusby* (M. E.) 1655 (GH).

2. F. **aestivalis** (Retz.) Vahl, Enum. **2:** 288 (1806). Annual, with fibrous roots. Culms to 2.5 dm. high, filiform. Leaves filiform or very narrowly linear, mostly shorter than the anthelate inflorescence. Involucre of 2 bracts, the lower equaling or exceeding the inflorescence, the other very short. Glumes rather narrowly ovate, 1-1.5 mm. long, carinate, the keel green and excurrent as a short tooth. Style bifid. Achene less than 0.5 mm. long, pyriform, lenticular or obscurely trigonous, evenly papillose. BENI (?): Río Beni, *Rusby* 287 (GH).

Note: the typical form of this species is somewhat pubescent or pilose. This glabrous specimen was determined by H. K. Svenson.

3. **F. monostachya** (L.) Hassk. Pl. Jav. Rar. 61 (1848). Perennial, caespitose, or with a short rhizome, to 3 dm. tall. Leaves flat or canaliculate, shorter than the culms, acute, the margins scabrid. Inflorescence reduced to a single ovoid head (rarely 2), to 1.5 cm. long. Involucre of a single reduced bract, shorter than the head. Lowermost glumes sterile and distichous, the fertile upper glumes spirally inserted on the axis; glumes to 5-6 mm. long, naviculate, carinate, the prominent green keel excurrent as a stout mucro. Style trifid, triangular, the angles densely pectinate-ciliate from base to top. Achene to 2.5 mm. long, somewhat stipitate, pyriform-globose or trigonous-globose, white or yellowish, tuberculate. BENI: YACUMA: near Lake Rogagua, 330 m., *Cárdenas* (M. E.) 1395 (GH). LA PAZ: NOR YUNGAS: Milluguaya, 1900 m., *Buchtien* 4177 (GH). TARIJA: ARCE: Padcaya, 2100 m., *Fiebrig* 2553 (GH).

9. BULBOSTYLIS Kunth

Annual or perennial, the slender, often filiform, culms usually caespitose, leafless, glabrous. Leaves filiform, the sheaths ciliate, especially at the orifice, cilia sometimes absent. Inflorescence monocephalous or anthelate, or the spikelets solitary or fasciculate, the scales often puberulent; flowers perfect. Perianth-bristles 0; stamens 2-3; style glabrous, trifid, the base persistent as a tubercle on the achene. Achene trigonous or compressed, smooth, puncticulate or undulate-rugose.

a. Inflorescence monocephalous.
  b. Inflorescences terminal and basal. .... 1. *B. Funckii.*

b. Inflorescences terminal only.
c. Inflorescence a single obconic spikelet. .... 2. *B. paradoxa.*
c. Inflorescence not a single spikelet.
d. Achene puncticulate but not rugulose. .. 3. *B. sphaerocephala.*
d. Achene transversely rugulose. .... 4. *B. juncoides.*
a. Inflorescence anthelate.
e. Leaves and sheaths densely puberulent. .... 6. *B. hirtella.*
e. Leaves and sheaths glabrous, but scabrid on the margins.
f. Achene puncticulate.
g. Rhizome present, very short; cilia at sheath-orifice brown. .... 8. *B. junciformis.*
g. Rhizome absent; cilia at sheath-orifice white, curling. .... 5. *B. papillosa.*
f. Achene transversely rugulose (occasionally quite smooth).
h. Spikelets solitary. .... 7. *B. capillaris.*
h. Spikelets fascicled (3-5). .... 4. *B. juncoides* var. *ampliceps.*

1. **Bulbostylis Funckii** (Steud.) C. B. Clarke in Kew Bull. Add. Ser. 8: 26 (1908). Annual (?). Culms to 6 cm. high, capillary. Leaves filiform-capillary, shorter than culms, occasionally exceeding the inflorescence; sheath white-ciliate at the orifice. Inflorescence of 2 kinds: terminal solitary spikelets, and basal spikelets. Terminal inflorescence to 4 mm. long, the subtending bract small, usually shorter than the spikelet; scales ovate, somewhat carinate and shortly mucronate; achene less than 1 mm. long, trigonous, transversely rugulose, yellowish-white to very pale brown, the style-base a small flattened brown disc with a minute central apiculus. Basal inflorescence: several flowers enclosed in the bases of modified, rather hyaline leaf-sheaths; achenes about 1.5 mm. long, more markedly rugulose than the terminal achenes. LA PAZ: LARECAJA: Cerro del Iminapi, 2700 m., *Mandon* 1410 (GH).

At first glance this extraordinary little plant may appear to be intermixed with *Isoëtes,* for the basal achene-groups bear a resemblance to the megasporangia of *Isoëtes.*

2. **B. paradoxa** (Spreng.) Lindm. in Bih. Sv. Vet.-Akad. Handl. 26, Afd. 3, no. 9: 17 (1900). Small, densely caespitose perennial from a short woody rhizome. Culms to 1.5 dm. high, but usually shorter. Leaves shorter than the culms, or sometimes nearly equaling them, narrow, obtuse, canaliculate, the base somewhat enlarged, sheath papery, open, densely long-ciliate with white curling hairs. Inflorescence a solitary, terminal, obconic spikelet to 1 cm. long, subtended by several flattened, narrow, long-acuminate bracts, these equaling or shorter than the spikelet; scales lanceolate, the thick green midrib long-excurrent, the basal margins thin, brownish, densely long-ciliate; stamens 2. Achene to 2 mm. long, obovoid, trigonous, the thickened obtuse angles pale, finely rugulose, pale to darkish brown, rather

shining. LA PAZ: CAUPOLICÁN: Altunkama, 2600 m., *Cárdenas* 5679 (US).

3. **B. sphaerocephala** (Boeckl.) C. B. Clarke in Bull. Herb. Boiss. (ser. 2) **3:** 1018 (1903). Caespitose perennial from a very short rhizome. Culms to 6 dm. high, rounded below, quadrangular above. Leaves filiform, flexuose, mostly shorter than the inflorescence, but occasionally longer, puberulent, ciliate; sheaths sparsely to copiously long-ciliate or even fimbriate at the orifice. Inflorescence a single more or less globose head of several to numerous spikelets, the heads to 1.2 cm. wide, subtended by 3 conspicuous puberulent involucral bracts (reflexed at maturity), the lowermost to 3 cm. long. Spikelets oblong, acute, to 4-5 mm. long, with 6-7 flowers; scales orbicular to oval, reddish-brown, ciliolate, mucronulate, to 2.5 mm. long; stamens 3. Achene whitish to brownish, obovoid, trigonous, to 0.7 mm. long, finely puncticulate, style-base flattened, with a dark center. SANTA CRUZ: SARA: Buenavista, *Steinbach* 6805 (Barros).

3a. **B. sphaerocephala** var. **macrocephala** Kükenth. ex Osten in Anal. Mus. Hist. Nat. Montevideo (ser. 2) **3:** 186 (1931). Taller, with a larger head of spikelets. Achene to 0.9 mm. long, grayish, the style-base dark. SANTA CRUZ: SARA: Buenavista, 400 m., *Steinbach* 6806 in part (as to Gray Herbarium sheet).

4. **B. juncoides** (Vahl) Kükenth. ex Osten in Anal. Mus. Hist. Nat. Montevideo (ser. 2) **3:** 185 (1931). Annual (?). Culms to 3 dm. tall, caespitose, obscurely quadrangular, scabrid. Leaves filiform-setaceous, scabrid on the veins and margins, shorter than the culms. Inflorescence a single terminal head of relatively few spikelets (up to 8, rarely more), to 1 cm. in diameter but usually narrower, subtended by 3 involucral bracts, the longest exceeding the head, puberulent, the base enlarged, long-ciliate. Spikelets oblong-ovate, to 5 mm. long, with 6-8 flowers; scales dark chestnut-brown, puberulent (at least the lower ones), ciliate, mucronate; stamens 2-3. Achene obovoid, 1 mm. long, trigonous, finely undulate-rugulose, light brown or grayish, the style-base the same color as the achene. LA PAZ: LARECAJA: near Sorata, 2900 m., *Mandon* 1408 (GH).

4a. **B. juncoides** var. **ampliceps** Kükenth. ex Osten in Anal. Mus. Hist. Nat. Montevideo (ser. 2) **3:** 188 (1931). *B. sphaerolepis* of the Catalogue. Mostly smaller than the species, the stems smooth, the inflorescence a contracted anthela of 3-5 spikelets sessile and 2 fascicles of 3-5 spikelets terminal on the rays, the involucral bracts mostly glabrous. Spikelets 4-6 mm. long; scales asymmetrical, ciliolate near the apex. Achene pale bluish-gray to whitish. LA PAZ: NOR YUNGAS: Milluguaya, 1100 m., *Buchtien* 4178 (GH); Polo-Polo, 1100 m., *Buchtien* 3649 (GH); SUR YUNGAS: Sirupaya, 2100 m., *Buchtien* 401 (GH). YUNGAS: *Rusby* 67 (GH), *Bang* 306 (GH). SANTA CRUZ: SARA: Buenavista, *Steinbach* 3544 (GH).

5. **B. papillosa** Kükenth. in Fedde, Rep. Sp. Nov. **23:** 198 (1926). Annual, caespitose. Culms to 8 dm. tall, basally terete, apically obscurely trigonous, smooth. Leaves very narrowly linear to filiform, to 1.5 mm. wide, shorter than the culms, the margins scabrid; sheath-orifice very long-ciliate with white curling hairs. Inflorescence a terminal anthela with up to 9 rays, subtended by 3-4 involucral bracts mostly shorter than the rays. Spikelets lanceolate, to 6 mm. long, sessile, in dense fascicles of 5-8; scales lance-ovate, dark reddish-brown, mucronate, glabrous or puberulent, to 2 mm. long; stamens 3. Achene oblong-obovoid, 1 mm. long, trigonous, grayish-white, minutely papillate-puncticulate. LA PAZ: SUR YUNGAS: Sirupaya, 2200 m., *Buchtien* 6929 (GH). SANTA CRUZ: CHIQUITOS: El Poston, 506 m., *Cárdenas* 4500 (US).

6. **B. hirtella** (Schrad. ex Schult.) Urb. Symbol. Antill. **2:** 166 (1900). Annual. Culms to 4.5 dm. tall, filiform, scabridulous. Leaves much shorter than the culms, filiform-setaceous, shortly pubescent, the sheaths with copious long white ciliation at the orifices. Inflorescence a terminal compound anthela, somewhat compressed, with 4-6 unequal spreading rays, subtended by 2-3 setaceous involucral bracts, the longest exceeding the anthela. Spikelets to 3-4 mm. long, lance-ovate; scales dark red-brown, mucronate or mucronulate, ciliolate, to 1.2 mm. long; stamens 3. Achene to 0.8 mm. long, oblong-obovoid, trigonous, finely puncticulate or somewhat transversely rugulose, the style-base more or less globose. SANTA CRUZ: CORDILLERA: Puerto Suárez, Etchichury (Barros).

7. **B. capillaris** (L.) C. B. Clarke in Hook. Fl. Brit. Ind. **6:** 652 (1893). Annual, caespitose. Culms to 3.5 dm. high, filiform, glabrous or scabrid. Leaves much shorter than the culms, filiform-setaceous, the margins scabrid, sheath-orifice long-ciliate. Inflorescence anthelate, with 2-5 principal rays, subtended by 2 foliar bracts, the longer usually much exceeding the inflorescence. Spikelets solitary, oblong-ovoid, to 6 mm. long, 6-15-flowered; scales lance-ovate, the upper margins ciliolate, the keel prominent, strongly serrate-scabrid, acute or mucronulate, to 2 mm. long, blackish-brown, finely puberulent; stamens 2 (-3). Achene to 0.8 mm. long, trigonous, obovoid to cordiform, pale brown, slightly or not at all transversely rugulose, the style-base dark. SANTA CRUZ: SARA: Buenavista, *Steinbach* 1913 (GH), 5186 (NY).

7a. **B. capillaris** var. **tenuifolia** (Rudge) C. B. Clarke in Urb. Symbol. Antill. **2:** 89 (1900). *B. tenuifolia* of the Catalogue. Plants to 4.5 dm. tall. Involucral bracts shorter than inflorescence. Spikelets narrower (about 1 mm. wide). Achene to 0.9 mm. long, smooth or somewhat transversely rugulose. LA PAZ: LARECAJA: San Carlos, Mapiri, 950 m., *Buchtien* 324 (GH). SANTA CRUZ: SARA: Buenavista, 450 m., *Steinbach* 5201 (NY, US), 6804 (GH), 6989 (GH).

8. **B. junciformis** (HBK.) C. B. Clarke in Trans. Linn. Soc. (ser. 2) **4:** 512 (1895). Caespitose, with a very short rhizome. Culms to 8 dm. tall, glabrous. Leaves much shorter than the culms, filiform, smooth or the margins slightly scabridulous, sheath-orifice ciliate with brown hairs. Inflorescence anthelate, compound but condensed, the involucral bracts usually shorter than the inflorescence, not ciliate or only slightly so at the base. Spikelets fasciculate, to 8 mm. long, oblong. Scales ovate, dark brown, minutely puberulent, the midrib somewhat excurrent. Achene obovoid to cuneate, not rugulose but finely puncticulate, pale brown to white, the style-base dark. SANTA CRUZ: SARA: Buenavista, 450-500 m., *Steinbach* 1903 (GH), 5185 (GH).

Bulbostylis boliviana Palla in Oesterr. Bot. Zeitschr. **59:** 191 (1908). I have seen no material of this species, and the original description does not enable me to place it. Consequently, it has been omitted from the key and from the formal treatment of the genus.

10. CLADIUM P. Br.

Cladium jamaicense Crantz, Inst. **1:** 362 (1766). Perennial, to 1-3 m. tall. Leaves long, to 1 cm. wide, flat, the margins and the midrib beneath scabridulous. Involucre of several bracts, the longest shorter than the inflorescence. Inflorescence to 9 dm. long, paniculate, the numerous spikelets small, red-brown, acute, fasciculate at the ends of the rays. Perianth absent; lowest glumes short, sterile; 1 or 2 above subtending staminate flowers, the terminal flower perfect, its glume to 5 mm. long, acute. Style bifid (or trifid); achene obovoid, the base truncate, apical tubercle not present. SANTA CRUZ: SARA: Cerro de Amboró, 1000 m., *Steinbach* 3007 (GH).

11. RHYNCHOSPORA Vahl (nomen conservandum) (including *Dichromena* and *Pleurostachys*)

See Kükenthal in Bot. Jahrb. **74:** 375-509 (1949); **75:** 90-195 (1950), 273-314 (1951), 451-484 (1952).

Perennial from rhizomes. Culms mostly triangular and leaf-bearing. Leaves long-sheathing, flat, sometimes subplicate. Inflorescence paniculate, composed of smaller panicles or corymbs, or often reduced to 1-3 rather dense glomerulate heads. Spikelets with the lowermost scales empty, the middle scales subtending perfect flowers, the uppermost bearing staminate or sterile flowers. Perianth present as scabridulous or smooth hypogynous bristles, or absent; stamens 2-3; style long, shortly or deeply bifid, the base persistent on the achene. Achene orbicular, obovoid, ovoid or oblong, biconvex, transversely rugulose, or finely cancellate, or scrobiculate, or smooth, usually shining.

a. Culms monocephalous.
  b. Bracts foliar, long, much exceeding the heads.
    c. Style-base bluntly triangular, not basally lobed. .... 22. *R. nervosa.*
    c. Style-base flattened, 2-lobed basally, the lobes decurrent on the achene. .... 23. *R. radicans.*
  b. Bracts not foliar, short, not equaling the heads.
    d. Bristles 3, not at all plumose. .... 12. *R. hirta.*
    d. Bristles 2-5, plumose on lower half. .... 11. *R. globosa.*
a. Culms not monocephalous.
  e. Bristles present.
    f. Bristles not plumose.
      g. Achene pitted, scrobiculate or cancellate, but not transversely rugulose.
        h. Achene pitted or scrobiculate.
          i. Spikelet many-flowered.
            j. Leaf-blade to 2 cm. wide, the base petiolately attenuate. .... 1. *R. umbraticola* var. *Kuntzei.*
            j. Leaf-blade filiform, to 1 mm. wide, the base not attenuate. .... 20. *R. confinis.*
          i. Spikelet 2-3-flowered. .... 6. *R. corymbosa.*
        h. Achene cancellate.
          k. Spikelet 5-6-flowered. .... 5. *R. polyphylla.*
          k. Spikelet 2-3-flowered.
            l. Rachilla strongly curved between spikelets. .... 4. *R. aristata.*
            l. Rachilla straight or nearly so, but not strongly curved between spikelets.
              m. Achene to 1.5 mm. long, very minutely cancellate. .... 2. *R. macrochaeta.*
              m. Achene to 2 mm. long, obviously cancellate. .... 3. *R. Schiedeana.*
      g. Achene transversely rugulose.
        n. Inflorescence of a few dense heads; style only slightly bifid. .... 7. *R. cyperoides.*
        n. Inflorescence of distant corymbs; style deeply bifid.
          o. Style-base conic-subulate, as long and broad as the achene. .... 13. *R. Mariscus.*
          o. Style-base conic, as wide as the achene but only half as long. .... 14. *R. glauca.*
    f. Bristles plumose, at least in part.
      p. Inflorescence of 5-6 lax distant corymbs. .... 24. *R. millegrana.*
      p. Inflorescence of 7-12 distant pyramidal panicles. .... 25. *R. puberula.*
  e. Bristles O.
    q. Achene horned at shoulders, appearing tridentate. ....

.... 21. *R. setacea.*

q. Achene not horned at shoulders, not appearing tridentate.

r. Achene gray.

s. Achene hardly or not at all rugulose. .... 9. *R. andina.*

s. Achene obviously rugulose. .... 19. *R. emaciata.*

r. Achene brownish to blackish.

t. Achene not transversely rugulose, but cancellate or scrobiculate.

u. Spikelets fasciculate; achene scrobiculate; style-base depressed, much shorter and narrower than achene. .... 20. *R. confinis.*

u. Spikelets solitary; achene cancellate; style-base conic-subulate, longer than and nearly as wide as achene. .... 10. *R. boliviensis.*

t. Achene transversely rugulose.

v. Leaf-blades to 1.4 cm. wide; panicle of relatively few dense heads. .... 8. *R. exaltata.*

v. Leaf-blades to 2-3 mm. wide; inflorescence not of dense heads.

w. Spikelets solitary or paired at ends of peduncles. .... 16. *R. velutina* var. *Sellowiana.*

w. Spikelets fasciculate.

x. Lowest scales (3-4) more or less long-apiculate, the apiculus hirtellous. .... 15. *R. robusta.*

x. Lowest scales not long-apiculate, not hirtellous.

y. Inflorescence of 2-3 remote lax corymbs. .... 18. *R. tenuis.*

y. Inflorescence of 2-3 remote lax pyramidal panicles. .... 17. *R. luzuliformis.*

1. **Rhynchospora umbraticola** var. **Kuntzei** (C. B. Clarke) Kükenth. in Bot. Jahrb. **74**: 391 (1949). *Dichromena Kuntzei* of the Catalogue. Culms to 4 dm. tall. Leaves mostly basal, the blades to 3 dm. long (occasionally to 5 dm.) and 2 cm. wide, glabrous, the bases subpetiolately attenuate. Inflorescences axillary and terminal, corymbose-paniculate; bracts foliar, usually exceeding the inflorescences. Spikelets solitary, oblong-elliptic, to 7 mm. long, with numerous (12-20) flowers; scales light brown, ovate, mucronate; bristles 6, antrorsely scabridulous, exceeding the achene; stamens 3; style shortly bifid, the style-base as long and broad as the achene. Achene to 3 mm. long, obovate, shining, brown, biconvex, densely and evenly scrobiculate. SANTA CRUZ: CERCADO: Cerro Amboró, *Steinbach* 3459 (GH); SARA: Río Yapacani, *O. Kuntze* (type; photo, GH); Buenavista, 450 m., *Steinbach* 2878 (GH). BENI: YACUMA: Rurrenabaque, *Cárdenas* (M. E.) 1586 (GH, NY), *White* (M. E.) 851 (GH, US).

2. **R. macrochaeta** Steud. ex Boeckl. in Linnaea, **38**: 632 (1874).

Culms to nearly 1 m. tall, with up to 3 cauline leaves. Leaves shorter than culms, to 6 mm. wide, glabrous, the revolute margins scabrid. Inflorescence of terminal and axillary, short, pyramidal or subpyramidal panicles, the terminal panicle larger and denser than the laterals; bracts foliar, exceeding the panicles. Spikelets linear to narrowly lanceolate, to 6-7 mm. long, solitary or paired, few-flowered (2-3); scales lance-oblong, membranous, brown or red-brown; bristles 4-6, antrorsely scabrid, slightly exceeding the achene; stamens 3; style apically subentire or somewhat bifid, the style-base pyramidal, rugose, as long and broad as the achene. Achene to 1.5 mm. long, brown to blackish, shining, minutely cancellate. COCHABAMBA: CERCADO: Cochabamba, *Bang* 1071 (GH); CHAPARE: Locotal, 1600m., *Steinbach* 9096 (GH).

2a. **R. macrochaeta** var. **Ruiziana** (Boeckl.) Kükenth. in Bot. Jahrb. **74:** 393 (1949). Components of inflorescence longer (to 9 cm.), spikelets 2-4-flowered, scales with the midrib excurrent as a long mucro. LA PAZ: NOR YUNGAS: Polo-Polo, 3200 m., *Buchtien* 698 (GH); LARECAJA: Ingenio del Oro, *Rusby* 167 (GH). SANTA CRUZ: VALLEGRANDE: Comarapa, 2800 m., *Steinbach* 8340 (GH, NY); Cerro San Mateo, Comarapa, 3500 m., *Steinbach* 8532 (GH, NY).

Rhynchospora macrochaeta var. *colombiensis* f. *condensata* and *R. macrochaeta* var. *quinquespicata,* listed in the Catalogue, seem hardly worthy of recognition.

3. **R. Schiedeana** (Schlechtd.) Kunth, Enum. Pl. **2:** 300 (1837). Culms to 1.5 m. high, glabrous. Leaves basal and cauline, very long, mostly exceeding the inflorescence, acuminate, to 1 cm. wide, the margins scabrid. Inflorescence paniculate, compound, interrupted, the component panicles pyramidal or subpyramidal. Spikelets solitary or paired, lanceolate, to 6-7 mm. long, 2-3-flowered; scales 5-6, red-brown, lance-ovate, mucronate; bristles 3-4, antrorsely scabrid, shorter than the achene; stamens 3; style entire or the apex very briefly bifid, the style-base conic-subulate, blackish, rugose, as long and broad as the achene. Achene much shorter than the scales, about 2 mm. long, broadly obovoid, shiny brown, cancellate. LA PAZ: NOR YUNGAS: Unduavi, 3200 m., *Buchtien* 2588 (GH), 2593 (GH), SUR YUNGAS: San Felipe, *Holway & Holway* (GH, NY).

4. **R. aristata** Boeckl. in Flora, **40:** 36 (1857). *R. aristata* var *latilaminata* Kükenth. in Fedde, Rep. Sp. Nov. **26:** 253 (1929). Culms to 9 dm. (-1.5 m.) high, glabrous. Leaves mostly basal (about 3 cauline), equaling the inflorescence, to 8(-20) mm. wide, glabrous, scabridulous near the apex. Inflorescence a lax, open, compound panicle, the terminal portion corymbose, the laterals pyramidal, branches divaricate; bracts foliar, exceeding the panicle, bractlets setaceous, basally ciliate. Spikelets solitary, distant, the rachilla

strongly curved between spikelets, 6-9 mm. long, 2-3-flowered, the lowermost flower perfect, the rest staminate or sterile; scales 6-7, brown or reddish-brown, mucronate or aristate; bristles 4-5, antrorsely scabrid, shorter or longer than the achene; stamens 3; style long, shortly bifid, the style-base ashy-gray, conic-subulate, longer and much narrower than the achene. Achene about 2 mm. long, broadly ovoid, shiny brown or stramineous, cancellate. LA PAZ: NOR YUNGAS: Polo-Polo, 1100 m., *Buchtien* 3651 (GH; type-number of var. *latilaminata*). COCHABAMBA: CHAPARE: Locotal, 1600 m., *Steinbach* 9100 (GH).

The variety *latilaminata* was recognized primarily on the basis of broader leaves (2 cm. wide), but an isotype available to me has leaves rather less than 1 cm. wide. Its separateness seems dubious.

5. **R. polyphylla** Vahl, Enum. **2**: 230 (1806). Culms to 9 dm. high, basally thickened, glabrous. Leaves increasing in size upwards on the culm, exceeding the inflorescence, to 1 cm. wide, glabrous or more or less pilose. Inflorescence a long, lax, compound, pale panicle, the 4-7 components distant, much-branched, more or less pyramidal; bracts foliar, exceeding the component panicles. Spikelets solitary, or occasionally 2-3 in a fascicle, 5-6-flowered, terete or lanceolate, 4-5 mm. long, distant on the produced rachilla; scales light-stramineous, lance-ovate, mucronate; bristles few, minute (rarely 1 or more exceeding the achene); stamens 2-3; style long, entire or slightly bifid, style-base pyramidal, greenish, as wide as the achene, but about half its length. Achene obovoid, slightly less than 1 mm. long, biconvex, cancellate, light brown. LA PAZ: LARECAJA: San Carlos, Mapiri, 850 m., *Buchtien* 341 (Kükenthal).

5a. **R. polyphylla** var. **laxa** (Beauv.) Pfeiff. in Fedde, Rep. Sp. Nov. **49**: 78 (1940). *Dichromena Mandonii* of the Catalogue. Culms taller, to 1.4 m., leaves broader (to 2 cm.), component-panicles 3-4, scales rusty-brown, bristles 4, exceeding the achene. LA PAZ: LARECAJA: Sorata, *Mandon* 1421 (Kükenthal).

5b. **R. polyphylla** var. **longispiculosa** Kükenth. in Bot. Jahrb. **74**: 406 (1949). Components of the panicle 3, approximate, spikelets dull brown, linear-subulate, to 9-10 mm. long. SANTA CRUZ: SARA: La Perdix, 450 m., *Steinbach* 7993 (GH).

6. **R. corymbosa** (L.) Britton in Trans. N. Y. Acad. Sci. **11**: 84 (1892). Culms to 1 m. high, glabrous, the cauline leaves inserted remotely. Leaves equaling or shorter than the culms, to 2 cm. wide, the midrib and margins scabrid. Inflorescence a panicle of 2-5 distant corymbs; bracts long, foliar. Spikelets many, usually fasciculate (2-5 in a fascicle), occasionally solitary, 6-8 mm. long, 2-3-flowered; scales red-brown, mucronate; bristles 6, antrorsely scabrid, exceeding the

achene; stamens 3; style nearly entire, the conic base as wide and long as the achene, brownish, basally bilobed, sometimes finely puberulent. Achene obovoid, 2-3 mm. long, brown or chestnut-brown, the 2 broad faces with irregular depressions, densely and finely pitted. SANTA CRUZ: SARA: Buenavista, *Steinbach* 6674 and 7051 (Kükenthal, 5215 (GH, NY). BENI: YACUMA: Reyes, 300 m., *White* (M. E.) 1527 (GH, NY); near Lake Rogagua, 300 m., *Rusby* (M. E.) 1642 (GH, NY).

7. **R. cyperoides** (Swartz) Mart. in Denkschr. Akad. Wiss. Münch. **6:** 149 (1820). Culms solitary, to 1 m. tall, scabrid on the angles, with 2-3 distant cauline leaves. Leaves shorter than the culms, to 7 mm. wide, the margins scabrid. Inflorescence a panicle of a few, dense, distant, globose heads (anthelate), bracts mostly exceeding the heads. Spikelets to 6 mm. long, ovate-lanceolate, many in a head; scales 7-8, mucronate, pale red-brown; bristles 6, antrorsely scabrid, 3 or 0 in male flowers; stamens 3; style slightly bifid, the base pale green, longer and much narrower than the achene, conic-subulate. Achene about 1.5 mm. long, shorter than the scale, obovoid, brown, shining, the margins slightly scabrid, finely transverse-rugulose. SANTA CRUZ: CERCADO: Santa Cruz, *Steinbach* 5343 (NY).

8. **R. exaltata** Kunth, Enum. Pl. **2:** 291 (1837). *R. exaltata* var. *ovalis* of the Catalogue. Culms to 1 m. or more. Leaves as long as the culms or shorter, to 1.4 cm. wide, the margins and nerves scabrid or serrulate-scabrid. Inflorescence a much-interrupted panicle of rather dense heads; bracts exceeding the heads. Spikelets more or less stellately arranged in the heads, to 6 mm. long, narrowly lanceolate to subulate; scales stramineous or pale brown, mucronate; bristles 0; stamens 3; style with 2 linear branches, the style-base subulate, ashy-gray, shorter than the achene. Achene to 2.5 mm. long, orbiculate to ovoid, chestnut-brown, shining, transversely rugulose. LA PAZ: LARECAJA: San Carlos, Mapiri. 850 m., *Buchtien* 339 (GH).

8a. **R. exaltata** var. **cephalophora** (Nees) Kükenth. in Bot. Jahrb. **74:** 440 (1949). Inflorescence racemose, of solitary, distant spikes. Bristles present (2-3). SANTA CRUZ: [prov. uncertain]: Cerro Hosana, *Steinbach* 3387 (Kükenthal).

9. **R. andina** Kükenth. in Fedde, Rep. Sp. Nov. **53;** 73 (1944). Culms to 3.5 dm. tall, glabrous, cauline leaves absent or 1, culms clothed basally in fibrous remains of old leaf-sheaths. Leaves much shorter than the culms, to 1 mm. wide, glabrous. Inflorescence a panicle of 2-4 distant corymbs, bracts shorter than or equaling the peduncles. Spikelets few, fasciculate, rarely solitary, to 4 mm. long, lance-oblong; scales 7-8, brown, midrib excurrent as an arista; bristles 0; stamens 3; style entire, the flattened base brownish, as broad as, but shorter than, the achene. Achene to 1 mm. long, obovoid, shining, gray,

obscurely or not at all transversely rugulose. LA PAZ: LARECAJA: Hacienda Casana, 1400-1600 m., *Buchtien* 7159 (GH; type-number).

10. **R. boliviensis** C. B. Clarke in Kew Bull. Add. Ser. **8**: 37 (1908). Culms to 2-3.5 dm. high. Leaves to 15 cm. long and 1-2 mm. wide, flat, glabrous. Inflorescence a lax slender panicle to 15 cm. long, spikelets solitary, pedicellate, 10-20 on a culm. Spikelets 5 mm. long, oblong-lanceolate; scales lanceolate to ovate, not mucronate, brown, the lowest 4 sterile; bristles 0; style very shortly bifid, style-bases basally inconspicuously bilobed, conic-subulate, 1.5 mm. long and nearly as wide as the achene. Achene 1 (-1.25) mm. long, obovoid, plano-convex, abruptly narrowed at the apex into an extremely short neck, brownish, cancellate. YUNGAS: 2000 m., *Rusby* 83 (NY; type-number). LA PAZ: NOR YUNGAS: Unduavi, 3300 m., *Rusby* 82 (NY), 85 (US).

11. **R. globosa** (HBK.) Roem. & Schult. Syst. Veg. **2**: 89 (1817). *R. globosa* var. *Loefgrenii* of the Catalogue. Culms to 9 dm. high, caespitose, glabrous, cauline leaves 0. Leaves shorter than culms, to 2 mm. wide, margins scabrid, grayish-green. Inflorescence monocephalous, the globose head to 1-2 cm. in diameter, bracts short, scale-like, not foliar, inconspicuous, firm-textured, brownish, mucronate, the margin ciliate on the upper portion. Spikelets 6-7 mm. long, lanceolate; scales reddish-brown, the lowest short, the upper longer, acute; bristles 5 in perfect flowers, usually 2 in staminate flowers, the basal portion densely white-plumose, the apical portion antrorsely scabrid; stamens 3; style very briefly bifid, the conical base light greenish-brown, narrower and shorter than the achene. Achene about 2 mm. long, oblong-obovoid, brown, the shoulders scabrid-ciliate at the apex. BENI: YACUMA: near Lake Rogagua, 330 m., *Rusby* (M. E.) 1700 (GH). LA PAZ: NOR YUNGAS: Milluguaya, 1800 m., *Buchtien* 4154 (GH). COCHABAMBA: CERCADO: near Cochabamba, *Bang* 873 (GH). SANTA CRUZ: SARA: Buenavista, 500 m., *Steinbach* 5351 (GH); Dolores, 450 m., *Steinbach* 1896 (GH); CHIQUITOS: 5 km. north of Santiago de Chiquitos, 700 m., *Cutler* 7020 (GH).

The heads of the last collection cited are described by the collector as lemon-yellow.

12. **R. hirta** (Nees) Boeckl. in Vidensk. Meddel. Kjoebenh. **1869**: 146 (1870). Culms solitary, to 6.5 dm. long, glabrous or somewhat pilose. Leaves shorter than the culms, to 5 mm. wide, the lower portion pilose-ciliate. Inflorescence monocephalous, the hemispherical to globose head to 2 cm. in diameter; bracts numerous, imbricate, ovate, acuminate, light brown, the margins entirely long-ciliate. Spikelets to 6-7 mm. long, lanceolate; scales 6, lance-oblong, pale brown; bristles 3, unequal, 1 exceeding, 2 shorter than, the achene, antrorsely scabrid, but not plumose; stamens 3; style hardly bifid,

the long-conic greenish-brown base half as long as and narrower than the achene. Achene 2 mm. long, oblong, concavo-convex, brown, finely puncticulate, apically papillose. SANTA CRUZ: eastern Velasco, *O. Kuntze* (Kükenthal).

13. **R. Marisculus** Lindl. & Nees in Mart. Fl. Bras. **2**(1): 142 (1842). Rhizome occasionally shortly stoloniferous. Culms to 1.5 m. high, smooth, with 4-5 distant cauline leaves. Basal leaves long, shorter than the culms, to 7 mm. wide, the margins scabrid. Inflorescence a panicle of 2-3 distant corymbs, the bracts shorter than the peduncles. Spikelets oblong-lanceolate, to 6-7 mm. long; scales 6, reddish-brown, lanceolate, mucronate; bristles 6, exceeding the achene, antrorsely scabrid; stamens 3; style deeply bifid, the conic-subulate base ashy-gray, as long and as broad as the achene. Achene 1.5 mm. long, obovoid, rather shiny, transversely rugulose. Without data: *Bang* 2204 (GH).

14. **R. glauca** Vahl, Enum. **2**: 233 (1806). Culms slender, to 7.5 dm. tall, with 3 distant cauline leaves. Leaves shorter than the culms, to 3 mm. wide, the margins scabrid. Inflorescence a small terminal panicle of 3-4 distant corymbs; bracts narrow, about equaling the corymbs. Spikelets few, more or less fasciculate, 3-4 mm. long, lanceolate; scales ovate, dark grown, shortly mucronate; bristles 6, of varying lengths but mostly equaling the achene, antrorsely scabrid; stamens 3; style deeply bifid, the conical base gray, as wide as the achene and up to half as long. Achene suborbicular to obovoid, yellowish-brown, shiny, to 2 mm. long, transversely undulate-rugose. YUNGAS: *Bang* 433 (GH). LA PAZ: LARECAJA: Guanai-Tipuani, *Bang* 1426 (Kükenthal); Hacienda Simaco, 1400 m., *Buchtien* 5360 (GH).

15. **R. robusta** (Kunth) Boeckl. in Linnaea, **37**: 616 (1873). Stoloniferous. Culms to 1.2 m. high, glabrous, smooth. Leaves firm, to 8 mm. wide, long, glabrous or ciliate. Inflorescence of 2-3 distant terminal corymbs; bract foliar, pilose. Spikelets solitary or fasciculate, to 1 cm. long, oblong-ovate; scales ovate to ovate-oblong, the lower with the midrib prolonged as a conspicuous hirtellous apiculus; bristles 0; stamens 3; style bifid, the base campanulate to bilobed, decurrent on the achene. Achene orbicular, to 1.5 mm. long, brown, undulate-rugose. BENI: YACUMA: near Lake Rogagua, 300 m., *Rusby* (M. E.) 1425 (GH, NY), 1442 (NY, US). SANTA CRUZ: SARA: Río Cuchi, 450 m., *Steinbach* 6619 (GH).

This species was not ascribed to Bolivia by Kükenthal. Although the material cited is young, there seem to be no perianth-bristles present. The hirtellous apiculus of the lowest scales is quite obvious, and I cannot attribute the specimens to any other species known from Bolivia.

16. **R. velutina** var. **Sellowiana** (Kunth) Boeckl. in Linnaea, **37:** 614 (1873). Culms to 9 dm. high, with 3-5 cauline leaves. Leaves shorter than the inflorescence, glabrous, 2-3 mm. wide, margins scabrid. Inflorescence of 1 terminal and 2 lateral corymbs; bracts 3, foliar. Spikelets solitary or paired at ends of peduncles, oblong-cylindrical, 5-6 mm. long; scales lance-ovate, the uppermost mucronate, brown or reddish-brown; bristles 0; stamens 3; style bifid, the campanulate base broadly bilobed at its base. Achene obovoid to orbicular, 2 mm. long, margined, chestnut-brown, shiny, transversely rugose. SANTA CRUZ: SARA: Buenavista, *Steinbach* (Kükenthal).

17. **R. luzuliformis** Boeckl. in Linnaea, **37:** 632 (1873). Rhizome elongate, producing scaly stolons. Culms to 3 dm. high, glabrous, not scabrid, with 2-3 distant cauline leaves. Leaves equaling the culms, to 2 mm. wide, the margins scabrid. Inflorescence a compound panicle of 2-3 remote, smaller, more or less pyramidal panicles; bracts long, linear, foliar, much exceeding the component panicles. Spikelets somewhat fasciculate, 3 mm. long, oblong-ovate, reddish or brown; scales densely imbricate, ovate to oblong-ovate, mucronate; bristles 0; stamens 3; style bifid, the base pyramidal, gray-green, decurrent on the shoulders of the achene, as broad and half as long as the achene. Achene subglobose, lenticular or biconvex, yellow-brown, transversely undulate-rugose. TARIJA: ARCE: Camacho, 2500 m., *Fiebrig* 2575 (GH).

18. **R. tenuis** Link in Spreng. Schrad. & Link, Jahrb. **1**(3): 76 (1820). Rhizome very short or lacking. Culms to 4 dm. high, filiform, smooth and glabrous, with 1-2 cauline leaves. Leaves shorter than the culms, to 2 mm. wide, glabrous. Inflorescence of 2-3 lax remote corymbs; bracts almost filiform. Spikelets usually fasciculate (2-3), 4-5 mm. long; scales 5-6, red-brown or stramineous, ovate to ovate-lanceolate, mucronate; bristles 0; stamens 3; style bifid, the base flattened-pyramidal, gray to blackish, its base bilobed, decurrent on the angles of the achene, half as long as the achene. Achene 1 mm. long, orbicular to obovoid, reddish-brown to blackish, conspicuously transverse-rugose. SANTA CRUZ: SARA: Buenavista, 500 m., *Steinbach* 5056 (GH, NY), 5060 (GH, NY).

19. **R. emaciata** (Nees) Boeckl. in Vidensk. Meddel. Kjoebenh. **1869:** 149 (1870). *R. tenuis* var. *emaciata* of the Catalogue. Culms to 6 dm. tall, trigonous, smooth and glabrous. Leaves very much shorter than the culms, filiform, canaliculate. Inflorescence terminal, of 1-2 remote lax corymbs; bracts long, bracteoles long-setaceous. Spikelets solitary, pedicellate, lance-oblong, 5-6 mm. long; scales 5-6, brownish with hyaline margins, aristate; bristles 0; stamens 3; style deeply bifid, the depressed-pyramidal base about one-third the length of the achene and much narrower, stramineous to castaneous, its base almost entire

and not decurrent on the achene. Achene 1 mm. long, orbicular, lead-gray, undulate-rugose. SANTA CRUZ: SARA: Buenavista, 450 m., *Steinbach* 1899 (GH), 6926 (GH).

20. **R. confinis** (Nees) C. B. Clarke in Kew Bull. Add. Ser. **8**: 40, 119 (1908). Rhizome long. Culms solitary, to 5 dm. tall, smooth, with remote cauline leaves to 1 mm. wide, shorter than the culms, scabrid. Inflorescence 2-3 dense long-pedunculate corymbs; bracts setaceous, exceeding the corymbs. Spikelets rather densely fasciculate, to 8 mm. long, many-flowered; scales oblong-lanceolate, aristate, reddish-brown; bristles usually 0, occasionally 3; stamens 3; style deeply bifid, the blackish base depressed-campanulate, narrower than the achene. Achene 1 mm. long, broadly obovoid, pale to chestnut-brown, finely scrobiculate. SANTA CRUZ: SARA: Buenavista, 450 m., *Steinbach* 6924 (GH), 7091 bis (GH).

21. **R. setacea** (Berg.) Boeckl. in Vidensk. Meddel. Kjoebenh. **1869:** 159 (1870). *R. tenerrima* of Catalogue. Caespitose, the bases of tufts somewhat enlarged, rhizome absent. Culms to 3.5 dm. high, filiform, smooth. Leaves mostly longer than culms, sometimes shorter, filiform, glabrous. Inflorescence of 2-4 axillary and terminal, somewhat lax, distant corymbs with 1-6 spikelets in each; bracts setaceous, exceeding the corymbs. Spikelets in small fascicles or solitary, 4-5 mm. long, lanceolate to terete; scales 7-8, ovate to lanceolate, firm, stramineous to reddish, with the midrib prolonged as an arista; bristles 0; stamens 2; style bifid, the base broad, flat, elongated as 2 horns at the shoulders of the achene, the achene thus appearing tridentate. Achene 1 mm. long, orbicular, brown, transversely undulate-rugose. SANTA CRUZ: SARA: Buenavista, *Steinbach* 1901 (GH).

22. **R. nervosa** (Vahl) Boeckl. in Vidensk. Meddel. Kjoebenh. **1869:** 143 (1870). *Dichromena ciliata* of the Catalogue. Rhizome short, often developing woody stolons. Culms to 7 dm. high, usually shorter, usually glabrous. Leaves as long as the culms or shorter, 1-2 mm. wide, basally sheathing, the old sheaths reduced to a basal collar of fibers, blades scabrid-ciliate. Inflorescence a single terminal head of 3-5 spikelets 6-8 mm. long; involucre of 4-7 unequal bracts, the bracts pubescent on the abaxial side and at least the basal portion ciliate. Scales oblong-ovate to lance-ovate, the midrib thickened, glabrous, white; bristles 0; stamens 3; style deeply bifid, the style-base bluntly pyramidal. Achene to 1.5 mm. long, orbicular to obovoid, or more or less lenticular, dark brown, transversely rugulose. YUNGAS: *Bang* 251 (GH). BENI: CERCADO MOJOS: Trinidad-Misiones Guarayos, 250 m., *Werdermann* 2487 (MO); YACUMA: Reyes, *White* (M. E.) 1537 (GH). LA PAZ: NOR YUNGAS: Milluguaya, 1900 m., *Buchtien* 396 (GH); Polo-Polo, 1100 m., *Buchtien* (GH). SANTA CRUZ: SARA: Buenavista, 450 m., *Steinbach* 3277 (GH), 6725 (GH).

The binomial *Rhynchospora ciliata* (Vahl) Kükenth. (based on *Dichromena ciliata* Vahl) is a later homonym of *R. ciliata* Vahl and therefore cannot be used for this species.

22a. **R. nervosa** var. **Jelskiana** (Boeckl.) Kükenth. in Bot. Jahrb. **75:** 298 (1952). Differs in having wider leaves (3-4 mm.), the culms often pilose, and spikelets to 12 mm. long. SANTA CRUZ: SARA: Río Surutú, *Steinbach* 6841 bis (Kükenthal).

24. **R. millegrana** (Nees) R. C. Foster, comb. nov. *Nemochloa millegrana* Nees in Mart. Fl. Bras. **2**(1): 148 (1842). Rhizome slender, scaly, horizontal. Culms to 1.2 m. high, smooth. Leaves long, but usually shorter than the culms, 5-7 mm. wide, the margins and nerves scabrid. Inflorescence of terminal and lateral distant lax corymbs; bracteoles narrow, setaceous. Spikelets to 2 mm. long, solitary or 2-3 approximate; scales broadly ovate, often emarginate, coppery or pale red-brown; bristles 4-5, plumose; stamens 3; style deeply bifid, the base conic-pyramidal, ashy gray, less than half the length of the achene. Achene to 1.5 mm. long, orbicular-obovoid, shiny, deep chestnut-brown, granulate-rugulose. LA PAZ: LARECAJA: San Carlos, Mapiri, 850 m., *Buchtien* 332 (GH); San Antonio, Mapiri, 850 m., *Buchtien* 1233 (GH).

This is the variant which has been distinguished as *Pleurostachys minuscula* Kükenth. in Fedde, Rep. Sp. Nov. **26:** 254 (1929).

According to the Index Kewensis, the binomial *Rhynchospora millegrana* has been published before, being attributed to Schrad. ex Steud. Syn. Pl. Cyp. 139 (1855). Examination of this citation shows that the binomial was published in synonymy, so that the name cannot serve as a bar to the proper transfer of the basionym.

25. **R. puberula** (Boeckl.) L. B. Smith in Phytologia, **1:** 82 (1934). *Pleurostachys puberula* var. *Buchtienii* of the Catalogue. Rhizome short, thick. Culms to 1.2 m. tall, thick. Leaves about equaling the culms, to 2 cm. wide, pilose or glabrate beneath, the sheaths puberulent. Inflorescence of 7-12 distant pyramidal panicles; bracts exceeding the panicles. Spikelets more or less globose, to 1.5 mm. long, in dense spikes at ends of branchlets; scales broadly ovate, reddish-brown; bristles 4-5, plumose, at least in part; stamens 3; style-base conic-pyramidal, much shorter than the achene. Achene 1 mm. long, obovoid, shiny chestnut-brown, densely granulate-rugose. LA PAZ: LARECAJA: San Carlos, Mapiri, 850 m., *Buchtien* 336 and 337 (Kükenthal).

12. CALYPTROCARYA Nees

Calyptrocarya glomerulata (Brongn.) Urb. Symbol. Antill. 2: 169 (1900). *Becquerelia glomerulata* and *Calyptrocarya fragifera* of the Catalogue. Perennial from a slender woody rhizome, to 3.5 dm. high, the entire plant glabrous. Leaves eligulate, linear, to 9 mm. wide, usually exceeding the inflorescence. Inflorescence of small terminal or axillary corymbose panicles, the individual subglobose heads to 3 mm. long, the flowers unisexual. Female flowers: 2 distichous basal glumes or scales, many-nerved, the mid-nerve very prominent; achene lenticular to biconvex, apiculate, covered by a puberulent membrane, about 1 mm. long; style bifid. Male spikelets 2-4 at base of pistillate flowers, each of 1-4 flowers reduced to single stamens. SANTA CRUZ: ICHILO: Río Vibora, 350 m., *Steinbach* 7579 (GH).

13. SCLERIA Berg.

See Core in Brittonia, 2: 1-105 (1936).

Perennial, rhizomatous or stoloniferous (1 species sometimes annual, with fibrous roots). Culms mostly triangular. Leaf-sheaths often trialate, ligulate; blades sometimes plicate. Inflorescence of distant glomerulate heads, or densely spicate, or obviously paniculate, or, in no. 1, of dense heads subsessile in the leaf-axils. Flowers unisexual, perianth absent. Pistillate spikelets 1-flowered, often in the axil of the lowest sterile scale of a staminate spikelet. Staminate spikelets few-to many-flowered. Hypogynium obscure or absent in a few species, but present in most. Achenes hard, bony, often smooth and shining, or reticulate, rugose, verrucose or tuberculate.

a. Inflorescence of dense spikelet-heads subsessile in leaf-axils. .... 1. *S. amphigaea.*
a. Inflorescence not of dense spikelet-heads subsessile in leaf-axils.
  b. Achenes smooth and glabrous.
    c. Hypogynium obscure or absent.
      d. Inflorescence simple, the spikelets in distant glomerulate heads.
        e. Scales hirsute. .... 2. *S. hirtella.*
        e. Scales glabrous. .... 3. *S. leptostachya.*
      d. Inflorescence branched.
        f. Achenes 2-2.5 mm. long. .... 4. *S. lithosperma.*
        f. Achenes 1.5-2 mm. long. .... 5. *S. castanea.*
    c. Hypogynium obviously present.
      g. Margin of hypogynium entire or undulate, not 3-lobed.
        h. Achenes 3.5-6 mm. long. .... 7. *S. macrophylla.*
        h. Achenes 3 mm. or less in length.
          i. Hypogynium long-ciliate on margin. .... 9. *S. mitis.*
          i. Hypogynium short-ciliolate on margin.
            j. Largest achenes 2 mm. long. .... 8. *S. microcarpa.*

j. Largest achenes 3 mm. long. .... 10. *S. obtusa.*
g. Margin of hypogynium 3-lobed.
k. Margin obscurely 3-lobed. .... 19. *S. vaginata.*
k. Margin obviously 3-lobed.
l. Lobes fimbriate.
m. Inflorescence and achenes purplish. ....
.... 12. *S. arundinacea.*
m. Inflorescence brown; achenes white. .. 13. *S. latifolia.*
l. Lobes entire.
n. Inflorescence purple or brownish-purple. ....
.... 20. *S. melaleuca.*
n. Inflorescence green or yellow-brown. .... 21. *S. pterota.*
b. Achenes not smooth and glabrous.
o. Hypogynium obscure or none.
p. Inflorescence of few, distant, glomerulate heads. ....
.... 3. *S. leptostachya.*
p. Inflorescence dense, spicate. .... 6. *S. composita.*
o. Hypogynium obviously present.
q. Hypogynium subentire, the margin undulate. .. 22. *S. secans.*
q. Hypogynium 3-lobed.
r. Plant scandent. .... 17. *S. tenacissima.*
r. Plant not scandent.
s. Achenes reticulate.
t. Achenes faintly reticulate, sparsely puberulent, 2-3 mm. long. .... 18. *S. lagoënsis.*
t. Achenes reticulate, the ridges pubescent, 2 mm. long. .... 16. *S. setacea.*
s. Achenes rugose, verrucose or tuberculate.
u. Staminate and pistillate spikelets in separate parts of inflorescence. .... 15. *S. bracteata.*
u. Staminate and pistillate spikelets not in separate parts of inflorescence.
v. Achenes minutely verrucose. .... 11. *S. cyperinoides.*
v. Achenes rugose-tuberculate. .... 14. *S. panicoides.*

1. **Scleria amphigaea** Raymond in Nat. Canad. **91:** 132 (1964). *Diplacrum longifolium* of the Catalogue. Perennial, with creeping scaly stolons, plants to 0.5 m. high. Stems leafy, leaves linear, to 5 mm. wide, glabrous, bearing dense, globular, subsessile heads of spikelets in the axils. Trifid style and achene subtended by 2 broad scales to 4-5 mm. long, flanked by 2 staminate spikelets, the staminate flowers monandrous, usually 6 to a spikelet, subtended by 2 narrow scales. Fruit suborbicular, shining white or ivory, longitudinally ridged or irregularly conspicuously reticulate. SANTA CRUZ: SARA: Cucichisito, 450 m., *Steinbach* 7014 (GH).

2. **S. hirtella** Swartz, Prodr. 19 (1788). Perennial, with a long slender rhizome. Culms to 6.5 dm. high, sharply triangular, slender,

glabrous, sometimes pubescent near the apex. Leaves to 2 dm. long and 5 mm. wide, pubescent to glabrous; sheaths pilose, at least in a vertical line below the orifice, ligule usually absent (minute, if present). Inflorescence terminal, simple, interrupted, the spikelets aggregated in small, sessile, remote, glomerulate heads, the rachis sparsely to densely pilose; bractlets not exceeding the glomerule, long-pilose or hirsute. Staminate scales narrow, brown, dorsally hirsute. Pistillate scales cuspidate, brown, broader than staminate scales. Spikelets 4-5 mm. long, brown, red-brown, or almost black; hypogynium absent; achene subglobose-trigonous, smooth, white, shining, apiculate, the base not or only slightly excavated. LA PAZ: LARECAJA: Hacienda Casana, 1400 m., *Buchtien* 7165 (GH). SANTA CRUZ: SARA: Buenavista, 450-500 m., *Steinbach* 1802 (GH), 5327 (GH), 6861 (GH).

3. S. **leptostachya** Kunth, Enum. Pl. **2**: 354 (1837). Perennial, with a long rhizome. Culms to 6 dm. high, filiform. Leaves to 3 dm. long, 1 mm. wide, blades glabrous; sheaths more or less pilose, ligule absent. Inflorescence terminal, interrupted, simple (sometimes few-branched), the spikelets aggregated in small heads; rachis ciliolate on the angles, otherwise glabrous; bractlets basally dilated, setaceous, glabrous. Spikelets to 5 mm. long, linear-oblong, obtuse. Staminate and pistillate scales reddish-brown, acuminate, membranous, glabrous, oblong, the pistillate much exceeding the achenes; hypogynium absent; achene short-stipitate, subglobose, white or dirty-white, transversely rugulose or nearly smooth, 1 mm. long. SANTA CRUZ: SARA: Buenavista, 500 m., *Steinbach* 5300 (GH).

4. S. **lithosperma** (L.) Swartz, Prodr. 18 (1788). Perennial, with short, nodulose rhizomes. Culms filiform, triangular, glabrous above, the angles often scabrid-ciliate below, to 6 dm. tall. Leaves to 2 dm. long and 3 mm. wide, margins scabrid; sheaths pilose to glabrous, ligule triangular, short, pilose. Inflorescences terminal and axillary, simple or branched, interrupted, the few spicate heads remote, few-flowered. Spikelets to 4 mm. long, bracts filiform, much exceeding the heads, bractlets dark brown; scales dark brown, ovate-lanceolate; hypogynium absent; achene to 2.5 mm. long, white, shining, smooth, oblong, basally attenuate, trigonous, the apex more or less umbonate. SANTA CRUZ: SARA: Buenavista, 500 m., *Steinbach* 5203 (GH).

As noted by Core, this collection is distinctive in that there are 2 narrow red-brown lobes at 2 corners of the base of the achene. These lobes may be entire or apically bifid, ciliolate or glabrous.

5. S. **castanea** Core in Brittonia, **1**: 239 (1934). *S. pleostachya* of the Catalogue. Perennial, the rhizome thick. Culms to 8 dm. tall, acutely triangular, the angles scabridulous. Leaves to 4.5 dm. long and 3 mm. wide, somewhat short-pilose along the margins and the

midrib beneath; sheaths reddish-purple, pubescent, the ligule shortly pilose, obtusely triangular. Inflorescence a terminal panicle, few-branched. Bracts setaceous. Spikelets to 7 mm. long, oblong or linear-oblong, densely clustered. Staminate scales red-brown, acuminate. Pistillate scales red-brown, lance-ovate; hypogynium absent; achene to 2 mm. long, oblong-ovoid, obscurely trigonous, apiculate, shining white and smooth, the triangular base narrowed. YUNGAS: *Bang* 203 (GH). COCHABAMBA: CHAPARE: Locotal, 1700 m., *Steinbach* 9068 (GH; type-number). SANTA CRUZ: SARA: Cerro Hosana, *Steinbach* 3421 (GH).

6. S. **composita** (Nees) Boeckl. in Linnaea, 38: 444 (1874). Perennial from a slender rhizome. Culms to 6 dm. tall, slender, triangular. Leaves to 2 dm. long and 2-5 mm. wide, pilose beneath and sparsely pilose to glabrous above; sheaths glabrous to densely ciliate, ligule rounded, ovate, pilose. Inflorescence terminal, densely spicate, the rachis sparsely to densely pilose; bracts setaceous (if present); bractlets setaceous, hairy, mostly not exceeding the spikelets. Spikelets brown, 2-3 mm. long; staminate scales lanceolate, to 4 mm. long; pistillate scales with pilose keel; hypogynium none, or almost none; achene obscurely trigonous, white or dirty-white, irregularly reticulate, mucronate, 1 mm. long. SANTA CRUZ: SARA: Buenavista, 450 m., *Steinbach* 6891 (GH).

7. S. **macrophylla** Presl, Rel. Haenk. 1: 200 (1830). *S. paludosa* of the Catalogue. Perennial, with thick rhizomes. Culms 1-3 m. tall, acutely triangular, the angles scabridulous, thick. Leaves to 4 dm. long and 4.5 cm. wide, the angles and margins scabridulous; sheaths trialate, the wings scabridulous, ligule ovate, obtuse, short. Inflorescence an axillary and terminal panicle with erect branches; bract leaf-like, bractlets setaceous, basally pubescent. Staminate spikelets to 4 mm. long, the scales lanceolate, acuminate-acute, puberulent. Pistillate scales broad, more or less puberulent, ciliate; hypogynium conspicuous, undulate, the margin ciliate; achene to 6 mm. long, subglobose, but very obscurely subtrigonous, white or dirty-white to pale brown, smooth, shining, the puberulent style-base persistent. SANTA CRUZ: SARA: Buenavista, 450 m., *Steinbach* 1465 (GH), 8021 (GH).

8. S. **microcarpa** Nees ex Kunth, Enum. Pl. 2: 341 (1837). Perennial from elongate rhizomes. Culms to 2 m. high, acutely triangular, glabrous. Leaves to 4 dm. long and 1 cm. wide, glabrous; sheaths trialate, glabrous, the lanceolate glabrous ligule to 1 cm. long. Inflorescence of terminal and axillary panicles, the branches erect, spikelets somewhat remote; bract foliar, bractlets very small, more or less subulate. Staminate spikelets oblong-ovate, with obtuse, ovate, straw-colored scales. Pistillate scales suborbicular, straw-colored; hypogynium undulate and densely ciliate; achene ovoid, to 2 mm. long,

smooth, white to pale buff, the style-base somewhat persistent. SANTA CRUZ: ICHILO: Río Vibora, 350 m., *Steinbach* 7564 (GH).

In its original use, in Linnaea, 9: 302 (1834), this binomial was a *nomen nudum*. Kunth's validation of the name in 1837 is the earliest known to me.

9. **S. mitis** Berg. in Vet. Akad. Handl. Stockh. **27**: 145, t. 5 (1765). Perennial, from moderately thick rhizomes. Culms to 3 m. tall, sharply triangular, smooth, rather thick. Leaves to 6 dm. long and 2.5 cm. wide, subplicate, the margins and nerves on the upper surface scabrid; sheaths trialate, glabrous, the lanceolate to long-deltoid ligule glabrous, to 3 cm. long (usually shorter). Inflorescence paniculate, lax, the branches erect; bract foliar, bractlets setaceous, short. Spikelets about 2 mm. long, ovoid-elliptic; pistillate scales orbicular, shortly acuminate; hypogynium with an undulate ciliate margin, the hairs dense, long, red-brown; achene ellipsoid-conic, 2-3 mm. long, white, smooth, the black style-base persistent. SANTA CRUZ: SARA: Buenavista, 500 m., *Steinbach* 2866 (GH).

10. **S. obtusa** Core in Brittonia, **1**: 240 (1934). Probably perennial (rhizomes lacking in material seen). Culms to 7.5 dm. high, slender, triangular, slightly scabridulous. Leaves to 2 dm. long and 1 cm. wide, scabridulous, especially on the upper surface; sheaths trialate (sometimes narrowly so), ligule narrow, 2-4 mm. long. Inflorescence a terminal and axillary few-branched panicle, the branches erect; bract long, slender. Spikelets to 2 mm. long, the pistillate scales brown, suborbicular, abruptly short-acuminate or apiculate; hypogynium brown or purplish-brown, the undulate margin ciliate; achene 2-3 mm. long, oblong-globose, the apex somewhat tapering, obtuse, shining white, smooth. BENI: YACUMA: Hacienda Rosario, 300 m., *White* (M. E.) 1224 (type-number; Gray Herbarium sheet mixed with *Scleria hirtella*).

11. **S. cyperinoides** C. B. Clarke in Kew Bull. Add. Ser. **8**: 61 (1908). Perennial from a rather thick rhizome. Culms to 1 m. high, sharply triangular, the angles scabridulous. Leaves to 3 dm. long and 1.6 cm. wide, the margins and prominent veins scabrid beneath; sheaths narrowly trialate, wing-margins scabrid, ligule ovate, conspicuous, membranous, to 1.5 cm. long. Inflorescence a dense terminal panicle, the rachis sparsely pilose to puberulent; bract long, foliar, bractlets subulate or setaceous. Staminate spikelets subsessile, numerous, the acuminate scales lanceolate, purplish. Pistillate scales lance-ovate, purplish; hypogynium 3-lobed, the lobes deeply dissected into several teeth; achene to 3 mm. long, shorter than the pistillate scales, verrucose, puberulent, especially near the apex, ovoid, subtrigonous (the angles rounded), usually purplish. SANTA CRUZ: ICHILO: Río Vibora, 350 m., *Steinbach* 7575 (GH).

12. S. **arundinacea** Kunth, Enum. Pl. 2: 347 (1837). Perennial from a short thick rhizome. Culms to 2 m. tall, triangular, the angles scabridulous. Leaves few, to 5 dm. long and sometimes to 5 cm. wide, glabrous, plicate or subplicate, abruptly narrowed to an acuminate tip; sheaths broadly trialate, inflated, pubescent, especially near the ovate ligule. Inflorescence an axillary and terminal panicle, purple, the rachis scabrid; bract foliar, to 2.5 dm. long, bractlets setaceous, to 2 cm. long. Staminate spikelets to 3 mm. long, lanceolate. Pistillate scales ovate, purplish, midrib green; hypogynium 3-lobed, lobes fimbriate, fimbriae to 1 mm. long, purple; achene to 3 mm. long, depressed-globose, shining, smooth, purplish to black (portions shielded by scales often whitish). LA PAZ: LARECAJA: San Carlos, Mapiri, 850 m., *Buchtien* 338 (NY).

13. S. **latifolia** Swartz, Prodr. 18 (1788). Perennial from a thick rhizome. Culms to 1 m. tall, triangular, short-pilose (at least on the upper portion). Leaves to 6 dm. long and 5 cm. wide, abruptly acuminate at the apex, the margins and principal nerves scabridulous on lower surface; sheaths trialate, puberulent to shortly pubescent, the deltoid-ovate ligule to 8 mm. long, sometimes pubescent. Inflorescence an axillary and terminal panicle, brownish, the peduncles pubescent; bract to 1.5 dm. long, foliar, bractlets filiform. Staminate spikelets lanceolate, to 4 mm. long, short-pedicellate. Pistillate spikelets with membranous, brown, puberulent, ovate scales; hypogynium 3-lobed, the lobes deeply toothed or fimbriate; achene depressed-globose, to 3 mm. long, shorter than the pistillate scales, smooth, white to purple. LA PAZ: LARECAJA: San Carlos, Mapiri, *Buchtien* 1227 (US); Hacienda Casana, *Buchtien* 7161 (US).

The only marked difference between *S. latifolia* and *S. arundinacea* seems to be in the color of the inflorescence and achene. This hardly seems to warrant retention of two "species", especially as the two are sympatric. The range of *S. latifolia* is apparently entirely included in that of *S. arundinacea.*

14. S. **panicoides** Kunth, Enum. Pl. 2: 348 (1837). Perennial from a thick rhizome. Culms to 2 m. high, triangular, sparsely pilose, the angles scabrid. Leaves to 3 dm. long and 5 cm. wide, sparsely pubescent; sheaths trialate, pubescent, the short ovate ligule densely pubescent to pilose. Inflorescence of axillary and terminal purplish panicles, the rachis and branches pubescent to puberulent; bract foliar, bractlets filiform, long. Staminate spikelets to 4 mm. long, ellipsoid-oblong, the scales purplish. Pistillate scales suborbicular, pubescent, acuminate; hypogynium 3-lobed, laciniate, purple; achene depressed-globose, to 4 mm. long, whitish, shining, rugose-tuberculate, the tubercles puberulent or glabrous. Without data: *Bang* 2350 (GH).

15. S. **bracteata** Cav. Ic. **5**: 34, t. 457 (1799). *S. bracteata* f. *simplicior* Kükenth. in Fedde, Rep. Sp. Nov. **26**: 253 (1929). Perennial from a thick rhizome. Culms to 3 m. long, triangular, scandent or subscandent. Leaves to 4.5 dm. long and 1.8 cm. wide, pubescent on both surfaces, tapering to a long-caudate tip; sheaths shortly villous, often purple-tinged, the ovate ligule to 4 mm. long, pubescent. Inflorescence a terminal and axillary panicle, with the staminate and pistillate portions separate. Pistillate inflorescence: bracts to 7 cm. long, filiform, scabrid; spikelets few-flowered, lance-ovate, cuspidate, purple; hypogynium 3-lobed, the margin purple, entire or dentate; achene subglobose, to 3 mm. long, white or dirty-white, subtuberculate to verrucose, the tubercles puberulent. YUNGAS: *Bang* 262 (GH). LA PAZ: LARECAJA: Hacienda Simaco, 1400 m., *Buchtien* 5102 (GH), 5107 (GH); Hacienda Casana, 1400 m., *Buchtien* 7164 (GH); NOR YUNGAS: Polo-Polo, 1100 m., *Buchtien* 3652 (GH); Hacienda El Choro, *Buchtien* 8067 (GH). SANTA CRUZ: SARA: Buenavista, 450 m., *Steinbach* 7038 (GH).

16. S. **setacea** Poir. Encycl. **7**: 4 (1806). Annual or perennial, with fibrous roots or a short rhizome. Culms to 8 dm. high, diffuse, triangular. Leaves long, linear, 1-4 mm. wide, glabrous or sparsely pilose; sheaths glabrous, sometimes alate, the short ligule rounded. Inflorescence of terminal and axillary panicles, the lateral peduncles very slender, drooping; bracts linear or lance-linear, mostly exceeding the culms, bractlets linear to subulate. Spikelets 2-4 mm. long. Pistillate scales lance-ovate, acuminate, straw-colored to purplish; hypogynium prominently 3-lobed; achene globose to ellipsoid, 2 mm. long, reticulate, the ridges pubescent, dirty-white. SANTA CRUZ: SARA: Buenavista, 500 m., *Steinbach* 5425 (GH).

17. S. **tenacissima** (Nees) Steud. Syn. Pl. Cyp. 175 (1855). Base not seen, plant scandent. Culms to 3 dm. tall, clustered at nodes of the principal axes, triangular, the angles scabrid. Leaves to 3 dm. long and 4 mm. wide, pilose on both surfaces; sheaths pubescent to glabrous, angled, the angles scabrid, the rounded short ligule pilose. Panicles few (1-3) at ends of branches, rachis pilose; bracts foliar, bractlets setaceous. Spikelets to 4 mm. long, the scales lanceolate, pubescent; hypogynium somewhat 3-lobed; achene globose, to 3 mm. long, white, reticulate-tuberculate. LA PAZ: LARECAJA: San Carlos, *Buchtien* 1235 (US). COCHABAMBA: CHAPARE: Puerto Polonia, *Cárdenas & Cutler* 7348 (GH).

18. S. **lagoënsis** Boeckl. in Vidensk. Meddel. Kjoebenh. **1869**: 151 (1870). Perennial from a rather thick rhizome. Culms to 7 dm. high, triangular, the angles scabrid. Leaves to 3 dm. long and 7 mm. wide, the margins and nerves scabrid; sheaths puberulent, the ovate ligule short, pilose on the margins. Inflorescence a terminal and axillary panicle, spikelets few in a cluster; bract foliar, bractlets subulate,

long-attenuate. Staminate spikelets oblong, the scales lanceolate. Pistillate scales lance-ovate, acute to mucronate, brownish, exceeding the achenes; hypogynium 3-lobed, the lobes small, acute; achene 2-3 mm. long, ovoid, white, subreticulate and very sparsely puberulent. LA PAZ: NOR YUNGAS: Milliguaya, *Buchtien* 4283 (US).

19. S. **vaginata** Steud. Syn. Pl. Cyp. 179 (1855). Base unknown, but the plant probably perennial. Culms to 1 m. tall, acutely triangular, the angles scabrid. Leaves to 6 dm. long and 1 cm. wide, exceeding the inflorescence, glabrous, the nerves of lower surface scabrid; sheaths glabrous, broadly trialate, the wings scabrid, the obtusely rounded glabrous ligule to 1 cm. long. Inflorescence a much-branched purplish panicle; bracts foliar, bractlets subulate. Staminate spikelets to 5 mm. long, few-flowered, scales lance-oblong, acuminate. Pistillate spikelets lance-ovate, purplish, acuminate, the scales exceeding the achenes; hypogynium small, obscurely 3-lobed; achene 3-4 mm. long, ovoid, shining, smooth, white (often tinged with purple). LA PAZ: LARECAJA: San Carlos, Mapiri, 750 m., *Buchtien* 1284 (GH).

20. S. **melaleuca** Reichb. ex Schlechtd. & Cham. in Linnaea, **6**: 29 (1831). Perennial from a rhizome. Culms to 9 dm. high, usually glabrous, narrowly trialate, the wings scabrous, the lance-ovate ligule to 1 cm. long, glabrous or pubescent. Inflorescence paniculate, terminal and axillary, purple or brownish-purple; bract foliar, bractlets subulate, ciliate. Staminate scales reddish-brown, lanceolate. Pistillate scales purple, suborbicular, acuminate; hypogynium 3-lobed, the lobes rounded, brown; achene subglobose, 2 mm. long, smooth and shining, purplish, occasionally with short pubescence near the base. LA PAZ: LARECAJA: San Carlos, Mapiri, *Buchtien* 333 (NY). SANTA CRUZ: SARA: Buenavista, 450 m., *Steinbach* 6950 bis (GH).

This is probably better treated as a variety of the next species, *S. pterota.* There seems to be almost no distinguishing mark aside from the color of the inflorescence. Since the latest monographer of the genus has retained them as species, as was also true of *S. arundinacea* and *S. latifolia,* I have followed his example, reluctantly.

21. S. **pterota** Presl in Isis, **21**: 268 (1826). Perennial from a thick rhizome. Culms to 3 m. tall, triangular, the angles scabrid, glabrous. Leaves to 4.5 dm. long and 1.5 cm. wide, the margins scabrid; sheaths narrowly trialate, the triangular ligule pilose, to 1 cm. long. Inflorescence of axillary and terminal panicles, greenish or yellowish-brown (sometimes purplish); bract foliar, large, bractlets filiform. Staminate scales lanceolate, acuminate, greenish-brown or tinged with purple. Pistillate scales orbicular, acuminate, stramineous; hypogynium 3-lobed, the lobes rounded, glabrous or ciliate; achene to 2.5 mm. long,

globose or depressed-globose, smooth, white or yellowish-brown. LA PAZ: LARECAJA: Mapiri, *Rusby* 79 (NY).

22. S. **secans** (L.) Urb. Symbol. Antill. 2: 169 (1900). *S. reflexa* of the Catalogue. Perennial from a rhizome. Plants scandent, the culms to 10 m. long, triangular, the angles scabrid. Leaves long, linear, to 5 mm. wide, usually basally pubescent on the upper surface and pilose beneath; sheaths scabrid, apically pubescent, the short ligule ovate, usually with an apical scarious appendage. Inflorescence terminal and axillary; bracts foliar, bractlets filiform-subulate, pubescent. Pistillate scales ovate, glabrous, acute, dark in color; hypogynium subentire, the margin undulate; achene 2-4 mm. long, globose, shining, white or dirty-white, usually minutely puberulent. LA PAZ: LARECAJA: San Carlos, Mapiri, 850 m., *Buchtien* 329 (GH). SANTA CRUZ: SARA: Buenavista, 500 m., *Steinbach* 5308 (GH).

14. UNCINIA Pers.

Stoloniferous perennials, the leaves mostly basal. Inflorescence a terminal spike, flowers unisexual; female flowers below the apical male flowers on the spike. Female flowers with a subtending scale, a 2-parted utricle, the achene with a trifid style, the rachilla of the spikelet long-exserted and apically hooked; achene oblong, obscurely trigonous. Male flowers with a smaller scale subtending 3 stamens, filaments broad.

Inflorescence narrowly cylindrical; rachilla markedly divaricate at maturity; utricles elliptic. .... 1. *U. hamata.*
Inflorescence clavate, broadest near the apex; rachilla hardly divaricate; utricles oblong. .... 2. *U. phleoides.*

1. **Uncinia hamata** (Swartz) Urb. Symbol. Antill. 2: 169 (1900). Plants to 7 dm. tall, the leaves exceeding the stem. Inflorescence to 2 dm. long. Female flowers: glume oblong-ovate, obtuse, ciliolate at the apex; utricles to 5-6 mm. long, exceeding the glumes, the margins coarsely hispid-ciliate, at least on the upper half; exserted portion of rachilla at least as long as the utricle, usually about 7 mm. long; achene oblong-obovate, to 4 mm. long. Male flowers: glumes shorter, abruptly obtuse. LA PAZ: NOR YUNGAS: Polo-Polo, 1100 m., *Buchtien* 3653 (GH).

2. **U. phleoides** (Cav.) Pers. Synops. Pl. 2: 534 (1806). Plants to 7.5 dm. tall, leaves to 12 mm. wide. Inflorescence to 15 cm. long. Female flowers: glume oblong, obtusely rounded, finely ciliolate in the upper portion; utricles to 5-6 mm. long, much exceeding the glumes, densely hispid on upper portion; exserted portion of rachilla much shorter than utricle in length; achene narrow, oblong, to 5 mm. long. Male flowers: glumes much shorter and proportionately broader. LA PAZ: LARECAJA: Lancha de Cochipata, 3300-3700 m., *Mandon* 1424 (GH).

15. CAREX L.

Perennial from a rather slender scaly rhizome. Culms mostly trigonous, the angles often scabrid or scabridulous, often clothed at the base in the fibrous remains of old leaves. Leaves mostly flat, occasionally reduced to sheaths. Inflorescence of solitary spikes, or spikes aggregated in dense capitula, or obviously paniculate. Flowers unisexual, the staminate flowers consisting of a scale and 3 stamens, borne at the base (gynaecandrous) or apex (androgynous) of a spike (in 1 species, staminate and pistillate flowers borne in separate spikes); pistillate flowers consisting of a scale subtending a specialized sac (perigynium) containing an achene; achene flattened, biconvex (lenticular) or trigonous; stigmas 2 or 3.

a. Pistillate and staminate flowers in separate spikes on the same plant. .... 5. *C. decidua* var. *Brehmeri.*
a. Pistillate and staminate flowers in the same spike.
  b. Staminate flowers at base of spike (gynaecandrous).
    c. Achene trigonous; stigmas 3. .... 9. *C. boliviensis.*
    c. Achene not trigonous; stigmas 2.
      d. Perigynia pale green, plano-convex; beak long; style-base thickened. .... 3. *C. Bonplandii.*
      d. Perigynia olivaceous to brown, concavo-convex; beak short; style-base not thickened. .... 2. *C. pinetorum.*
  b. Staminate flowers at apex of spike (androgynous).
    e. Achene trigonous; stigmas 3.
      f. Achene not constricted in the middle.
        g. Perigynia pubescent to glabrate. .... 10. *C. phalaroides.*
        g. Perigynia glabrous. .... 4. *C. cladostachya* var. *maxima.*
      f. Achene constricted in the middle. .... 8. *C. Jamesonii* var. *subfulva.*
    e. Achene not trigonous; stigmas 2.
      h. Achene biconvex and torulose. .... 7. *C. fecunda.*
      h. Achene not biconvex, not torulose.
        i. Perigynia green, subalate, ampullaceous, beak long. .... 1. *C. nebularum.*
        i. Perigynia deep chestnut or purplish-brown, not alate, not ampullaceous, beak short. .... 6. *C. pichinchensis.*

1. **Carex nebularum** Phil. in Anal. Univ. Chile, **93:** 492 (1896). Plants to 2 dm. high, the culms trigonous, scabridulous above. Leaves shorter or longer than the culms, to 4 mm. wide, the midrib prominent, at least the margins scabridulous. Inflorescence a dense, terminal, ellipsoid to ovoid, ebracteate capitulum of numerous androgynous (staminate flowers at apex) spikes. Staminate flowers: scales narrow-

ly lanceolate, to 4 mm. long, acute to somewhat mucronate, the broad margins hyaline or brown-hyaline, the rather prominent midrib brown. Pistillate flowers: scales lanceolate, broader, to 6 mm. long, acute, the margins broadly hyaline, the center pale to dark brown, midrib green; perigynium equaling or shorter than the scale, to 4 mm. long, plano-convex, the over-all shape ampullaceous, subalate, the long beak and upper wings scabrid-serratulate, apex of beak deeply bidentate; stigmas 2; achene small, flattened, pale brown. LA PAZ: MURILLO: La Paz, 3800 m., *Buchtien* 9245 (GH; det. Kükenthal).

2. C. **pinetorum** Liebm. in Vidensk. Selsk. Skr. Kjoebenh. (ser. 2) **5**: 263 (1851). *C. Mandoniana* of the Catalogue. Culms mostly to 1 dm. tall, rarely to 3.5 dm., trigonous, the angles smooth or occasionally scabridulous. Leaves mostly shorter than the culms, to 2 mm. wide, scabridulous beneath. Inflorescence a congested ovoid capitulum of 3-5 gynaecandrous (staminate flowers at base) spikes, the bracts and bracteoles mostly setaceous. Staminate flowers: scales ovate, obtuse, brown with a green keel, the apex hyaline. Pistillate flowers: scales ovate, acute, chestnut-brown with a green keel; perigynium to 4 mm. long, slightly exceeding the scale, ovoid, concavo-convex, nerves subconspicuous, narrowly alate, the margin ciliate-scabrid, olivaceous, becoming brown, the beak medium long, reddish-brown, bidentate; stigmas 2; achene shining brown, ovoid, style-base not thickened. LA PAZ: LARECAJA: Lancha de Cochipata, 3100-4300 m., *Mandon* 1429 in part (GH; type-number of *C. Mandoniana*).

3. C. **Bonplandii** Kunth, Enum. Pl. **2**: 380 (1837). Culms 3 dm. tall, trigonous, the angles scabrid. Leaves shorter or longer than the culms, to 2.5 mm. wide. Inflorescence of 4-10 densely flowered, ovate, approximate, gynaecandrous (staminate flowers at base) spikes, mostly ebracteate. Staminate flowers: scales ovate, obtuse or subobtuse, chestnut-brown, the keel green, hyaline margin broad. Pistillate flowers: scales lance-ovate, subacute, chestnut-brown, the keel green; perigynium to 3-3.5 mm. long, exceeding the scale, plano-convex, ovoid, nerves few and inconspicuous, pale green, subalate, the margins scabrid from the middle upward, beak long, reddish, bidentate; stigmas 2; achene small, ovoid, brown, style-base thickened. LA PAZ: LARECAJA: Lancha de Cochipata, *Mandon* 1429 in part (GH); MURILLO: near La Paz, 3300 m., *Bang* 62 (GH); 3700 m., *Buchtien* 9244 (GH; inflorescence like *C. pinetorum* but technical details of *C. Bonplandii*); NOR YUNGAS: Unduavi, 3200 m., *Buchtien* 6405 (US).

4. C. **cladostachya** var. **maxima** Kükenth. in Engler, Pflanzenr. IV, **20**(38): 268 (1909). Culms to 5 dm. high. Leaves longer or shorter than the culms, to 1 cm. wide, scabrid above and beneath. Inflorescence paniculate or sometimes apparently racemose, the spikes short-pedicellate; basal bract foliar, exceeding the inflorescence, bracteoles setaceous, equaling or shorter than the spikes. Spikes ovoid,

solitary (occasionally paired), to 1 cm. long, androgynous (staminate flowers at apex). Staminate flowers: scales ovate, about 2 mm. long, the central portion thin, with 3 prominent ribs, light greenish-brown, the broad margins hyaline, apex slightly emarginate, midrib excurrent as a short scabridulous mucro. Pistillate flowers: scales slightly broader, thinner-textured, paler, midrib green, very prominent, mucro longer and more scabrid; perigynium about 2-3 mm. long, exceeding the scale, trigonous, ovoid-ellipsoid, the sides thickened, 3-5 nerves prominent, thin-textured, pale green, gradually contracted into the bidentate beak; achene ellipsoid, trigonous, warm brown, the angles stramineous, the sides densely and evenly papillate; stigmas 3. LA PAZ: LARECAJA: Hacienda Simaco, 1400 m., *Buchtien* 5108 (GH); MURILLO: near La Paz, *Rusby* 74 (NY). Without data: *Bang* 2210 (GH; type-number).

5. C. **decidua** var. **Brehmeri** (Boeckl.) Kükenth. in Engler, Pflanzenr. IV, **20** (38): 307 (1909). *C. Goodenowii* var. *stolonifera* of the Catalogue. Plant to 1 dm. high, culms shorter than or about equaling the leaves. Leaves to 3 mm. wide, scabridulous beneath. Inflorescence contracted, of 4-7 spikes, the uppermost staminate, the lower pistillate, bracts small but foliar, mostly exceeding the inflorescence. Staminate flowers: scales to 2.5 mm. long, cuneate to spatulate, obtuse, brown, the midrib and central portion green. Pistillate flowers: scales to 2 mm. long, ovate to obovate, subacute, warm deep brown with a narrow, hyaline, white margin; perigynium to 2 mm. long, not, or only slightly, exceeding the scale, plano-convex, few-nerved, ovate to lance-ovate, papillose, abruptly contracted into a very short entire beak; stigmas 2; achene nearly as large as the perigynium, flattened, finely scrobiculate, pale brown, the style-base about 0.5 mm. long. LA PAZ: LARECAJA: Cochipata, 3200 m., *Mandon* 1427 (GH; type-number of *C. Brehmeri*).

6. C. **pichinchensis** HBK. Nov. Gen. & Spec. **1**: 233 (1815). Culms to 4.5 dm. high, acutely trigonous, the angles scabridulous. Leaves numerous, as long as the culms, to 7-8 mm. wide, glaucous, not scabridulous, finely nerved, the midrib usually prominent. Inflorescence a terminal panicle of several to many dense, more or less oblong, androgynous (staminate flowers at apex) spikes, the basal bract long, foliar, sometimes exceeding the inflorescence. Staminate flowers: scales narrowly ovate, to 3 mm. long, acute, deep chestnut-brown with a pale midrib. Pistillate flowers: scales ovate, acute to acuminate, to 3.5-4 mm. long, deep chestnut-brown to blackish-brown; perigynium nearly as long as the scale, ovoid, plano-convex, deep chestnut-brown or purplish-brown, abruptly contracted into a short bidentate beak; stigmas 2; achene oblong to obovoid, pale brown to stramineous, finely pitted, plano-convex. LA PAZ: LARECAJA: Ticonguaya, 3300-3800 m., *Mandon* 1426 (GH); Ingenio del Oro, 3300 m., *Rusby* 170 (GH); NOR YUNGAS: Unduavi, 3600 m., *Buchtien* 2596 (GH). SANTA CRUZ: VALLEGRANDE: Comarapa, 2800 m., *Steinbach* 8339 (NY).

6a. **C. pichinchensis** var. **obtusisquamea** R. Gross in Notizbl. **14:** 193 (1938). Inflorescence small; scales obtuse or subobtuse, not acute to acuminate. COCHABAMBA: AYOPAYA: Sailapata, 3000 m., *Cárdenas* 3204 (type-number; not seen).

7. **C. fecunda** Steud. Syn. Pl. Cyp. 194 (1855). Culms to 1 m. high, acutely trigonous, the angles scabridulous. Leaves mostly as long as the culms, to 8 mm. wide, scabridulous. Inflorescence paniculate, the lower bracts foliar, the bracteoles setaceous. Spikes numerous, many-flowered, cylindric, androgynous (staminate flowers at apex). Staminate flowers: scales lance-ovate, acuminate to shortly mucronate, reddish-brown, the midsection green, about 3 mm. long. Pistillate flowers: scales like the staminate scales; perigynium a little shorter than the scale, ovoid, plano-convex, the marginal nerves thickened (almost subalate), contracted rather abruptly into a short bidentate beak, the beak-margins sometimes serrate-scabrid; stigmas 2; achene biconvex, pale to medium brown, once or twice contracted near the middle, hence somewhat torulose. LA PAZ: LARECAJA: Cochipata, 3200 m., *Mandon* 1425 (GH). SANTA CRUZ: VALLEGRANDE: Cerro San Mateo, Comarapa, 3000 m., *Steinbach* 8390 (NY).

8. **C. Jamesonii** var. **subfulva** Kükenth. in Fedde, Rep. Sp. Nov. **8:** 7 (1910). Culms to 1 m. tall, but usually shorter, strongly angled, the angles scabrid. Leaves equaling the culms, to 1 cm. wide, with 2 prominent nerves on upper surface. Spikes in a panicle, androgynous (staminate flowers at apex). Scales fulvous, lanceolate, to 4 mm. long, prominently 3-nerved, the apex-margins scabrid; perigynium about equaling the scale, outwardly curved, narrowly ovoid or lanceolate, subtrigonous, nerves inconspicuous to obsolete; stigmas 3; achene trigonous, constricted (subtorulose) in the middle, the style-base not thickened. Without data: *Bang* 2376 (GH; type-number).

9. **C. boliviensis** v. Heurck & Muell. Arg. in v. Heurck, Obs. Bot. 32 (1870). Culms to 4.5 dm. high, very slender, decumbent, the upper portion scabrid on the angles. Leaves entirely basal, very much shorter than the culms, to 2-3 mm. wide. Inflorescence of 2-3 approximate spikes, the uppermost gynaecandrous (staminate flowers at base), the others pistillate, bracts short, hardly foliar, the lowermost slightly longer than the lowest spike. Spikes to 1.5 cm. long, oblong-ovoid. Staminate flowers: scales to 3 mm. long, ovate to obovate, brown, the green midrib prominent but not excurrent, the apex somewhat hyaline at the margin. Pistillate flowers: scales to 3 mm. long, broadly ovate, thin, brown, the central portion green and 3-nerved, with a short blunt mucro, or the mucro absent; perigynium exceeding the scale, lance-ovoid, with 3-5 prominent ribs dorsally and about 5 less prominent ribs ventrally, apically shortly attenuate into the short entire or subentire beak; achene obovoid, sharply trigonous, finely and evenly papillate; stigmas 3, the lower portion densely

glandular-pilose. LA PAZ: LARECAJA: near Lacatia, 3200-3300 m., *Mandon* 1428 (GH; type-number).

10. **C. phalaroides** Kunth, Enum. Pl. **2:** 482 (1837). Culms to 2 dm. tall, obtusely trigonous, smooth, the bases mostly clothed in fibrous remains of old leaves. Leaves exceeding the culms, to 2-3 mm. wide, smooth or scabridulous on the margins and more prominent veins. Inflorescence of 4-6 distant, androgynous (staminate flowers at apex), dense, subglobose spikes to 1 cm. long; bract foliar, exceeding the inflorescence. Staminate flowers: scales narrowly elliptic-ovate, the margins whitish, central portion yellowish-green, the midrib dark green, with a thick scabrid arista less than half the length of the scale. Pistillate flowers: scales similar but much broader, the arista usually longer than the body of the scale; perigynium coriaceous, obovoid-oblong, trigonous, 3-4 mm. long, yellowish-green, densely short-pubescent (the hairs white, thick, curled), 2 lateral nerves prominent, basally long-attenuate or stipitate, the apex abruptly contracted into a short entire beak; achene obovoid, trigonous, the somewhat thickened style-base about half the length of the achene; stigmas 3. TARIJA: MENDEZ: Tucumilla, *Fiebrig* 2639 (Barros). LA PAZ: MURILLO: La Paz, 3800 m., *Buchtien* 6407 (US).

10a. **C. phalaroides** var. **moesta** (Kunth) Kükenth. in Verhandl. Bot. Ver. Brandenb. **47:** 208 (1905). Taller (to 3 dm.), leaves narrower (1-2 mm.). Spikes oblong-clavate, distant, androgynous. Perigynium shorter, the base shortly or hardly at all stipitate, the beak shorter and its apex shortly notched or emarginate. Without data: *Bang* 1870 (GH). LA PAZ: LARECAJA: Cerro del Iminapi, 2650-3950 m., *Mandon* 1430 (GH).

GRAY HERBARIUM,
HARVARD UNIVERSITY

GENOTYPIC VARIATION IN THE PHACELIA STRICTIFLORA COMPLEX[1]

GEORGE W. GILLETT

The *Phacelia strictiflora* complex occurs from the Texas Gulf Coast to peripheral upland habitats of northeast Mexico, the Edwards Plateau, Oklahoma, Arkansas, Louisiana, Mississippi, and eastern Alabama. It embraces populations nominally included under *P. strictiflora* (Engelm. & Gray) A. Gray; and *P. patuliflora* (Engelm. & Gray) A. Gray; also a large number of intermediate populations. The two species of this complex were included in a recent biosystematic study of the Cosmanthus phacelias, in which a crossing program was completed with eight additional Cosmanthus phacelias (Gillett, in press). Constance (1949) recognized four varieties of *P. strictiflora* and two varieties of *P. patuliflora*. Material grown in this study would correspond more nearly to *P. strictiflora* var. *lundelliana* Constance and to *P. patuliflora* var. *patuliflora*. Recognition of the *P. strictiflora* complex as a distinct evolutionary line seems justified by genetic and morphological evidence presented earlier (op. cit.). The current objective is to present evidence that has an important bearing on the evolutionary relationship of the two species of the complex.

Both species of this complex are self-compatible outcrossers with nine pairs of chromosomes. Populations of *Phacelia patuliflora* occur on lowland habitats, very often on sandy alluvium near sea level along the coast, extending inland to central Texas. Its penetration inland centers along alluvial lowlands between the Colorado and Nueces Rivers. Its coastal distribution extends from the vicinity of Houston to the mouth of the Rio Grande, the southern populations showing considerable gradation to intermediate forms. On the other hand, *P. strictiflora* is a species of upland habitats and occurs over a wide expanse of territory from northeast Mexico to Oklahoma and eastern Alabama. It is highly variable and very often occurs as a weed in fallow fields, roadsides, and disturbed areas.

[1]Aided by grants from the National Science Foundation.

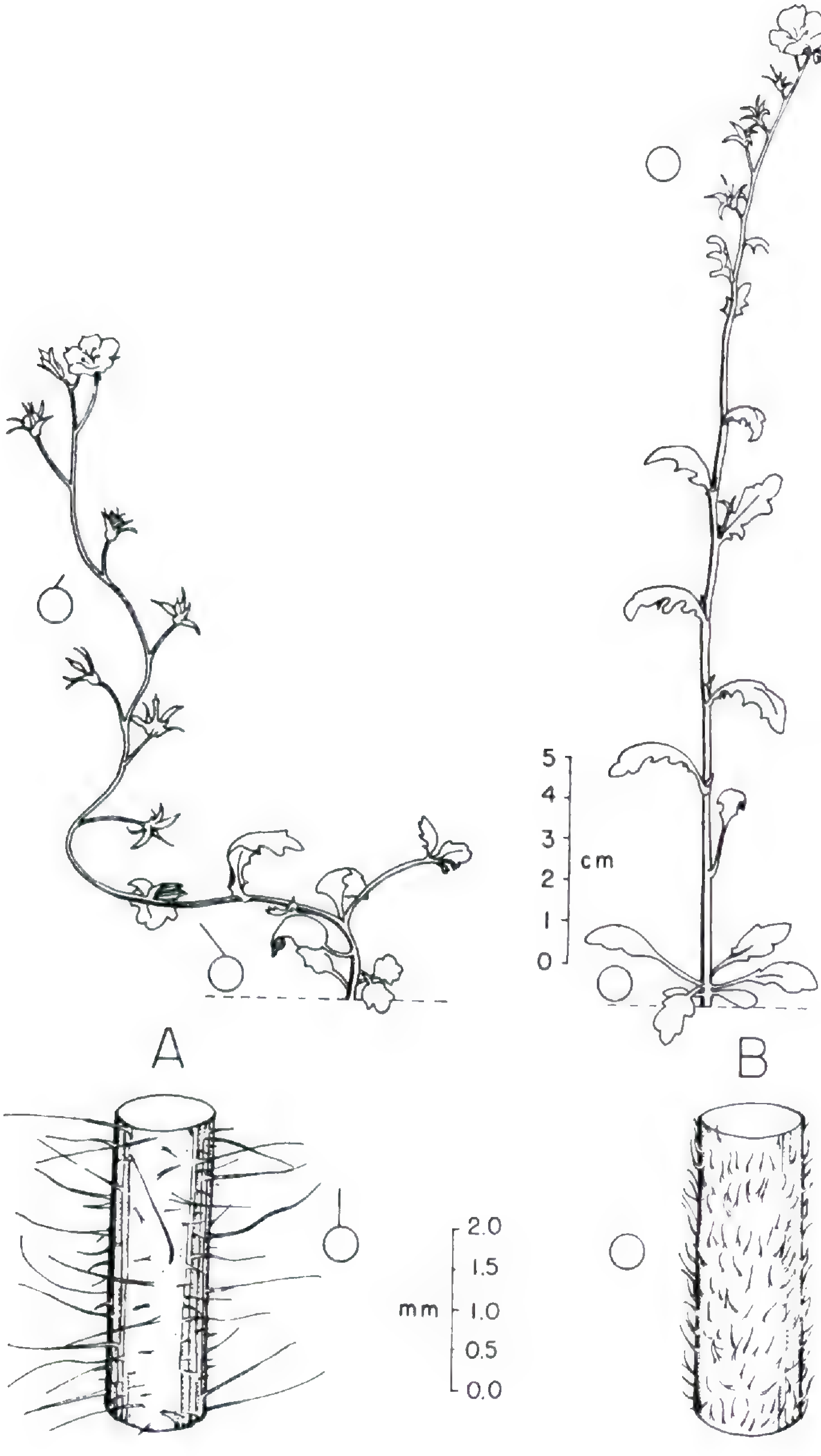

Fig. 1. Habit; pedicel length; and size and orientation of nonglandular hairs in: (A) *Phacelia patuliflora* (*Gillett 1216* UC); and (B) *P. strictiflora* (*Gillett 1257* UC).

A useful comparison of *Phacelia strictiflora* and *P. patuliflora* is given in the following table:

Phacelia strictiflora	*Phacelia patuliflora*
Corolla with crenulate to entire margin.	Corolla with entire margin.
Calyx accrescent.	Calyx non-accrescent.
Colleters small; 0.1 - 0.2 mm long.	Colleters of two size classes: small, 0.1 - 0.2 mm; and large, 0.3 - 0.5 mm long.
Habit virgate to ascending.	Habit reclining to ascending.*
Non-glandular hairs fine, ascending.	Non-glandular hairs coarse, spreading.*
Pedicel length 0.5 - 1.5 cm.	Pedicel length 1.5 - 2.0 cm.*

*Clinal variation (determined by the study of herbarium specimens).

The variability of the last four characters in the above table was determined by direct measurement or by comparison. Voucher specimens of each species were prepared from plants grown together in the greenhouse and were used for making comparisons with herbarium specimens. Line drawings of these vouchers are shown in Fig. 1.

The glandular hairs (colleters) of *Phacelia strictiflora* and *P. patuliflora* are of two size classes that show no intergradations (Fig. 2). The larger glandular hairs are quite distinct and easily recognized on dried material, but the

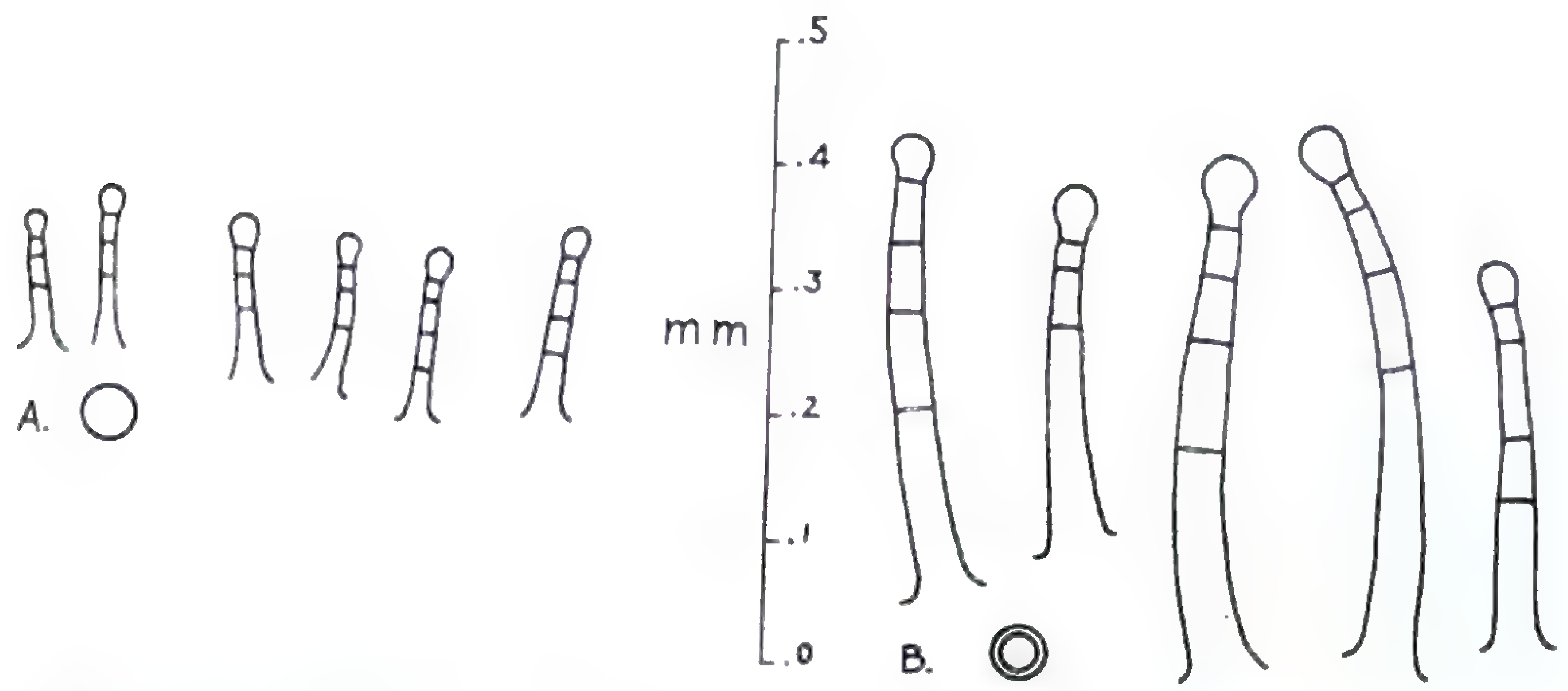

Fig. 2. Glandular hairs (colleters) of the *Phacelia strictiflora* complex. (A) small glandular hairs of *P. strictiflora* and southern populations of *P. patuliflora* (*Gillett 1257* UC); (B) large glandular hairs of northern populations of *P. patuliflora* (*Constance and Cory 3247* UC).

smaller become shrunken upon drying, presenting a distorted appearance. It was, therefore, quite easy to score herbarium specimens for these. The larger glandular hair is apparently restricted to the northern and interior populations of *P. patuliflora*.

The three additional characters scored in this complex were: (1) the length of the lower pedicels of the inflo-

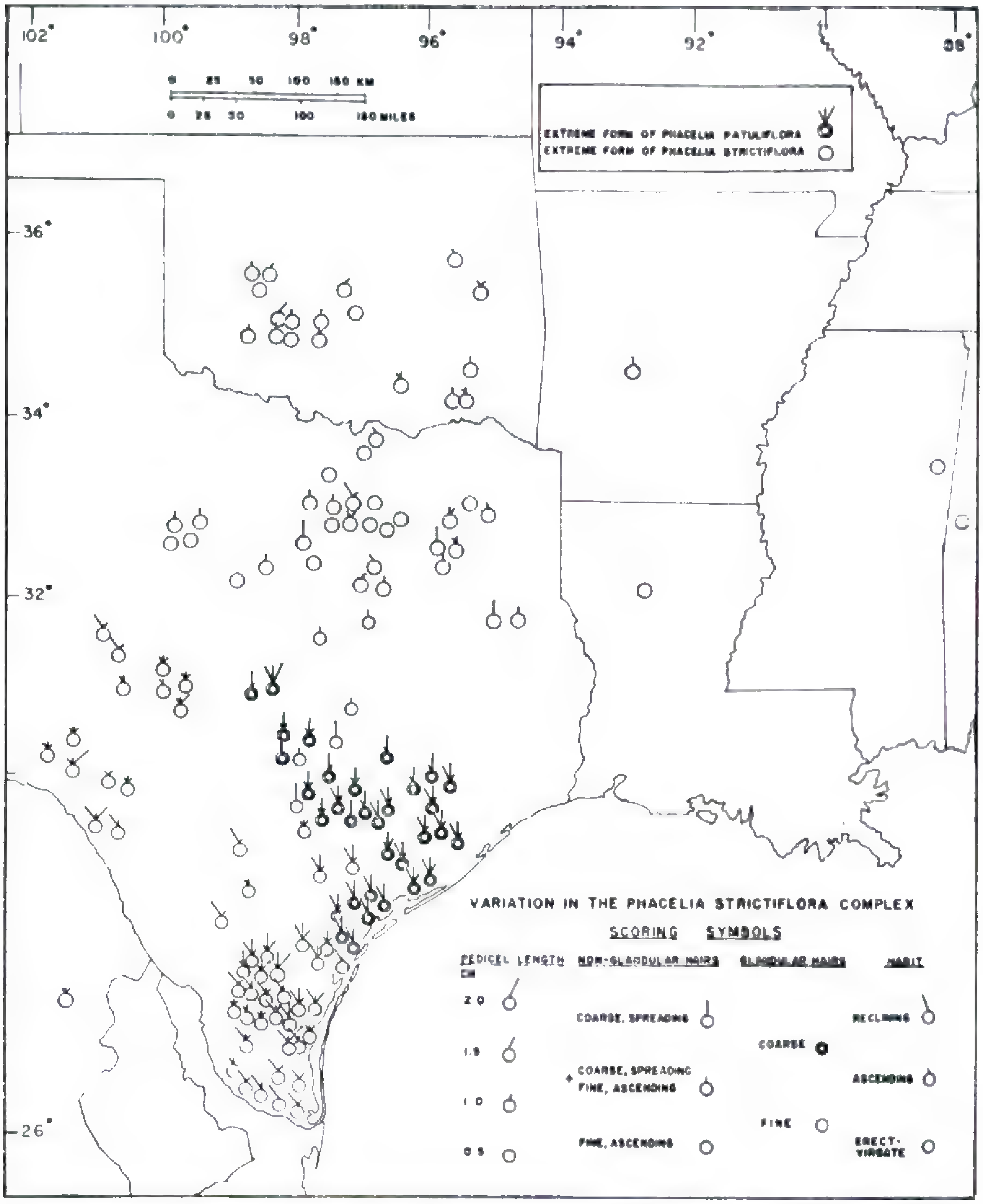

Fig. 3. Geographical distribution and variation in *Phacelia strictiflora* and *P. patuliflora*.

rescence (by direct measurement); (2) the cauline pubescence of non-glandular hairs (by comparison); and (3) habit (by comparison). Each of these three characters is metrical with a continuous spectrum of expression between the extremes portrayed in Fig. 1. The classes scored were the two extreme expressions, each with a representation of near-extremes, and an intermediate class that included an arbitrarily designated central expression along with intermediates on either side. In scoring the variation in pedicel length, two intermediate classes were designated, so that four classes were recorded for this character. The scoring for these metrical characters was admittedly unsophisticated, but it permitted a graphic portrayal of variability in each character over the entire range of the complex, so that morphological variation may be related to ecological differences. (Fig. 3).

The presence of both qualitative (glandular hairs) and quantitative characters in this material probably reflects the genetic make up of many wild plants. This genetic versatility may be even greater, for the metrical or quantitative characters could represent more than one of the four basic types of polymeric gene systems cited by Clausen & Hiesey (1958).

The four characters portrayed in Fig. 3 are correlated, so that the gene frequencies for the extreme expression of *Phacelia strictiflora* are relatively higher in the populations in Oklahoma and are progressively lower in those of central Texas, portraying generalized genoclines. On the other hand, the gene frequencies for the extreme expression of *P. patuliflora* are relatively higher in populations from central Texas (Burnet County) to the Gulf Coast and are progressively lower south to the Rio Grande. It is notable that the intermediate expression of all three metrical characters is found in widely separated populations of the southern Gulf Coast, the Edwards Plateau (about 300 miles northwest), and central Texas. The clinal variation of these characters suggests that the past migrational histories of *P. patuliflora* and *P. strictiflora* have involved contact and introgressive hybridization along the Rio Grande, or along the northern distributional limit of *P. patuliflora*, or possibly in both regions.

It was not possible to confirm experimentally the abundant evidence of natural hybridization between *Phacelia strictiflora* and *P. patuliflora*. In the first cultures of experimental hybrids grown only two flowers of each species were cross-pollinated, with no seed resulting. In later crosses with cultures grown at Turku, Finland, seven flowers of *P. patuliflora* were pollinated with *P. strictiflora* pollen. The *P. patuliflora* stigmas were examined on the stage of a 30X stereoscopic microscope and thus verified to be clean and free of "selfed" pollen before cross-pollination. The ovules of these seven cross-pollinated flowers were analyzed between 25 and 30 days after pollination. Of 69 ovules examined, only five had normal endosperm and apparently normal embryos. The remaining 64 ovules had no visible endosperm, but 14 of these had deformed embryos. This would suggest that the sterility barrier involves failure of endosperm development and incompatibility between the embryo and surrounding tissue as discussed by Stebbins (1958) and reported in PRIMULA by Valentine (1952, 1955). In the latter work, Valentine was able to secure hybrids from over 4000 seeds obtained from his crosses. In the present material of *P. strictiflora* and *P. patuliflora*, compatibility ranges from zero to apparently normal endosperm and embryos in a very limited population of only 69 ovules. It seems most likely, therefore, that a larger number of cross-pollinations might have produced hybrids. It is also possible that additional reciprocal crosses to the *P. strictiflora* seed parent might have produced hybrids. Therefore, the incompatibility shown by these experiments appears to be relative and by no means absolute.

The taxonomic conclusions of this study provide little satisfaction in terms of readily identifiable species or varieties for the evolutionary dynamics involved here work against, rather than for, discrete taxa. Species limits are established by morphological and often geographical reference points. In *P. strictiflora* and *P. patuliflora* a broad expanse of territory contains innumerable intermediates, each of which is a logical reference point for circumscribing the limit of either species. It is impossible to communicate a species or subspecies limit that can be unerringly confirmed by subsequent workers because a given intermediate population could be ascribed to *P. patuliflora* or to *P. strictiflora* with equal justification. Combining eco-geographical and morphological criteria, I suggest the reasonable compromise of including in *P. strictiflora* those populations of upland habitats from northeastern Mexico through the Edwards Plateau, and including those populations north of central (Burnet County) Texas. On the other hand, it seems reasonable to circumscribe within *P. patuliflora* the coastal populations and those contiguous populations extending inland to and including Burnet County, Texas. This is an admittedly imperfect designation because it leaves populations of *P. strictiflora* within the area ascribed to *P. patuliflora,* as clearly shown on the map of Fig. 3.

ACKNOWLEDGEMENTS

This research was carried out at the Department of Botany, University of Turku, Finland, under a Fulbright Lectureship. The space and facilities provided by Professor Antero Vaarama and his staff at Turku are gratefully acknowledged. The line drawings are by Miss Nina Tarén.
DEPARTMENT OF BOTANY, UNIVERSITY OF HAWAII

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INTERPRETATION OF CROSSING DIAGRAMS

DAVID L. MULCAHY[1]

Since the taxonomic value of experimentally performed interspecific crosses was so ably demonstrated by the work of Clausen, Keck, and Hiesey (1941), most biosystematic monographs have included one or more of the now classic crossing diagrams. Those first authors included data on the fertility of the F_1 and the F_2 generations of crosses between taxa. Similar data, coupled with other information, have been used by many authors in the determination of taxonomic affinities, the assumption being that the closer the relationship between taxa, the greater is the probability that they will produce a fertile hybrid. This assumption is generally valid and, when coupled with data from morphological studies, constitutes the basis for a valuable method of analysis. When, however, the conclusions based on crossing diagrams are not substantiated by other studies, gross misinterpretations may result.

In a recent study of six species within *Oxalis* section CORNICULATAE (Oxalidaceae), a series of interspecific crosses was made in an attempt to determine the taxonomic relations between these species. The results of these crosses are shown in Fig. 1. *Oxalis corniculata* L., *O. dillenii* Jacq., and *O. stricta* L. are fully interfertile and also receptive to pollen from *O. priceae* Small, *O. suksdorfii* Trelease, and *O. grandis* Small but the reciprocal crosses fail. *Oxalis priceae, O. suksdorfii,* and *O. grandis* are intersterile.

According to the general interpretation of crossing diagrams, since *Oxalis corniculata, O. dillenii,* and *O. stricta* are interfertile, they should be closely interrelated. Similarly, because *O. priceae, O. suksdorfii,* and *O. grandis* are not interfertile, they should be distantly interrelated.

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[1]The author wishes to express his appreciation to Dr. R. B. Channell, Vanderbilt University, under whose guidance this work was conducted.

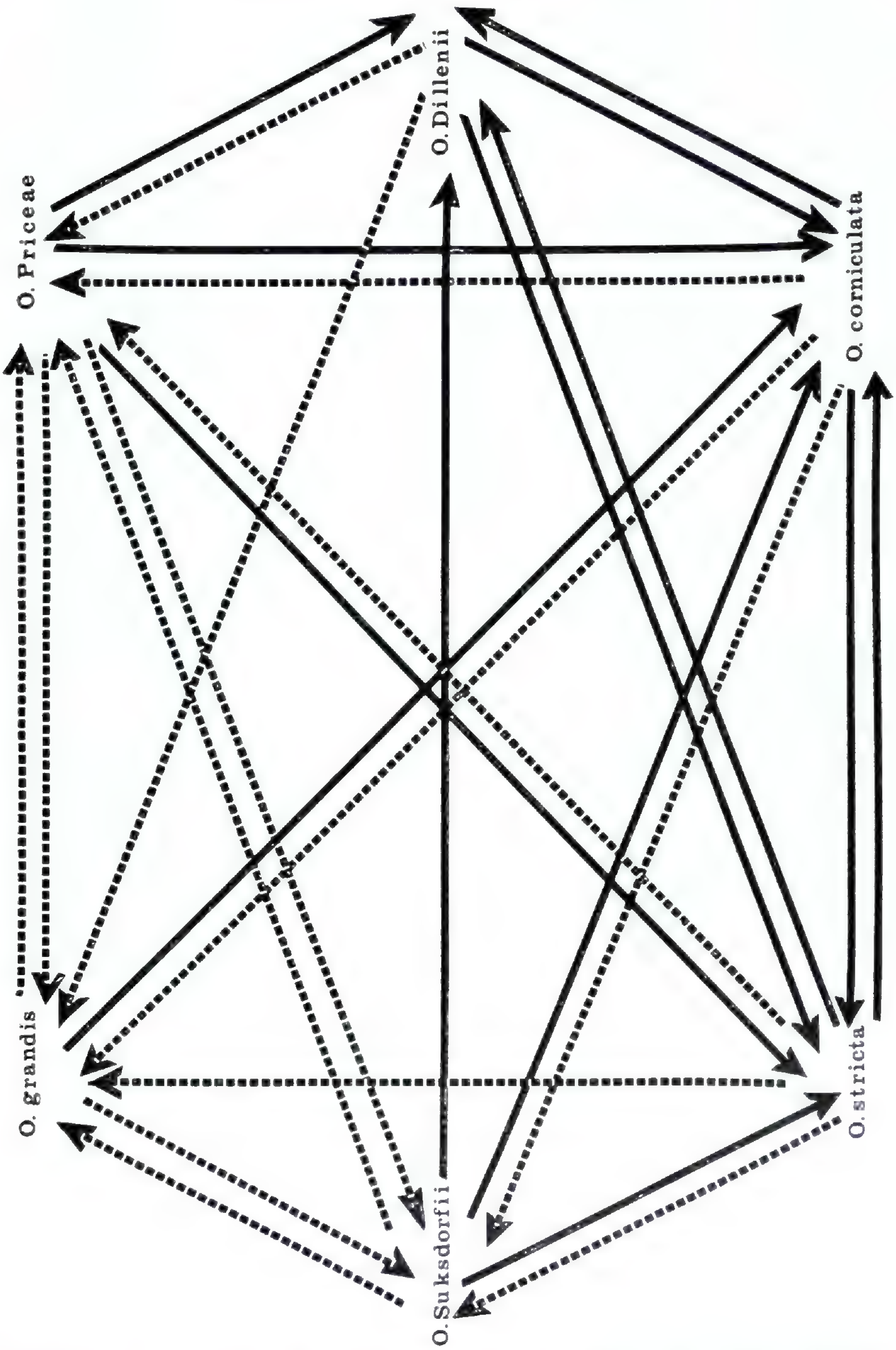

Figure 1. Diagram of crosses between six species of *Oxalis*. Arrows indicate the direction of pollen transfer. Solid lines indicate that seeds were produced. Broken lines indicate that no seeds were produced.

Morphological evidence indicates that *Oxalis stricta* and *O. grandis* are closely interrelated while the remaining four species form another natural group. Eiten (1963) refers to these two groups as subsection STRICTAE and subsection CORNICULATAE, respectively. He, however, places *O. suksdorfii* in subsection STRICTAE. A combination of morphological data and the results of interspecific crosses, interpreted in the usual way, indicates the phylogenetic sequence represented in figure 2. Other data must be considered however.

The species *Oxalis corniculata, O. dillenii,* and *O. stricta* are homostylous and predominantly inbreeding. The remaining three species are heterostylous and mostly outbreeding. In Fig. 2, furthermore, the homostylous species are represented as ancestral to the heterostylous ones, but several facts indicate that, generally, and in *Oxalis* in particular, heterostyly represents the ancestral condition. These facts are:

1. Homostylous species are inbreeding. Inbreeding species are considered to be derived (Stebbins, 1957). Therefore, homostyly represents the derived condition. (See also Baker, 1959.)

2. A vast majority of *Oxalis* species in South Africa are heterostylous (Salter, 1944), as are most South American species (Eiten, 1963). Such a preponderance of heterostyly,

Figure 2. The taxonomic relations suggested by a strict interpretation of data derived from interspecific crosses.

especially in these, the generic centers of distribution, strongly indicates the ancestral position of heterostyly within the genus.

3. *Biophytum* (Oxalidaceae), closely related to *Oxalis*, is also heterostylous. Since tristyly is known for only three angiospermous families, its evolution must be considered to be a relatively rare phenomenon and its occurrence in two genera of the same family probably indicates a single and early origin of tristyly within the family. If heterostyly represents the ancestral condition in the Oxalidaceae, it must certainly be considered ancestral in *Oxalis*.

These considerations contradict the conclusions based on the interspecific crosses represented in Fig. 1 and a revised phylogenetic sequence (Fig. 3) has been proposed. This revised sequence can be supported by morphological and cytological evidence.

Although the homostylous species are interfertile, it is unlikely that they are ancestral to the heterostylous ones. This indicates that experimentally performed interspecific

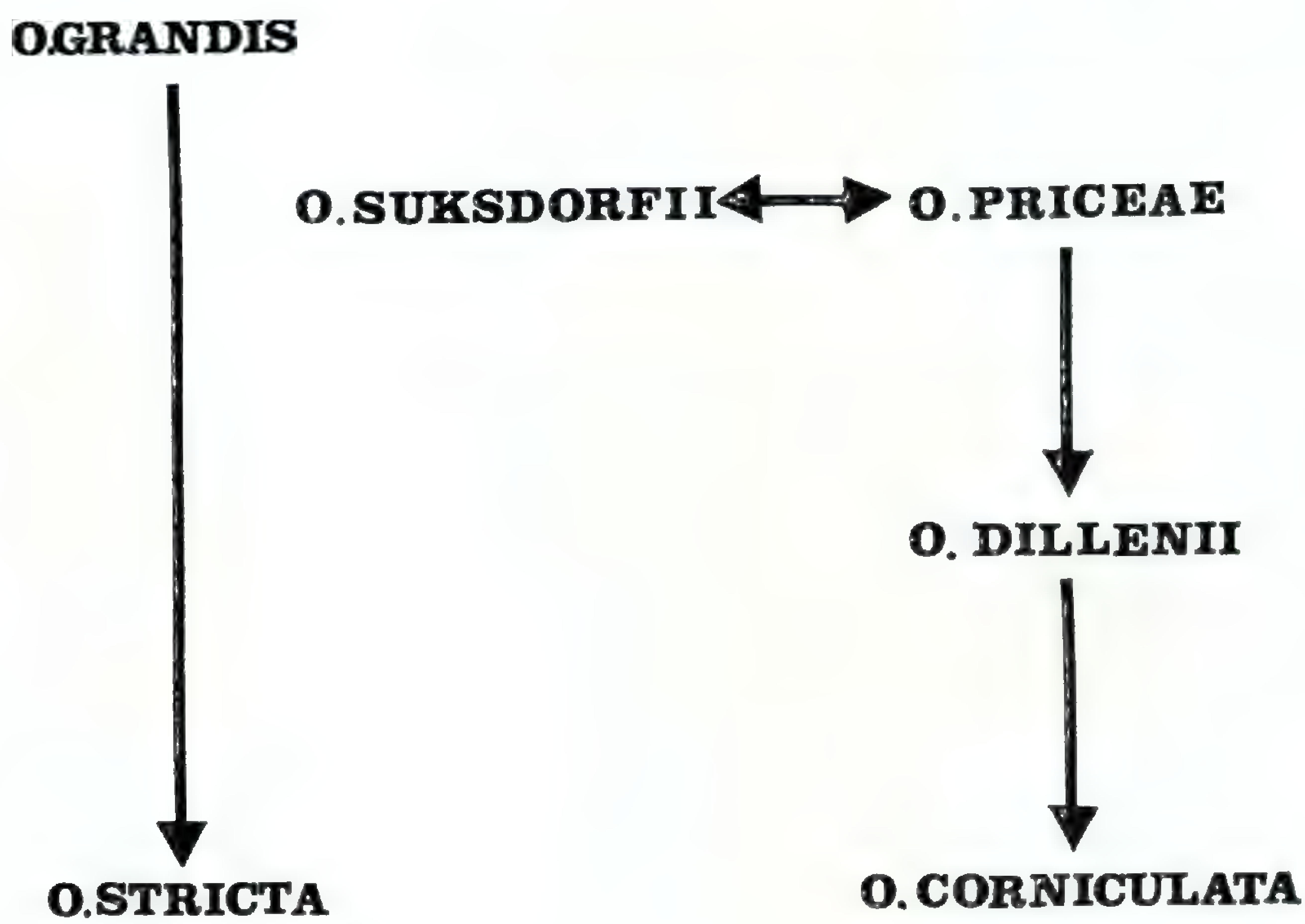

Figure 3. Revised taxonomic relations suggested by a consideration of the reproductive biology of the six species.

crosses cannot be relied upon as an unfailing guide in biosystematic studies. Factors other than taxonomic affinities must be capable of influencing the outcome of such crosses.

One aspect of the relationships between inbreeding (self compatible) species and outbreeding (self incompatible) species was reviewed by Lewis and Crowe in 1958. Those authors, concerned primarily with pollen tube growth or inhibition, performed many crosses between species, genera, and even families. Combining their data with that already present in the literature, they formulated the following rule:

> "In the four possible combinations in crossing self-incompatible (SI) and self-compatible (SC) pollentube growth is uninhibited except in the cross SI style × SC pollen, where it is inhibited similarly to SI pollination."

Lewis and Crowe present data which indicate that the above rule applies to representatives of gametophytic and sporophytic systems of incompatibility, as well as to heteromorphic systems, although only distylous species are specifically mentioned.

Homostyled species generally are self fertile and heterostyled ones are not; thus, the results of the present study appear to be largely in conformity with the Lewis and Crowe rule although some crosses were not performed. The homostyled species are interfertile. Furthermore, these three species are receptive to pollen from the heterostyled species, and the reciprocal crosses, pollen from homostyles on the stigmas of heterostyles, fail. The primary indication of this unilateral incompatibility is that it reveals the profound and overriding influence that differences in breeding systems have on the outcome of interspecific crosses. *Oxalis corniculata* cannot be closely related to *O. priceae* without *O. priceae* being closely related to *O. corniculata.* Yet this is what would be indicated by a strict interpretation of crosses between these two species. It is necessary, therefore, to consider the details of these breeding systems before the crossing diagram can be understood.

Though heterostylous, *Oxalis priceae* is self compatible; yet, like a self incompatible species, it cannot be fertilized by self compatible, homostylous species. Thus, it appears to violate the Lewis and Crowe postulate. This anomalous behavior, however, can be explained by considering that several events are involved in the degeneration of self incompatibility.

Lewis (1951) indicates that a well established system of self compatibility is the result of three mutational steps. The first step results in pollen which will grow in the style of the flower which produced it, as well as in any other SI style. The properties of the style are, however, not affected by this first mutation. A second mutation destroys the activity of the style so that no pollen is inhibited on it. A final mutation is postulated "which leaves the pollen unprotected from the inhibitory effect of the SI style."

If it can be assumed that *Oxalis priceae,* like several homomorphic examples listed by Lewis and Crowe (1958), has passed through only the first step in the evolution of self compatibility, its behavior in interspecific crosses becomes clear. The properties of the style are unaffected and, thus, growth of pollen from homostyles is inhibited, even though the species is self fertile. This assumption implies, however, that the nature of incompatibility in tristylous species is fundamentally the same as that found in non-tristylous groups of the plant kingdom. Whether or not this assumption is valid cannot be decided until further investigations have been performed.

According to Lewis and Crowe (1951), heterostylous species are expected to be interfertile, as are homostylous ones. The homostylous species are indeed interfertile but the heterostylous ones are not. A possible explanation for this behavior may be that, since these are interspecific crosses, failure to set seeds may be due to genetic difference between the heterostyled species. Under the proposed system of taxonomic relationship (Fig. 3), however, the genetic differences between the homostylous species *Oxalis corniculata* and *O. stricta* are expected to be even greater than those between the heterostylous species. This apparent conflict may be resolved by a consideration of inbreeding species in general.

The proximity of anthers to stigmas in homostylous species, coupled with self compatibility, promotes a high degree of inbreeding in homostylous species. This arrangement contributes to the success of homostylous species as weeds. A single individual (Baker, 1959) can, in a few seasons, give rise to a large population and thus colonize any suitable niche which may have become available. Inbreeding leads to a loss of genetic variability and evolutionary potential but Stebbins (1957) points out that inbreeding species occasionally hybridize with other taxa, resulting in greatly increased heterozygosity and the production of many new gene combinations. This is followed by a period of intensive selection. Surviving biotypes may give rise to new inbreeding races. This concept implies that introgression is an important source of genetic variability for inbreeding species.

Within *Oxalis* section CORNICULATAE, the homostylous species exhibit great morphological variability, often in the direction of the heterostylous species (Eiten, 1963). This indicates that within these inbreeding species, as in others discussed by Stebbins (1957), introgression is an important source of genetic variation. The selective advantage of introgression will favor, in homostylous species, the selection of genes or genotypes which are, in the words of Mayr (1954), "good mixers" i.e., those which will function in a wide variety of genetic environments. Thus, homostylous species are expected to be more likely to participate successfully in interspecific crosses than are heterostylous species. This concept may apply to many inbreeding species and thus must be considered in the interpretation of experimentally performed interspecific crosses.

In view of the above discussion, the crossing diagram (Fig. 1) can obviously be interpreted in two ways. The first possibility, based solely on the crossing diagram and morphological data, assigns to the homostylous species, *Oxalis corniculata* and *O. stricta,* a position ancestral to the heterostylous species. This necessitates a rejection, in this case, of the rule formulated by Lewis and Crowe, as well as information which indicates the derived nature of homostyly.

The second interpretation is that, although often of considerable value in determining taxonomic relationships, the crossing diagram, because of the differences in the breeding systems between the species involved, provides little useful information in this particular example. The results of interspecific crosses in this instance are determined largely by reproductive characteristics of the species involved.

The morphological variability of the homostylous species indicates, not that they are ancestral to the heterostylous species, but rather that they have undergone extensive introgression from the heterostylous species.

When interspecific crosses are incorporated into biosystematic studies, it is essential to know which of the taxa involved are self fertile and which are self sterile. Otherwise the several factors which influence the compatibility reactions may produce very deceptive results. Furthermore, crosses should be carried through the F_1 and F_2 generation. This gives a better indication of the genetic similarity between taxa but even these results can be modified by selective forces favoring genetic compatibility or genotypic flexibility. If, because of the nature of the species, further generations cannot be obtained, caution must be exercised during interpretation of the data.

DEPARTMENT OF BOTANY, UNIVERSITY OF GEORGIA, ATHENS

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II. MONOGRAPH OF THE GENUS ELODEA, SUMMARY.

CONTINUED FROM P. 35

HAROLD ST. JOHN

Resurrection of the Family Elodeaceae.
Key to genera.
Egeria.
Elodea.
Key to subgenera, sections and species.
List of *Elodea* species.
Names and synonyms in *Elodea*.
Index to exsiccatae of *Elodea*.

ELODEACEAE Dumortier
Analyse des familles des plantes (1829) 54.

Submerged perennial aquatics, growing from rootstocks or stolons. Leaves opposite or mostly whorled. Flowers perfect or dioecious, enclosed at first by a spathe; hypanthium in perfect and in pistillate flowers well developed, an elongating thread-like tube; perianth regular; sepals 3; petals 3 (or 0); stamens 3 in perfect flowers, or as 3 staminodia in pistillate flowers, or reduced to 1-2; style equaling or exceeding the hypanthium; stigmas 3, and 2-lobed (or entire); ovary superior, 1-celled, with 3 parietal placentae; ovules orthotropous or anatropous, several to numerous; capsule ellipsoid, indehiscent or tardily dehiscent; seeds ellipsoid. Staminate flowers of most dioecious species exserted from the spathe by the elongating, slender tubular base of the hypanthium; stamens 9, mostly in 2 series, the 6 outer ones with short filaments, radiating in a lower ring, the 3 inner ones raised on their fused filaments. In *E. Nuttallii* the staminate flowers sessile, becoming detached and floating to the surface of the water.

Lectotype: *Elodea* Rich. in Michx., Fl. Bor.-Am. 1 (1803) 20.

Also in this family is the genus *Egeria* Planchon.

Dumortier based his new family Elodeaceae on the genera *Elodea, Anacharis,* and *Hydrilla. Anacharis* is a taxonomic synonym of *Elodea. Hydrilla* is superfically very similar, but the pistillate flowers are epigynous, so it is here restored to the Hydrocharitaceae. That leaves of the original ones in the Elodeaceae only the genus *Elodea,* and it is here designated as the lectotype of the family.

Though very different in vegetative characters the genus *Vallisneria* has flowers similar to those of *Elodea*. However, its staminate spathes have many flowers and the flowers have 1-3 stamens; the pistillate flowers have the ovary and fruit truly inferior. Consequently it must remain in the Hydrocharitaceae.

There is a publication by Moldenke (1940: 354) which credits St. John with the *Elodeaceae*. This publication was not authorized by the present writer, and at that time he did not classify *Egeria* or *Elodea* as in the Elodeaceae, but rather in the Hydrocharitaceae.

NATURAL KEY TO GENERA.

Staminate spathes 1-flowered, with a slender stalk-like base, or if sessile, subglobose and containing a sessile staminate flower that is liberated at anthesis, or if with an urceolate spathe the flowers perfect; staminate flowers with 9 stamens, the 3 central ones raised on a common stalk of connate filaments, or rarely the stamens 9 and equal; anthers with 2 locules explosively dehiscing at the axial side of the connective into one widespreading valve (septifragal) which then simulates a heavy ribbed petal; or the flowers perfect, with 3 stamens; filaments smooth, non-glandular, much shorter than the anthers in the staminate flowers; petals smaller than or but little larger than the sepals; nectary lacking; pistillate spathe evenly and shallowly bifid at apex; pistillate flowers with 3 (or 4) entire or bifid or bipartite stigmas; flowers water-pollinated after the explosion of the anthers. *Elodea.*

Staminate spathes 2-4-flowered, sessile, funnelform or ellipsoid; stamens 9 (-10), distinct; filaments papillose glandular above, at least thrice as long as the anthers; anthers each with 2 locules dehiscing by longitudinal lateral sutures into 2 equal valves (loculicidal); petals about thrice larger than the sepals; in the center of the flower a dark nectary; pistillate spathe split halfway down one side; the 3 stigmas 2-3-parted; flowers insect-pollinated. *Egeria.*

EGERIA Planch.

Ann. Sci. Nat., Bot. III, **11**: 79-81. 1849. St. John in Darwiniana **12**: 293-307. 1961.

Egeria densa Planch., Ann Sci. Nat. Bot. III, **11** (1849) 80. *Elodea densa* (Planch.) Caspary, Monatsber. Kgl. Preuss. Akad. Wissensch. **1857** (1857) 48; also in Pringsheim's Jahrb. Wissensch. Bot **1** (1858) 475 (and 99 in repr.); *Elodea canadensis* Rich. in Michx. var. *gigantea* Hort. in Bailey, L. H., Standard Cyclop. Hort. **2** (1914) 111; *Elodea* *gigantea* Santos, Bot. Gaz. **75** (1923) 44, 50; *Elodea densa* (Planch.) Casp. var. *longifolia* Hort. in Parey's Blumengärtnerei, ed. by C. Bonstedt (1931) 110; *Anacharis densa* (Planch.) Victorin, Contrib. Lab. Bot., Univ. Montréal **18** (1931) 41; *Philotria densa* (Planch.) Small, Man. Southeastern Flora (1933) 28; see St. John, in Darwiniana **12** (1961) 297-298, 300-302, fig. 1, a-e, 2.

Description of all specimens examined: Submersed aquatic; stem stout, 2-3 mm. in diameter; lower leaves in whorls of 3, and 3-7 mm. long, 1.5-2 mm. wide, ovate or lance-ovate; middle and upper leaves in whorls of 4 or 5, and 12-40 mm. long, 1.7-5 mm. broad, oblong to broadly linear, acute, serrulate; nodes close together, but the leaves mostly divergent; flowers dioecious; staminate spathes borne in the upper axils, 11-12 (-14) mm. long, 3.5 mm. broad, elliptical, cleft down one side, the apex bifid with 2 short blunt teeth; staminate flowers 2-4 from each spathe, long stipitate, raised above the water by the slender, thread-like, elongating hypanthium which is 3-6 cm. long; sepals 3-4 mm. long, elliptic-oblong, boat-shaped, dark striate; petals 9.5-11 mm. long, 3.5-9 mm. wide, obovate to suborbicular, subacute at tip, cuneate at base, white, erect; stamens 9 (-10), distinct, 2-2.5 mm. long, the central ones not connate; filaments heavy, clavate, flattened, glandular papillose above; anthers 0.5-1.2 mm. long, unequal; nectary central, green, 3-lobed, secreting abundant nectar; pistillate plants unknown to the writer, not represented in any of the numerous herbaria examined, including that of L. Hauman-Merck in Brussels, but described in detail by him while in Buenos Aires, and the following description is drawn from a translation of his article in Rec. Inst. L. Errera 9 (1913 = 1912) 34-35; pistillate spathe 10-11 mm. long, entire or slightly cleft along the median line, 1-flowered; calyx like the above; corolla smaller, the petals 8 mm. long, 8 mm. wide, less regularly plaited; the 3 staminodia 2.5 mm. long, filiform, sharp, yellow, covered with papillae, alternating with the branches of the style; style white, trifid to the base, with filiform lobes 3 mm. long, deeply 2-3-cleft and covered with papillae for their whole length; at the base of each lobe towards the outside, a little green nectary; ovary surmounted by a thread-like stalk 2-6 cm. long, 1 mm. in diameter; ovary cavity small, 1-celled, producing a swelling at the base of the neck; ovules 3-6, erect; fruit 7-8 mm. long, 3 mm. in diameter, obscurely trigonous, attenuate at the summit and surmounted by a vestige of the neck of the ovary; pericarp membranous, transparent; seeds 7-8 mm. long, (rare), sessile, fusiform, completely filling the locule owing to their swollen, mucilaginous seed coat and papillae, surmounted by a slender 2 mm. filament.

Holotype: "in ditione Platensi, prope Bonariam; *Tweedie* in herb, Hook." (= Buenos Aires, Argentina), (K)! Type examined!

Range: Southern Brasil, Paraguay, Uruguay, and northern Argentina.

Egeria densa is universally cultivated in biological laboratories, and frequently grown in aquaria and water cultures. It has escaped from cultivation and has established itself in the waters of Massachusetts, New York, New Jersey, Pennsylvania, Maryland, Virginia, North Carolina, South Carolina, Georgia, Florida, Kentucky, Alabama, Louisiana, Texas, Nebraska, Arkansas, Missouri, Arizona, Oregon, and California. It is also established in Germany, France, Italy, Japan.

ELODEA L. C. Richard in Michaux

Perennial submerged aquatic herbs in fresh (or rarely brackish) water, rooting in the (usually muddy) bottom or free drifting when broken loose; roots unbranched, smooth, with a root cap; stems slender, simple or sparsely dichotomously branched; lowest leaves alternate, opposite, or in whorls of 3, and reduced; middle and upper leaves opposite or in whorls of 3-7, linear to oblong, acute or obtuse, sharply serrulate, 1-nerved; stipules minute, evanescent; flowers hypogynous, and in a few species perfect, with 3 alternate stamens and 3 stigmas; flowers of most species dioecious and raised to the surface by a slender hypanthium enclosing the style; sepals 3, elliptic, chartaceous; petals 3 (rarely 0), membranous, white to purple, elliptic to linear; staminate flowers with 9 stamens, usually 6 in a lower, outer ring, and the inner 3 raised on a fused filament column; anthers bilocular, explosively septifragal; pollen exine spiny; pistillate flowers with 3 alternate staminodia; common style running up through and slightly exceeding the hypanthium tube; style branches 3; stigmas 3, bifid (or entire), exceeding the perianth; ovary unilocular with 3 parietal placentae and/or a basal placenta; ovules several, orthotropous or anatropous; fruit capsular; seeds cylindric to fusiform, glabrous, papillose, hirsutulous, or mucilaginous.

The writer has been doing research on *Elodea* since 1919, has studied it in the field and in many of the major and minor herbaria of the world. He has seen the holotypes of all previously described species and minor taxa.

Like most other flowering plants, the species of *Elodea* have their most constant and best diagnostic characters in the structure of their flowers. These are tiny, so in our illustrations they are shown five times magnified.

For the benefit of curators of herbaria and for students of local floras, the distribution of each species is mapped, and all the collections that have been studied, are cited, but this is done as briefly as possible. Such a detailed presentation is valuable, as the identification of collections of *Elodea* has proven so difficult that the individual botanist has usually felt uncertain of his determinations.

The natural ranges of the species of *Elodea* are of interest. In North America only *E. canadensis* spans the continent, from Quebec to British Columbia, south to Alabama, and California. This species is also the one which, when introduced to Ireland in 1836, soon ran rampant over Europe, and now is also established in Asia, Africa, and Australia. *Elodea Nuttallii* has the next largest range, being abundant in the lowlands from Maine to North Carolina, and occurring westward to Missouri, and also in Idaho (where it is probably introduced). The other North American species are more restricted in occurrence, and several are known only from single localities.

In South America, too, there is one widespread species, *Elodea granatensis* Humb. & Bonpl. It occurs from Colombia eastward to French Guiana, and southward to Argentina. The other species of that continent have much smaller ranges.

Between the northern border of Mexico and the southern border of Panama there are no known collections of indigenous *Elodea*. The genus does not occur naturally in any part of the West Indies or Central America. The North American species are all of temperate regions, but several of the South American ones are of the tropics, so the absence in Central America cannot be due solely to the climate, nor does it seem to be due to lack of collecting. The writer can offer no explanation of this broad gap between the areas occupied by the 9 North American and the 8 South American species.

Many botanists have assisted the writer during his prolonged investigation. They are too many to thank individually, but one of them must be singled out. Dr. J. E. Dandy, Keeper of Botany, Natural History Museum, London, has contributed much from his knowledge of aquatics and their nomenclature.

GENERAL MORPHOLOGY — The members of the genus *Elodea* are submerged aquatics, rooting in the bottom, or free floating (when broken loose). Their growth is erect until they reach the surface of the water.

The roots are slender, white or pale, and unbranched. They have a root cap, but no root hairs. Adventitious roots are freely produced from nodes of the stem, and most abundantly so on detached, drifting branches.

The stems are erect, rather weak and brittle, cylindric, simple or dichotomously branched.

The lowest leaves are alternate, opposite, or in whorls of three. The middle and upper leaves are opposite or in whorls of 3-7. They are from linear to oblong, acute or obtuse, and sharply serrulate. Their venation consists of a single midrib, and the thin, bright or pale green blades are translucent.

Axillary scales or stipules, entire or fimbriate, are present and visible on fresh specimens. They are minute and evanescent, and on dried specimens are invisible.

The flowers are solitary, axillary, and in bud are enclosed in a membranous, globose or urceolate spathe which opens at the bifid apex. Hypanthium (present in most species) filiform, elongating and raising the bud to the surface where it expands. Flowers perfect and with only 3 stamens in a few species, or as in most species, dioecious. Sepals 3, elliptic, concave, firm, chartaceous, in part greenish and in many streaked with black or purple. Petals 3, membranous, white or bluish or the outer part purple, elliptic to spatulate or linear. Staminate flowers with 9 erect stamens, of which 6 are in an outer, lower ring, and the inner 3 are mostly elevated on a smooth, fused filament column, or rarely all of equal length and attachment. Anthers with 2 locules, these septifragal, explosively dehiscent at the axial side of the connective, becoming flat and resembling heavy ribbed petals. Pistillate flowers with similar hypanthium, sepals and petals. Staminodia 3 and diverse in the different species, being a mere subulate filament or a filament with more or less abortive, sterile anther remnants. Ovary 1-celled; ovules several, borne on parietal or basal placentae. Style filiform, exceeding the hypanthium which surrounds it, the apex 3-lobed. Stigmas 3, ligulate or spatulate, deeply bifid (or entire), reddish papillose on the upper receptive surface. Fruit capsular; seeds cylindric to fusiform, glabrous, papillose, hirsutulous, or mucilaginous.

POLLEN GRAINS — The pollen grains are nonaperturate, 94-125 μ long, and the surface bears thin, sharp spinules, separate or on a connecting reticulum. The grains become separate or remain attached in tetrads. Apparently only the following species have had their pollen described: *E. callitrichoides, E. canadensis, E. Ernstae,* and *E. Matthewsii* (Erdtman 1943: 62, pl. 2, fig. 22; 1952: 207-208).

CHROMOSOMES — The 2X number of chromosomes is 16 in *Elodea callitrichoides,* and 24 in *E. canadensis.* The related genus *Egeria* has in its species *E. densa* 48 chromosomes (Darlington & Janaki Ammal, 1945: 276). The record of the number 48 for *Elodea canadensis* is evidently due to examination of a misidentified specimen of *Egeria densa.*

POLLINATION — Nearly all of the species of *Elodea* are dioecious. Their flowers grow upward, raised by the elongating hypanthium, till they reach the surface of the water. There the flowers expand, the three sepals spread outward and reflex slightly, and their waxy outer surfaces repel water and serve as floats to uphold the flower.

In the pistillate flowers the longest, heaviest parts are the three bifid stigmas which project beyond the perianth parts, overweight it, causing it to partly flop over on one side. Thus the two nearest stigmas arch over and their tips rest on the water surface. Due to their weight and unwettable nature, they push down and cause a depression of the surface film of the water.

The staminate flowers, in all the dioecious species but one *(E. Nuttallii),* in growth are raised to the water surface by an elongating, thread-like hypanthium, just as are the pistillate ones. The anther dehiscence is by an explosion which scatters the pollen grains on the nearby water surface. The outer coat of the pollen grains is covered with spines which entrap air, hold back the water, and give buoyancy to the grains. They float and bob along on the surface of the water. When and if they drift to a pistillate flower, the grains slide down into the depression of the water surface around a stigma, contact its sticky papillose surface, and are in position to accomplish pollination and fertilization.

This ingenious method of pollination is effective, and it does work. Fertilization does occur and seeds are formed, but rarely. It is quite clear that the two sexes of the species are not equal in number. In the more local and rarer species, mere chance has determined whether the staminate or the pistillate was collected and hence is the only sex known. Among the other species of wide distribution, in which both sexes are known, there is still an evident disparity. In collections the pistillate plants are many times more abundant than the staminate. It appears that seed formation is rare.

DISPERSAL — Ripe seeds, freed in the water of the lake or stream, may be carried some distance by moving water and allow the establishment of a new colony. From the rarity of seed production, this natural dissemination seems to be a minor method of dispersal of a species.

The branches of *Elodea* plants are slender and rather brittle. They bend and sway with water currents, but are easily broken. Detached branches, still submerged, drift away. Unless stranded and dessicated they retain life and continue growth. Adventitious roots are produced at the nodes, and by them the loose branch may again be rooted in the bottom of the body of water. It seems very clear that this vegetative propagation by fragmentation is the principal method of dispersal of the species.

Species of *Elodea* may also be dispersed by water birds. Stems removed from the water and exposed to the air for 23 hours, and then replaced in water have recovered in one day. Rootstocks of *E. canadensis* have been found in the nests of the common tern on islands on the coast of Sweden (Ridley, 1930: 537-538). Such deliberate or accidental transport by birds is apparently the principal means of spread of the plant from one water system to another. That these methods are effective, has been evidenced by the phenomenal spread of the pistillate plant of *E. canadensis* throughout Europe.

DISTRIBUTION — The genus *Elodea* contains at present 17 species, 9 of which occur in North America, and 8 in South America.

In North America the indigenous species occur across southern Canada from Quebec to British Columbia, and southward in the United States to Alabama, Mississippi, New Mexico, Arizona, and California. The published records of occurrence in Texas are unsubstantiated.

In South America native species are known from Colombia southward to Peru, at both low and high altitudes. They also occur from Colombia eastward to French Guiana, and south to Argentina.

In the West Indies there are no records of *Elodea.*

In Central America, the only records are in Mexico, of *Elodea canadensis* and *Egeria densa,* recently established at a few localities near Mexico City. They are doubtless adventives, escaped from culture in gold fish bowls or tanks. Good habitats are numerous both in the temperate and in the tropical sections of the region. Having been created in one of the Americas, the genus must have spread to the other one across Central America. Its absence in Central America now seems to be a fact and not a mere apparent absence due to lack of collecting. Panama, Costa Rica, Guatemala, and Mexico have been explored too long and too thoroughly for that hypothesis to receive any credence by the writer.

PHYLOGENY — Most of the species of *Elodea* are dioecious or functionally dioecious. However, in their pistillate flowers they all have staminodia, three in number, alternate with the petals. These staminodia are abortive in various degrees. The extreme in reduction is to a slender, subulate structure, representing solely a filament. Other species have an expanded apex, bidentate or retuse, representing an abortive remnant of an anther. These diverse sorts of staminodia evidence an evolutionary trend towards loss of stamens in the flowers. It would not be reasonable to postulate evolution in the other direction, — that these staminodia were stages in the development of perfect stamens. Hence, it seems clear that in this genus the more primitive type of flower is the bisexual or perfect one. These more primitive species are the South American *E. granatensis* and the North American *E. Brandegeae,* and *E. Schweinitzii.* The second and third of these are rare and very local, but the first is common and with a very broad range. Among these three the writer cannot single out one as the most primitive species.

NATURAL KEY TO THE SUBGENERA, SECTIONS AND SPECIES OF ELODEA

Flowers perfect. subgenus *Apalanthe.*
- Stigmas entire, included, equaling the filaments; median and upper leaves in whorls of 3. 2. *E. Brandegeae.*
- Stigmas exserted,
  - Stigmas 3, bifid, equaling the anthers; middle and upper leaves in whorls of 7 (or 5). 8 (part 1), 13 (part 3). *E. granatensis.*
  - Stigmas 4 (or 3), usually entire; middle and upper leaves in whorls of 3. 17. *E. Schweinitzii.*

Flowers dioecious. subgenus *Elodea.*
- Staminate flowers sessile, at anthesis liberated, floating to and expanding on the surface of the water. section *Natator,* with a single species. 7 (part 1), 18 (part 4). *E. Nuttallii.*
- Staminate flowers protruded from the spathe by the elongating, filiform base of the hypanthium, not liberated. section *Elodea.*

Section ELODEA

Dioecious species with both sexes known.
- Stigmas entire.
  - Staminodia 1.5 mm. long, obtuse; pistillate spathe 3-7 cm. long, the apical teeth divergent; staminate petals 0.6 mm. broad, linear. 5 (part 1), 21 (part 4). *E. longivaginata.*
  - Staminodia 0.3 mm. long, bifid; pistillate spathe 1.8 cm. long, the apical teeth erect; staminate petals 1.5 mm. wide, oblanceolate; pistillate sepals oblong-elliptic. 12. *E. titicacana,*
- Stigmas bifid.
  - Stigmas bifid for half or more than half of their length.
    - Anthers 4 mm. long; middle and upper leaves in whorls of 3-4. 11. *E. Potamogeton.*
    - Anthers 3.5 mm. or less in length.
      - Middle and upper leaves opposite or occasionally some of them in whorls of 3. 14. *E. callitrichoides.*
      - Middle and upper leaves in whorls of 3-4.
        - Pistillate petals wanting; staminate petals 0.4-0.6 mm. wide, linear, acute; middle and upper leaves in whorls of 3-4. 16. *E. Richardii.*
        - Pistillate petals present; staminate petals 1.1-2 mm. wide, somewhat dilated, obtuse; middle and upper leaves in whorls of 3.

Pistillate sepals oblong-deltoid; stigmas 5-5.5 mm. long; staminate petals 1.1 mm. wide, slightly dilated. 15. *E. Ernstae.*

Pistillate sepals oblong to elliptic; stigmas 3.5-3.8 mm. long; staminate petals spatulate.

Pistillate sepals 3 mm. long; staminate sepals ovate; staminate petals 1.5 mm. wide. 10. *E. peruviensis.*

Pistillate sepals 2.4-2.6 mm. long; staminate sepals elliptic; staminate petals 1.8-2 mm. wide. 9. *E. Matthewsii.*

Stigmas bifid for a third or less than a third of their length.

Pistillate sepals 2-2.2 mm. long; staminate petals slightly dilated near the apex; middle and upper leaves in whorls of 3. 3 (part 1), 19 (part 4). *E. canadensis.*

Pistillate sepals 1.4 mm. long; staminate petals linear; middle and upper leaves opposite or occasionally in whorls of 3 at a few of the upper nodes. 1. *E. bifoliata.*

Dioecious species of which only one sex is known.

Leaves 0.5-1.5 mm. broad, the median and upper ones in whorls of 3.

Leaves less than 1 mm. broad; pistillate flowers unknown; staminate petals 0.5 mm. wide; stamens equal, all attached to summit of hypanthium. 20. *E. linearis.*

Leaves 0.5-2 mm. broad; pistillate flowers known; petals 1.1 mm. wide.

Staminodia obdeltoid, petaloid throughout; middle and upper leaves 0.5-1.5 mm. wide, flaccid. 4. *E. columbiana.*

Staminodia subulate at base, the tip petaloid, elliptic; middle and upper leaves 1-2 mm. wide, thin but not flaccid. 6. *E. nevadensis.*

LIST OF ELODEA SPECIES.

Monograph, part 1. Res. Stud. Wash. State Univ. **30:** 19-44. 1962.

1. E. bifoliata St. John
2. E. Brandegeae St. John
3. E. canadensis Rich. in Michx.
4. E. columbiana St. John
5. E. longivaginata St. John
6. E. nevadensis St. John
7. E. Nuttallii (Planch.) St. John

Monograph, part 2. Caldasia **9:** 95-113, 1964.

8. E. granatensis Humb. & Bonpl.
9. E. Matthewsii (Planch.) St. John
10. E. peruviensis, St. John
11. E. Potamogeton (Bert.) Espinosa
12. E. titicacana, St. John

Monograph, part 3. Darwiniana **12:** 639-652. 1963.
13. (8.) E. granatensis Humb. & Bonpl.
14. E. callitrichoides (Rich.) Casp.
15. E. Ernstae St. John
16. E. Richardii St. John

Monograph, part 4.
17. E. Schweinitzii (Planch.) Casp.
18. (7.) E. Nuttallii (Planch.) St. John
19. (3.) E. canadensis Rich. in Michx.
20. E. linearis (Rydb.) St. John
21. (5.) E. longivaginata St. John

NAMES AND SYNONYMS IN ELODEA.

Synonyms are in italic and accepted names in roman type. The names published in *Elodea* Juss. (an orthographic variant of *Elodes* Adans.), and like it in the Hypericaceae, are omitted here.

Anacharis

A. Alsinastrum Babington, Ann. & Mag. Nat. Hist. II, **1:** 83-84, 86, 1848; Ann. Sci. Nat. Bot. III, **11:** 74, 1849 = Elodea canadensis.

A. callitrichoïdes Rich., Mém. Inst. de France **12**(2): 7-8, 75, *pl. 2* bottom, 1811 = 1814 = Elodea callitrichoides.

A. canadensis Planch., Ann. & Mag. Nat. Hist. II, **1:** 86, 1848; Ann. Sci. Nat. Bot. II, **11:** 75, 1849, independent species, not based on *Elodea canadensis* Rich. in Michx., but = Elodea canadensis.

var. *latifolia* (Casp.) Sanio, Verhandl. Bot. Verein Prov. Brandenburg **32:** 121, 1890 = Elodea canadensis.

var. *latifolia* (Casp.) Sanio, var. *repens* Sanio, Verhandl. Bot. Verein Brandenburg **32:** 121, 1890, invalid, a variety under a variety.

var. *Planchonii* (Casp.) Victorin, Contrib. Lab. Bot., Univ. Montréal **18:** 40, 1931 = Elodea canadensis.

A. chilensis Planch., Ann. & Mag. Nat. Hist. II, **1:** RF, 1848, Ann. Sci. Nat. Bot. III, **11:** 75, 1849 = Elodea Potamogeton.

A. densa (Planch.) Victorin, Contrib. Lab. Bot., Univ. Montréal **18:** 41, 1931 = Egeria densa.

A. Hilariana Casp., Monatsber. Kgl. Preuss. Akad. Wissensch. **1857:** 49, 1857 (in repr. p. 13); Pringsheim's Jahrb. **1:** 476, 1858, published in the synonymy of *Elodea Naias* = Egeria Naias.

A. linearis (Rydb.) Victorin, Contrib. Lab. Bot., Univ. Montréal **18:** 41, 1931 = Elodea linearis.

A. Matthewsii Planch., Ann. & Mag. Nat. Hist. II, **1:** 86, 1848 = Elodea Matthewsii.

A. Naias (Planch.) Victorin, Contrib. Lab. Bot., Univ. Montréal **18:** 42, 1931. The authorities were published as "(Casp.) Victorin." = Egeria Naias.

A. Nuttallii Planch., Ann. & Mag. Nat. Hist. II, **1:** 86, 1848; Ann. Sci. Nat. Bot. III, **11:** 74, 1849 = Elodea Nuttallii.

A. occidentalis Victorin, Contrib. Lab. Bot., Univ. Montréal **18:** 40, 1931, based on *Serpicula occidentalis* Pursh, a superfluous name which cannot be transferred = Elodea Nuttallii.

A. Planchonii (Casp.) Rydb., Fl. Prairies & Plains Cent. N. Am. 57, 1932 = Elodea canadensis.

A. Planchonii (Casp.) M. E. Peck, Man. Higher Pl. Ore. 76, 1941 = Elodea canadensis.

A. pomeranica (Reichenb.) Peterm., Deutschl. Fl. 530, *t. 82, fig. 650 a, b*, 1849. The description and the leafy shoot, *fig. 650* = Hydrilla verticillata (L. f.) Royle. The staminate and pistillate flowers shown in *fig. 650* = Elodea canadensis.

A. Potamogeton (Bert.) Victorin, Contrib. Lab. Bot., Univ. Montréal **18:** 41, 1931 = Elodea Potamogeton.

A. Tripteris (L.) Steud., Nom. Bot., ed. 2, **1:** 82, 360, 1840. This was an obvious error, not a combination intended by the author, as is confirmed under Chrysostemma on page 360. = Coreopteris Tripteris L.

Apalanthe

Ap. granatensis (Humb. & Bonpl.) Planch., Ann. & Mag. Nat. Hist. II, **1:** 87, 1848; Ann. Sci. Nat. Bot. III, **11:** 76, 1849 = Elodea granatensis.

Ap. guyannensis (Rich.) Planch., Ann. & Mag. Nat. Hist. II, **1:** 87, 1848; Ann. Sci. Nat. Bot. III, **11:** 76, 1849 = Elodea granatensis.

Ap. Schweinitzii Planch., Ann. & Mag. Nat. Hist. II, **1:** 87, 1848; Ann. Sci. Nat. Bot. III, **11:** 76, 1849 = Elodea Schweinitzii.

Babingtonia

B. pestifera Syme in Sowerby, English Bot. ed. 3, **9:** 83, 1869, published in synonymy = Elodea canadensis.

Diplandra

D. Potamogeton Bert., Mercurio Chileno **13:** 612, 1829 = Elodea Potamogeton.

Elodea

E. bifoliata St. John, Res. Stud., Washington State Univ. **30:** 23-24, figs. 3, b, c, 4, a, b, 5, 1962.

E. Brandegeae St. John, Res. Stud., Wash. State Univ. **30:** 25-26, figs. 2, c, d, 4, m, n, 5, 1962.

E. callitrichoides (Rich.) Casp., Monatsber. Kgl. Preuss. Akad. Wissensch. **1857:** 47-48, 1857 (in reprint pp. 11-12). The combination was made by Caspary, but with a question mark. Yet, it was a valid publication.

var. *ernstae* Erdtman, Pollen Morphology and Plant Taxonomy, Angiosperms 207-208, 1952. The variety lacks a diagnosis, and is invalid = Elodea Ernstae.

E. canadensis Rich. in Michx., Fl. Bor.-Am. **1:** 20, 1803.

var. *β angustifolia* Aschers. & Graebn., Syn. Mitteleur. Fl. **1:** 403, 1897, *nomen nudum*.

var. *angustifolia* (Britton ex Rydb.) Farw., Am. Midl. Nat. 10:203, 1927 = E. Nuttallii.

var. *gigantea* Hort., Bailey, Stand. Cyclop. Hort. **2**: 1,111, 1914 = Egeria densa.

var. *latifolia* (Casp.) Sanio var. *repens* Sanio, Verhandl. Bot. Vereins Prov. Brandenb. **32**: 121, 1891 = 1890, a variety under a variety, and hence invalid.

var. *latifolia* Aschers. & Graebn., and forma *latifolia* Aschers. & Graebn., Synops. Mitteleur. Fl. **1**: 403, 1897 = E. canadensis.

var. *Planchonii* (Casp.) Farw., Am. Midl. Nat. **10**: 203, 1927 = E. canadensis.

E. capensis M. Ernst, Ber. Schweiz. Bot. Ges. **55**: 35, 1945, published in synonymy.

E. chilensis (Planch.) Casp., Monatsber. Kgl. Preuss. Akad. Wissensch. **1857**: 47, 1857 (in repr. p. 11) = E. Potamogeton.

E. chinensis Casp. ex. Ind. Kew. Suppl. **1**: 152, 1901-1906, misprint for *E. chilensis.*

E. columbiana St. John, Res. Stud., Wash. State Univ. **30**: 37-38, figs. 3, d, 4, g, h, 5, 1962.

E. crispa Hort. ex Henkel, Haupt-Katalog 26, 1908 = Lagarosiphon major (Ridl.) Moss.

E. densa (Planch.) Casp., Monatsber. Kgl. Preuss. Akad. Wissensch. **1857**: 49, 1857 (in repr. p. 13). The combination was made with a question mark, but was a valid one = Egeria densa.

var. *crispa* Hort. ex Wehrh., Gartenstauden **1**: 10, 1929, published in synonymy = Hydrilla verticillata Royle var. crispa Casp.

var. *longifolia* Hort. ex Bonstedt in Parey's Blumengaertnerei 1: 110, 1930, = Egeria densa.

E. Ernstae St. John, Darwiniana **12**: 644, 646, 648, figs. 1, a, b, d, e, 3, 1963.

E. gigantea Santos, Bot. Gaz. **75**: 44, 50, 1923 = Egeria densa.

E. granatensis Humb. & Bonpl., Pl. Aequin. **2**: 150, *pl. 128,* 1813.

E. guyannensis Rich., Mém. Inst. France **12**(2): 4, 75, *pl. 1,* 1811 = 1814 = E. granatensis.

var. *dicranoides* Casp., Monatsber. Kgl. Preuss. Akad. Wissensch. **1857**: 48, 1857 (in repr. p. 12), and in Pringsheim's Jahrb. **1**: 502, 1858 = E. granatensis.

f. *longifolia* Chodat & Hassler, Bull. Herb. Boiss. II, **3**: 1,033, 1903 = Egeria Naias.

E. ioensis Wylie, Nat. Hist. Bul., State Univ. Iowa **6**(4): 48-50, *pl. 1-2* 1913 = E. canadensis.

E. iowensis Wylie (as *Iowensis*), Proc. Iowa Acad. Sci. 17: 82, 1910, *nomen provisorium,* = E. canadensis.

E. Kochii Herter, Revista Sudamer. Bot. **6**: 134, *fig. 2,* 1940 = E. Naias.

E. latifolia Casp., Monatsber. Kgl. Preuss. Akad. Wissensch. **1857:** 46, 1857 (in repr. p. 11), published as a doubtful species, based upon sterile material = E. canadensis.

E. linearis (Rydb.) St. John, made above in this paper.

E. longivaginata St. John, Res. Studies, Wash. State Univ. **30:** 38-40, figs. 2, e-j, 4, c, d, 5, 1962.

E. Matthewsii (Planch.) St. John ex Erdtman (as Plach.), Introd. Pollen Analysis 62, *pl. II, fig. 22,* 1943. It has the measurements of a pollen grain, and an outline drawing of one grain. It lacks the reference to the basionym, and the publication was not authorized by St. John. Erdtman apparently saw the binomial written upon an herbarium sheet.

E. Matthewsii (Planch.) St. John, Darwiniana **12:** 307, 1961; Caldasia **9:** 101, 103, figs. 4, a, b, 5, a, b, 8, 1964.

E. minor (Small) Farwell, Rept. Mich. Acad. Sci. **17:** 181, 1916 = E. Nuttallii.

E. Naias (Planch.) Casp., Monatsber. Kgl. Preuss. Akad. Wissensch. **1857:** 49, 1857 (in repr. p. 13-14); and altered to *E. Najas* in Pringsheim's Jahrb. **1:** 476-477, 503, 1858. = Egeria Naias.

E. nevadensis St. John, Res. Stud., Wash. State Univ. **30:** 41-43, figs. 3, a, 4, i, j, 5, 1962.

E. Nuttallii (Planch.) St. John, Rhodora **22:** 29, 1920, sensu basionym, *Anacharis Nuttallii* Planch., non sensu St. John (1920).

E. oblongifolia Michx. ex Casp., Pringsheim's Jahrb. **1:** 462, 1858, published in synonymy = E. canadensis.

E. occidentalis St. John, Rhodora **22:** 27-29, 1920. This was ostensibly a combination based upon *Serpicula occidentalis* Pursh, excluding his synonym *E. canadensis* Michx. The epithet *canadensis* was available, and Pursh should have adopted it, so his new epithet *occidentalis* is illegitimate and cannot be transferred. St. John also cited in synonymy *Philotria minor* Small. The epithet *minor* was available and should have been adopted, so St. John's epithet is also illegitimate = Elodea Nuttallii.

E. orinocensis Rich. (as *Orinocensis*), Mém. Inst. de France **12(2):** 75, 1811 = 1814, = E. granatensis.

E. paraguayensis Herter, Revista Sudamer. Bot. **6:** 134, *fig. 3,* 1940 = Egeria Naias.

E. peruviensis St. John, Caldasia **9:** 103, 105, 107, figs. 3, a, b, 5, g. h, 6, 8, 1964.

E. Planchonii Casp., Monatsber. Kgl. Preuss. Akad. Wissensch. **1857:** 47, 1857; and Pringsheim's Jahrb. **1:** 468-469, 500-501, 1858 = E. canadensis. This was based upon *Anacharis canadensis* Planch. and doubtfully on *A. canadensis* Chatin.

E. Potamogeton (Bert.) Espinosa, Rev. Chil. Hist. Nat. **31:** 150-155, *fig. 10, 10(2),* 1928.

E. Richardii St. John, Darwiniana **12:** 649, 651, *figs.* 1, f, g, 2, a, b, 3, 1963.

E. Schweinitzii (Planch.) Casp., Monatsber. Kgl. Preuss. Akad. Wissensch. **1857**: 46, 1857 (in repr. p. 10-11); Pringsheim's Jahrb. **1**: 468, 500, 1858, published with a question mark as a doubtful species, yet it is valid.

E. titicacana St. John, Caldasia **9**: 111-112, figs. 3, d, e, 5, c, d, 8, 1964.

E. verticillata (L. f.) F. Muell., Key Syst. Vict. Pl. **1**: 423, 1888 = Hydrilla verticillata (L. f.) Royle.

Hapalanthe

H. Schweinitzii Planch. ex Peterm, Deutschl. Fl. 530, *t. 82, fig. 650 e*, 1849. The generic name is merely an orthographic variant of *Apalanthe*, and the species = Elodea Schweinitzii.

Luchia

L. Berteroniana Steud., Nom. Bot. ed. 2, **2**: 75, 1841, *nomen nudum* = Elodea Potamogeton.

Philotria

P. angustifolia Britton ex Rydb., Fl. Colo. 15, 1906 = Elodea Nuttallii. Rydberg in Bull. Torrey Bot. Club. **35**: 460, 1908 stated that he applied the name to a different species, that is to *Philotria Planchonii* (Casp.) Rydb. = Elodea canadensis.

P. densa (Planch.) Small, Man. S. E. Fl. 28, 1,503, 1933 = Egeria densa.

P. Canadensis (Rich. in Michx.) Britton, Science II, **2**: 5, 1895 = Elodea canadensis.

P. granatensis (Humb. & Bonpl.) Victorin, Contrib. Lab. Bot., Univ. Montréal **18**: 42, 1931 = Elodea granatensis.

P. guyannensis (Rich.) Victorin (as *guyanensis*), Contrib. Lab. Bot., Univ. Montréal **18**: 42, 1931 = Elodea granatensis.

P. Iowensis Wylie, Proc. Iowa Acad. Sci. **17**: 82, 1910, published as a synonym of *Elodea iowensis*, a provisional name = Elodea canadensis.

P. Iowensis Wylie, Science, n. s. **33**: 263, 1911 = Elodea canadensis.

P. linearis Rydb., Bull. Torrey Bot. Club **35**: 464, 1908 = Elodea linearis.

P. minor Small, Fl. S. E. U. S. 47, 1903, published as (Engelm.) Small, but Engelmann's *Udora verticillata* var. *minor* was not validly published = Elodea Nuttallii.

P. Nuttallii (Planch.) Rydb., Bull. Torrey Bot. Club **35**: 461-462, 465, 1908, a provisional name, and hence invalid = Elodea Nuttallii.

P. Nuttallii (Planch.) Rydb. ex Britton & Brown, ILL. Fl. N. E. U. S., ed. 2, **1**: 105, 1913 = Elodea Nuttallii.

P. occidentalis House, Bul. N. Y. State Mus. **243-244**: 55, 1923, based upon *Serpicula occidentalis* Pursh, a superfluous name which cannot be transferred = Elodea Nuttallii.

P. orinocensis (Rich.) Victorin, Contrib. Lab. Bot., Univ. Montréal **18**: 42, 1931 = Elodea granatensis.

P. Planchonii (Casp.) Rydb., Bull. Torrey Bot. Club **35**: 462-463, 1908 = Elodea canadensis.

Serpicula

S. canadensis (Rich. in Michx.) Eaton, Man. ed. 5, 390, 1829. In large part and as to basionym = Elodea canadensis.

S. occidentalis Pursh, Fl. Am. Sept. 1: 33, 1814. A superfluous name substituted for the available *Elodea canadensis* Rich. in Michx. In part, *Elodea Nuttallii,* and illegitimately adopted for that by St. John (1920).

S. verticillata L. f. var. *β angustifolia* Muhl., Cat. Pl. Am. Sept. 84, 1813, *nomen nudum* = Elodea Nuttallii.

Udora

U. brasiliensis Mart., Fl. Brasil. 3(1): 99-100, 1847, a superfluous name, as he included as a synonym the valid and available *Elodea granatensis* Humb. & Bonpl.

U. canadensis (Rich. in Michx.) Nutt., Gen. N. Am. Pl. **2**: 242, 1818, a superfluous name, since his monotypic new genus and species included the earlier and available *Elodea canadensis* Rich. in Michx.

U. granatensis (Humb. & Bonpl.) Spreng., in Linnaeus' Syst. Veg., ed. 16, 4(2): 25, 1827 = Elodea granatensis.

U. guyannensis (Rich.) Steud., Nom. Bot., ed. 2, **2**: 727, 1841, (as *guianensis*) = Elodea granatensis.

U. lithuanica Andrz. ex Bess., Flora, Beibl. **1832**(2): 13, 1832 (erroneously as *Hydora lithuanica*) = Hydrilla verticillata (L. f.) Royle.

U. occidentalis Koch, Syn. Fl. Germ. & Helvet. 669, 1837, based upon *Serpicula occidentalis* Pursh, and therefore, as to type = Elodea canadensis.

U. orinocensis (Rich.) Spreng., Syst. Veg. of Linnaeus, ed. 16 by Spreng., 4(2): 25, 1827 = Elodea granatensis.

U. pomeranica Reichenb., Ic. Fl. Germ. Helvet. **7**: 31, 1845 = Hydrilla verticillata (L. f.) Royle

U. surinamensis Miq. ex Schomburgh, Reisen Brit.-Guiana **3**: 900, 1848, a dubious species, with inadequate diagnosis. He said only that it was a perennial herb that bloomed all year.

U. verticillata Spreng. in Linnaeus' Syst. Veg., ed. 16 by Spreng., **1**: 170-171, 1825. As to basionym = Hydrilla verticillata (L. f.) Royle, but, in part, is Elodea canadensis.

minor Engelm. ex Caspary Monatsber. Kgl. Preuss. Akad. Wissensch. **1857**: 46, 1857 (in repr. p. 10); Pringsheim's Jahrb. **1**: 465, 500, 1858, published in synonymy = Elodea Nuttallii.

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Macoun, J. *13724* (3), (19);

13725 (5), (21); *27001, 61003, 68806, 82331, 85553, s.n.* (3), (19).
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Mandon, G. *1461* (11).
Martindale, I. C. *s.n.* (7), (18).
Martius, K. F. P. von *453, s.n.* (8), (13).
Martyn, E. B. *425* (8), (13).
Massey, A. W. R. *s.n.* (3), (19).
Matthews, A. *581* (9).
Maxon, W. R. *6329* (7), (18).
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Merrill, E. D. *508, 963, s.n.* (7), (18).
Metcalf, F. P. *358, 569* (5), (21); *924, 929, 1089, 1232* (7), (18); *2222, 2364* (3), (19).
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Mühlenberg, H. *s.n.* (3), (19).
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Muenscher, W. C. & A. R. Bechtel *50, 51* (3), (19).
Muenscher, W. C. & P. R. Burkholder *16366, 16367 16368, 16369, 16370* (3), (19).
Muenscher, W. C. & O. F. Curtis *5570* (7), (18).
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Mumbauer, J. R. *313* (7), (18).
Murrill, W. A. *s.n.* (3), (19).
Nash, G. V. *1* (3), (19).
Nelson, A. *1429* (3), (19).
Nicollet, I. N. *415* (3), (19).
Northrup, J. I. & G. R. *s.n.* (3), (19).
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Nuttall, T. *s.n.* (4); *s.n.* (7), (18).
O., R. C. & E. B. W. *s.n.* (3), (19).
Oberlin College *s.n.* (7), (18).
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Palmer, E. L. *73* (3), (19).
Palmer, E. L. & A. J. Eames *72* (3), (19).
Parker, *s.n.* (8), (13).
Parodi, L. R. *11889, 11890* (14).
Passarge, & Selwyn *s.n.* (8), (13).
Pastore, F. *135* (15).
Patterson, H. N. *s.n.* (7), (18).
Pease, A. S. *2063, 2638, 29912, 36781* (7), (18).
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Peter, R. *s.n.* (3), (19); *s.n.* (7), (18).
Phelps, O. P. *279* (3), (19).
Philippi, R. A. *87, 682, s.n.* (11).
Pickering, C. *s.n.* (3), (19).
Pieters, A. J. *s.n.* (3), (19).
Piper, C. V. *s.n.* (3), (19).
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6962 (3), (19); *7279* (7), (18); *11212* (3), (19).
Pursh, F. *s.n.* (7), (18).
R., J. L. *s.n.* (3), (19).
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Radford, A. E. & Haesloop & Miller *7683* (7), (18).
Raimondi, A. *9524, 10506* (9).
Redfearn, P. L., Jr. *5742* (3), (19).
Redfearn, P. L. & T. Stombaugh *4210* (7), (18).
Reed, A. N. & Webb *929* (3), (19).
Reed, E. C. *s.n.* (11).
Remy, J. *s.n.* (3), (19).
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Richard, L. C. M. *s.n.* (8), (13).
Riedel, L. *848* (8), (13).
Ripley, W. S., Jr. *16138, 17494* (3), (19).
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Robbins, *s.n.* (3), (19).
Rolland-Germain, Freère *6472* (3), (19); *7498* (7), (18).
Rose, J. N., A. Pachano & G. Rose *22823* (9).
Rossbach, G. B. *96, 97* (3), (19).
Rothrock, J. T. *s.n.* (7), (18); *s.n.* (3), (19).
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Rust, H. J. *373* (7), (18).
St.-Hilaire, A. de B1, *581, s.n.* (8), (13).
St. John, H. *679, 2548a* (7), (18); *3438* (3), (19); *s.n.* (15).
St. John, H. & F. A. Warren *3423* (3), (19).
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Sartwell, H. P. *s.n.* (3), (19).
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Schinz Herb. *s.n.* (3), (19).
Schuette, J. H. *s.n.* (7), (18).
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Short, C. W. *s.n.* (7), (18).
Short, Herb. *s.n.* (3), (19).
Shull, G. H. *146* (7), (18); *467* (3), (19).
Small, J. K. *s.n.* (7), (18); *s.n.* (3), (19).
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Speggazzini, C. *2218* (15).
Splitgerber, F. L. *s.n.* (8), (13).
Spreadborough, W. *62633* (3), (19).
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Spruce, R. *1991* (8), (13); *5458* (9).
Standley, P. C. *8274* (5), (21).
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Stevens, F. L. *305* (3), (19).

Strohm, F. H. *s.n.* (3), (19).
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Thomson, R. *9, 177* (7), (18).
Thorne, R. F. *10472, 11395* (7), (18); *14595, 17862, s.n.* (3), (19).
Tidestrom, I. *94* (7), (18); *7185* (3), (19); *10664* (6).
Topping, D. L. *s.n.* (3), (19).
Torrey, J. *s.n.* (3), (19); *s.n.* (17); *s.n.* (7), (18).
Torrey Herb. *s.n.* (3), (19).
Torrey & Gilman *s.n.* (7), (18).
Tracy, S. M. & Evans *475* (6).
Trelease, W. *s.n.* (3), (19).
Troll, C. *2321, 3043* (10).
Trudell, H. W. *s.n.* (3), (19).
Tutin, T. G. *s.n.* (8), (13).
U., E. B. *s.n.* (3), (19).
Ule, E. *4074, 7758* (8), (13).
Underwood, L. M. *3211, s.n.* (3), (19).
Usteri, A. *s.n.* (8), (13).
Vail, A. M. *s.n.* (7), (18).
Van Eseltine, G. P. & T. W. Moseley *203* (7), (18).
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Venturi, S. *175* (15).
Victorin, Fr. Marie *8171, 9910, 11256, 20318* (3), (19); *20322* (7), (18); *24725, 28388, 28393* (3), (19).
Victorin, Fr. Marie & Fr. R-Germain *7310, 7410, 33905, 33996, 44974, 45631, 49140, 49147, 49306, 49361* (3), (19).
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Victorin, Fr. Marie, Fr. R.-Germain & Rouleau *2017, 6534* (3), (19).
Waite, M. B. *s.n.* (3), (19).
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Warming, E. *1103, s.n.* (8), (13).
Watson, *s.n.* (7), (18).
Weatherby, C. A. *367* (7), (18); *2700* (3), (19); *3373, 3591* (7), (18); *3595, 3604* (3), (19); *3777* (7), (18).
Webb, R. J. *s.n.* (7), (18).
Weddell, H. A. *3367* (8), (13).
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Widmann, O. *s.n.* (7), (18).
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Wiegand, K. M. *13355* (3), (19); *13358* (7), (18); *13358* in part (3), (19); *13359, 13360, 13361* (3), (19).
Wiegand, K. M. & M. L. Fernald *14546* (3), (19).
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Williamson, C. S. *s.n.* (7), (18); *s.n.* (3), (19).
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Addenda

Vol. 67, p. 7. At the end of the first paragraph add: capsules 4-6 mm. long, 1.3-1.8 mm. in diameter, lance-ellipsoid, 1-loculed, somewhat involute on the 2 flattened sides; seeds 3.5-5 mm. long, 0.5 mm. in diameter, cylindric, brown, white puberulous.

Corrigenda

Vol. 67, p. 1, line 3 from below, after 1-8, change the comma to a semicolon, and delete: is in press in Mutisia;

Page. 32, in the legend, for *longivaginat*, read: *longivaginata*

FLOWERING PLANTS NEW TO OR RARE IN KENTUCKY[1]

ELIZABETH M. BROWNE AND E. T. BROWNE, JR.[2]

In an effort to catalog more completely the species of vascular plants in Kentucky and to plot their distribution, extensive field work has been done in the last three years. As a result, several species have been found in the state which were previously unknown to occur here or were first reported many years ago without having been reported since. Among these are the following:

SPOROBOLUS CRYPTANDRUS (Torr.) Gray. This species was reported for the only time previously by Price (1893). Fulton Co. Kentucky Point. *EMB & ETB 6051; EMB & ETB 6469; EMB & ETB 7624.5.*

[1]Contribution No. 3 of the Kentucky Flora Project, University of Kentucky.

[2]The junior author wishes to express his sincere appreciation to the Faculty Research Committee, Graduate School, University of Kentucky, for several grants which partially defrayed field expenses and enabled him to make the trips to the herbaria. Dr. H. P. Riley has kindly reviewed the original manuscript.

In addition to the above-named species, others have been collected of which there is no record in the literature of their occurrence in Kentucky:

ERIOCHLOA GRACILIS (Fourn.) Hitchc. Fulton Co. Kentucky Point. *EMB & ETB 6020, 6098; EMB & ETB 6409; EMB & ETB 7632.*

CHENOPODIUM PUMILIO R. Br. Trimble Co. Strawberry field near Bedford. *Millard Maxey, Co. Agent, s.n.* (Det. by James W. Herron and ETB.)

AMARANTHUS ARENICOLA I. M. Johnst. Fulton Co. Kentucky Point. *EMB & ETB 6060.*

TRIBULUS TERRESTRIS L. Fulton Co. Kentucky Point. *EMB & ETB 6018.*

AMPELOPSIS ARBOREA (L.) Koehne. Fulton Co. Kentucky Point. *EMB & ETB 5607; EMB & ETB 6070.*

JUSSIAEA LEPTOCARPA Nutt. Fulton Co. Kentucky Point. *EMB & ETB 7618;* Henry Co. Ox-bow W of Kentucky R. and 0.5 mi. E of dirt road to Lockport. *EMB & ETB 5976.*

DICLIPTERA BRACHIATA (Pursh) Spreng. Fulton Co. Kentucky Point. *EMB & ETB 5562; EMB & ETB 6100.*

HETEROTHECA LATIFOLIA Buckley. Fulton Co. Kentucky Point. *EMB & ETB 5573; EMB & ETB 6067; EMB & ETB 6431; EMB & ETB 7963.*

No herbarium specimens of these species from Kentucky are to be found in A, GH, NY or US. Consequently, all except the first species mentioned herein are believed to be new state records. The kindness of the curators and staffs of these herbaria is gratefully acknowledged.

1234 KASTLE RD., LEXINGTON, KENTUCKY
DEPARTMENT OF BOTANY, UNIVERSITY OF KENTUCKY, LEXINGTON

LITERATURE CITED

PRICE, SADIE F. 1893. A Flora of Warren County, Kentucky. New London, Wisconsin.

THE TYPIFICATION OF XANTHOCEPHALUM (COMPOSITAE)

OTTO. T. SOLBRIG

The genus *Xanthocephalum* was described by Willdenow in 1807 (Ges. Naturf. Fr. Berlin Mag. 1:140. 1807) based on material collected and described by Humboldt. In the original description, which was very short and not diagnostic of any species, no specific name was given. Kunth (Humboldt, Bonpland and Kunth, Nov. Gen. et Sp. Pl. 4:310. 1820) referred the species *X. centauroides* (without a description) to Willdenow's description, stating that he had not seen any material of it. This is the first specific epithet ascribed to *Xanthocephalum*, and was considered by me (Rhodora 63:151-164. 1961) as the type species. Nevertheless, in the same work Kunth described the new genus *Xanthocoma* with one species *X. humile* HBK. (= *Xanthocephalum humile* (HBK.) Sch. Bip. ex Hemsley), and redescribed *X. centauroides* as *Pyrethrum bonplandianum* Kunth. Since I was unable to see type material there was some doubt as to the identity of *X. centauroides*. Furthermore, there was the possibility, in case no original material was extant, that *Xanthocephalum* would have to be abandoned as a "nomen confusum" and have to be replaced by *Xanthocoma*.

During the last summer I had an opportunity to visit and study at the Botanisches Museum in Berlin-Dahlem[1] where the Willdenow herbarium is deposited. In it a specimen (see Fig. 1) of *Xanthocephalum* (Willdenow no. 16523), collected by Humboldt is preserved. In the upper left hand corner is the annotation of Willdenow (see Schlechtendahl, Flora 15:561-567. 1832) "Syngenesia frustranea, Xanthocephalum centauroides, Habitat in Mexico." In addition, in the lower right hand corner is stated "Humboldt W," pre-

[1]I want to thank the Botanical Society of America and the National Science Foundation for a travel grant. I also want to thank very particularly Dr. W. Domke, for all the help while in Berlin and for the photograph of the type of *Xanthocephalum*.

Plate 1311
Fig. 1. Detail of the type specimen of *X. centauroides* (Willdenow no. 16523, B)

sumably copied from the back of the original sheet, where Willdenow used to write the procedence of his material (see again Schlechtendahl, 1832). There is also a copy of the original diagnosis affixed after Willdenow's death by Schlechtendahl, and a later annotation by Schulz-Bipontinus, where *Xanthocephalum* (Pyrethrum) *bonplandianum* (HBK.) DC is equated to *X. centauroides*. A last annotation "Pyrethrum Bonplandianum Kunth" could not be traced to its author.

It is clear, that this specimen is the type of *Xanthocephalum centauroides* Willd. ex HBK. (Nov. Gen. et Sp. 4:312. 1820), and that this is the type species of the genus as I had concluded in my previous work. Furthermore, it confirms *Xanthocoma* as a generic synonym provided *X. humile* is considered a member of *Xanthocephalum*.

GRAY HERBARIUM, HARVARD UNIVERSITY

TWO SPECIES OF CHAMAESYCE (EUPHORBIACEAE) NEW TO THE UNITED STATES

Collections made in peninsular Florida for a taxonomic revision of the genus *Chamaesyce* in the Caribbean region have included two species not previously reported for the United States. The two, *Chamaesyce mendezii* (Boiss.) Millsp. and *C. thymifolia* (L.) Millsp., are known from Mexico and Cuba, with the range of the latter extending through the West Indies to South America.

Chamaesyce mendezii resembles the commoner *C. prostrata* (Ait.) Small, and *C. thymifolia* is very similar in appearance to *C. maculata* (L.) Small (*sensu* most authors, not Wheeler). All four are prostrate plants with serrate leaves, pubescent stems and capsules, and cyathia borne in the axils of leaves or on leafy side shoots, but they may readily be distinguished on characters of inflorescence and seed.

Capsule pubescent only along the angles.

Stem short-pubescent on lines; cyathial appendages minute or obsolete; seed with deep transverse furrows often extending through the angles .... *C. prostrata*

Stem long-hirsute, at least on lines; cyathial appendages prominent, pink or white; surface of seed rippled, the ridges not extending through the angles .... *C. mendezii*

Capsule pubescent all over, sometimes sparingly so.

Capsule completely exserted from cyathium when mature, widest just below the equator; styles .2-.4 mm. long, spreading; angles of seed rounded, faces with low irregular ridges; diameter of seed sub-equal except at extremities .... *C. maculata*

Capsule only partially exserted, splitting one side of cyathium when mature, widest close to base; styles .4-.6 mm. long, only rarely spreading; seed with sharp angles, ridges on faces transverse, well marked; seed tapering from base to apex .... *C. thymifolia*

Chamaesyce mendezii was first collected in Florida in 1957 (Brass 29046, St. Lucie County, as *C. adenoptera* (Bertol.) Small), and then in 1959 in the Redlands area of Dade County (Atwater M-113, as *Euphorbia adenoptera*). It is now widespread in disturbed areas in Dade, Monroe and Collier counties, and has been collected in Highlands and Polk counties. It must be considered a well established element of the flora of the southern counties, and at least an occasional weed in the central part of the state.

C. mendezii: COLLIER COUNTY: Goodland, 26 Sept 1964, *D. Burch 401* (GH, US); Naples, 27 Sept 1964, *DB 412* (BM, F); Goodland, 22 Nov 1964, *R. K. Godfrey, 65468a;* Naples, 22 Nov 1964, *RKG 65527;* DADE: Redlands, 5 July 1959, *Atwater M-113;* S. Miami, 11 Aug 1963, *DB 158;* Coral Reef Dr., Miami, 11 Aug 1963, *DB 160;* Old Cutler Rd., Miami, 29 Nov 1963, *DB 219* (NY, US); Everglades National Park, 17 Apr 1964, *D. Burch & D. B. Ward 293;* Homestead, 19 Apr 1964, *DB & DBW 313;* Homestead, 19 Apr 1964, *RKG 63361;* HIGHLANDS: Lake Annie, junction FLA 17 and FLA 70, 18 Nov 1964, *DB & DBW 528* (NY); MONROE: Flamingo, Everglades National Park, 17 Apr 1964 *DB & DBW 288;* Plantation Key, 21 Nov 1964, *DB & DBW 563;* Cudjoe Key, 30 Dec 1964, *G. Avery s.n.;* POLK: Babson Park, 27 Nov 1964, *DB 580;* ST. LUCIE: Nigger Jim Scrub, 26 Oct 1957, *L. Brass 29046.*

Chamaesyce thymifolia has only been found in three counties to date, all on the west coast of Florida and in each case close to salt or brackish water. The collections were all made in 1963 or 1964, but the colonies were thriving and appeared from their extent to have been in the area for some time.

C. thymifolia: CHARLOTTE COUNTY: Charlotte Harbor, 27 Sept 1964, *DB 417* (BM, GH, NY, US); LEE: Fort Myers, 13 Aug 1963, *DB 186a;* Fort Myers, 27 Sept 1964, *DB 413* (BM, F, FSU, GH, NY, US); Fort Myers, 27 Sept 1964, *DB 414;* PINELLAS: Dunedin, 15 Oct 1964, DB *451.*

Specimens representing the above collections are on deposit in the herbarium of the Agricultural Experiment Station, University of Florida, Gainesville, and duplicates are being distributed to the institutions indicated.

DEREK BURCH
DEPARTMENT OF BOTANY,
UNIVERSITY OF FLORIDA, GAINESVILLE

CHROMOSOME NUMBERS IN PENSTEMON (SCROPHULARIACEAE) I: NEW MITOTIC COUNTS

FRANK S. CROSSWHITE AND SHOICHI KAWANO

Living plants of *Penstemon* were collected for cytological analysis by Delzie Demaree, Dr. W. G. Dore, Dr. Dennis Knight, and the authors. These were transported to the University of Wisconsin greenhouses and botanical garden, where they have been grown for two successive years. Root-tips were used exclusively.

Initially, root-tips were sectioned and stained with crystal-violet, but most of the preparations were made by a new orcein technique (Kawano, unpublished). Excised root-tips were stored in 0.001-0.002 mol. 8-hydroxyquinoline aqueous solution for 4-6 hours at 17-20°C, then fixed in Östergren & Heneen's fixative overnight, then treated with 5% aqueous pectinase for 1-2 hours at 30-38°C, and subsequently stained in lactopropionic orcein (Dyer, 1963) for more than 6 hours. The root-tips were then transferred into lactopropionic orcein-1 N hydrochloric acid (1:1) in which they were allowed to remain for 30 seconds to 5 minutes. Each of the root-tips was then transferred to a glass slide, treated with a drop of propionic acid (45%)-glycerine (9:1) for 5 to 20 seconds, after which it was gently heated over an alcohol flame and the root-tip squashed.

Since part II of this series, a revue of the cytology of *Penstemon,* is in preliminary manuscript, and will be published soon, no discussion of the taxonomic ramifications of the new counts is presented here. The new counts, together with voucher specimens, are cited below. Metaphase drawings are presented in Figure 1.

Penstemon arkansanus Pennell. $2n = 16$.
(including *P. multicaulis* Pennell and *P. wherryi* Pennell)

ARKANSAS. FAULKNER CO.: 2 mi. e. of Conway, *Crosswhite & Crosswhite* (WIS); 4-5 mi. n. of Conway, *Crosswhite & Crosswhite 62-325* (WIS). FRANKLIN CO.: 7 mi. w. of Ozark, *Crosswhite & Crosswhite 62-310* (WIS). GARLAND CO.: Hwy. 7, 1 mi. s. of Hamilton Lake, *Crosswhite & Crosswhite 62-320* (WIS). HOT SPRINGS CO.:

Big Hill Creek, 2 mi. n. of Bismark, *Crosswhite & Crosswhite 62-322* (WIS). INDEPENDENCE CO.: 5 mi. s. of Batesville, *Crosswhite & Kawano 63-407* (WIS). JACKSON CO.: 2 mi. s. of Denmark, *Crosswhite & Kawano 63-408* (WIS). LOGAN CO.: 8 mi. s.e. of Paris, *Crosswhite & Crosswhite 62-314* (WIS). PERRY CO.: 3½ mi. s. of Hollis, *Crosswhite & Crosswhite 62-318* (WIS). SALINE CO.: 1 mi. e. of Owensville, *Crosswhite & Crosswhite 62-324* (WIS). YELL CO.: 2 mi. n. of Havana, *Crosswhite & Crosswhite 62-315* (WIS).

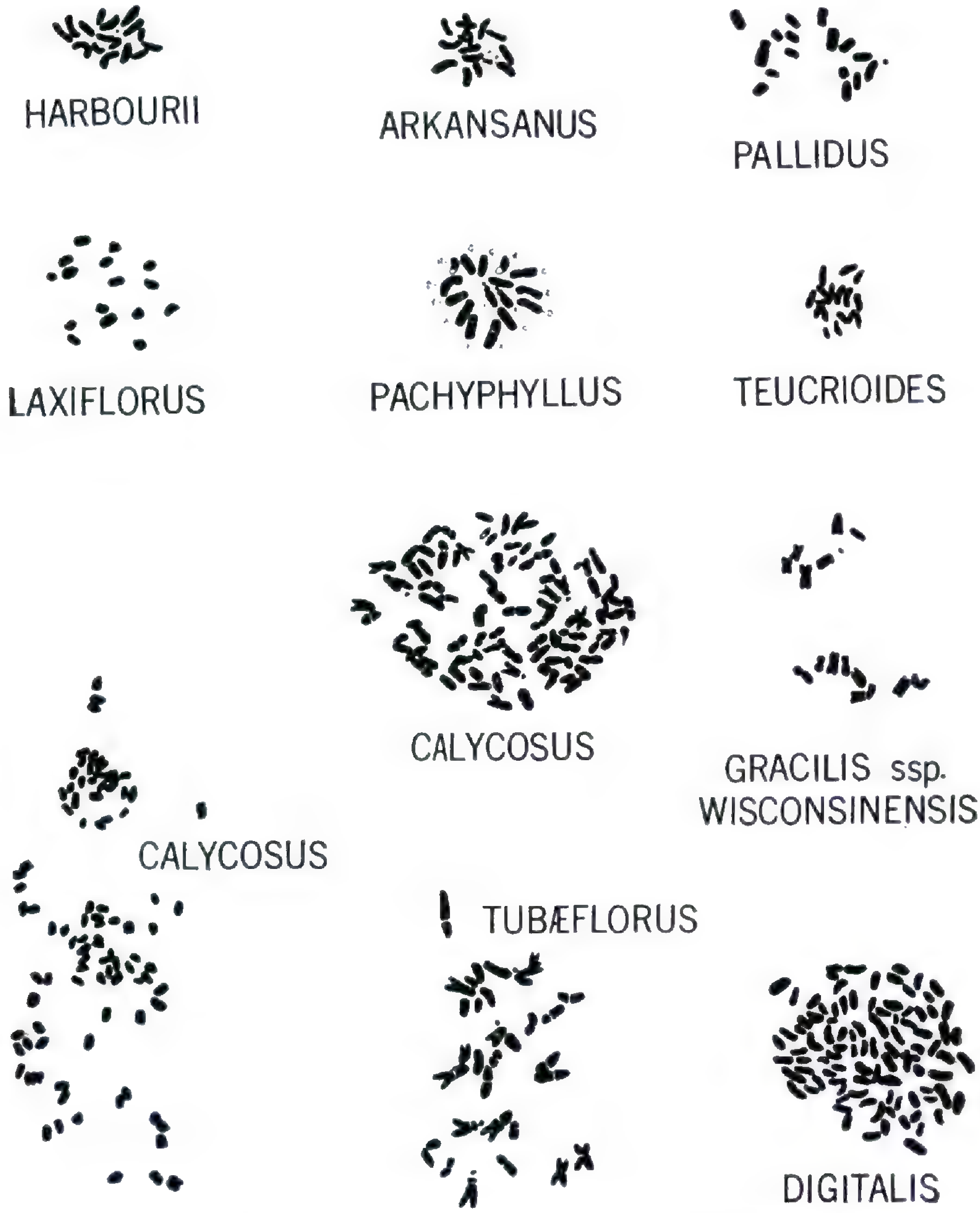

Fig. 1. Camera-lucida drawings of the chromosome complements of several *Penstemon* taxa.

Penstemon calycosus Small. $2n = 96$.

ILLINOIS. MARSHALL CO.: 2 mi. n. of Lacon, *Crosswhite & Crosswhite 62-305* (WIS). SHELBY CO.: 9 mi. s. of Pana, *Crosswhite & Crosswhite 62-330* (WIS). WASHINGTON CO.: 2 mi. s. of Irvington, *Crosswhite & Crosswhite 62-239* (WIS).

Penstemon digitalis Nutt. $2n = 96$.

ARKANSAS. PERRY CO.: 3 mi. s. of Hollis, *Crosswhite & Crosswhite 62-317* (WIS). SHARP CO.: 1 mi. s. of Hardy, *Crosswhite & Kawano 63-414* (WIS). LOUISIANA. EVANGELINE PARISH: Chicot State Park, *Crosswhite & Kawano 63-415* (WIS). MISSOURI. MILLER CO.: 5 mi. s.e. of Eldon, *Crosswhite & Nickerson 62-306* (WIS). WISCONSIN. RICHLAND CO.: Richland Center, *Crosswhite 63-412* (WIS). SAUK CO.: Lake Delton, *Crosswhite & Crosswhite 63-413* (WIS). ONTARIO: Jaspar, *Dore 19184* (WIS).

Penstemon gracilis Nutt. ssp. **gracilis.** $2n = 16$.

SOUTH DAKOTA. DEUEL CO.: 4 mi. e. of Clear Lake, *Knight s.n.* (WIS). PENNINGTON CO.: Mt. Rushmore, *Crosswhite & Crosswhite 63-400* (WIS). WISCONSIN. TREMPEALEAU CO.: Trempealeau, *Crosswhite 63-401* (WIS).

Penstemon gracilis ssp. **wisconsinensis** Pennell. $2n = 16$.

WISCONSIN. ADAMS CO.: 2 mi. n. of Plainville, *Crosswhite & Crosswhite 62-303* (WIS); Friendship, *Crosswhite & Crosswhite 62-304* (WIS). WAUSHARA CO.: Plainfield, *Crosswhite & Crosswhite 63-402* (WIS).

Penstemon grandiflorus Nutt. $2n = 16$.

WISCONSIN. ADAMS CO.: New Rome, *Crosswhite & Crosswhite 63-416* (WIS).

Penstemon harbourii A. Gray. $2n = 16$.

COLORADO. GUNNISON CO.: Mt. Belleview, *Crosswhite 62-221X* (PH, RM, SMU, WIS).

Penstemon laxiflorus Pennell. $2n = 16$.

ALABAMA. MOBILE CO.: Creola, *Crosswhite & Kawano 63-411* (WIS). LOUISIANA. GRANT PARISH: 15 mi. s. of Winnfiield, *Crosswhite & Kawano 63-409* (WIS). EVANGELINE PARISH: 5 mi. n. of Turkey Creek, *Crosswhite & Kawano 63-410* (WIS).

Penstemon pachyphyllus A. Gray ssp. **pachyphyllus.** $2n = 16$.

UTAH. UINTAH CO.: 13 mi. n. of Vernal, *Crosswhite & Crosswhite 62-254X* (PH, RM, SMU, WIS).

Penstemon pallidus Small. $2n = 16$.

ARKANSAS. INDEPENDENCE CO.: ½ mi. s. of Cave City, *Crosswhite & Kawano 63-405* (WIS). SHARP CO.: 5 mi. s. of Ash Flat, *Crosswhite & Kawano 63-406* (WIS). ILLINOIS. JACKSON CO.: Giant

City State Park, *Crosswhite & Kawano 63-404* (WIS). WASHINGTON Co.: s. of Centralia, *Crosswhite & Kawano 63-403* (WIS).

Penstemon teucrioides Greene. $2n = 16$.

COLORADO. GUNNISON Co.: Almont, *Crosswhite & Crosswhite 62-229X* (PH, RM, SMU, WIS); Sapinero, *Crosswhite & Crosswhite 62-230X* (PH, RM, SMU, WIS).

Penstemon tubaeflorus Nutt. $2n = 32$.

ARKANSAS. CRAIGHEAD Co.: 1 mi. n. of Jonesboro, *Crosswhite & Crosswhite 62-328* (WIS); 5 mi. s. of Jonesboro, *Crosswhite & Crosswhite* (WIS). CRAWFORD Co.: 4 mi. n. of Mountainberg, *Crosswhite & Crosswhite 62-313* (WIS). JOHNSON Co.: Ozone, *Crosswhite & Crosswhite 62-309* (WIS).

We wish to thank the Research Committee of the University of Wisconsin for supplying funds for this study from the Wisconsin Alumni Research Foundation. The work by Dr. Kawano was supported in part by a grant from the National Science Foundation to Dr. Hugh H. Iltis. We are very grateful to Dr. Iltis for his interest in the project, and for critically reviewing the original manuscript.

HERBARIUM, UNIVERSITY OF WISCONSIN, MADISON
DEPARTMENT OF BOTANY, UNIVERSITY OF TOKYO, JAPAN

ADDITIONS TO THE VASCULAR FLORA OF OKLAHOMA

The vascular flora of most of the major areas of Oklahoma has been fairly well collected. There are, however, many areas within the boundary of the state that have not been thoroughly investigated. The species discussed in this paper come from two of these areas. Until recently, Bryan Co. represented an essentially uninvestigated area. Prior to 1960, only a few specimens of vascular plants had been collected from this county of approximately 900 sq. miles. Specimens from the county have added a few new taxa to the flora of the state, and have added range extensions for many eastern and a few western species, (Taylor & Taylor, 1964a, 1964b, and in press). Many unique habitats are found in Bryan County. Hillside, seepy, bog-like habitats are formed along the flanks of small valleys cut in the Woodbine Sandstone (Cretaceous in age) where porous overlying strata have been truncated. Some of these habitats are only an acre or so in size, while others are several acres in extent (Taylor & Laughlin, 1963). Another unique habitat in this area is a strip of sand dunes lying along the north side of the Red River. The more recently formed dunes contain a sparse, xeric type of vegetation composed partially of western and southwestern species. The older dunes are stabilized and a type of bottomland forest invades them. Some of these forested areas have been cleared and cultivated, then subsequently allowed to go fallow. Some western and southwestern species also occur in these old fields (Taylor & Taylor, in press). Another area in Oklahoma that as yet has not been thoroughly studied is a 48 sq. mi. area (triangular in outline with the towns of Mill Creek, Mannsville, and Ravia at the apices) lying along the eastern side of the Arbuckle Mountains. It is an area underlain mainly by limestone strata (Tishomingo granite outcrops along the eastern side) and dissected by a number of spring-fed streams that flow year round — even in very dry years. This area, and other parts of the Arbuckle Mountains lying adjacent to it on the west, contain several eastern species. Hall (1952) and Hall and Carr (1964) discussed the affinities of some of this eastern element. Taylor and Taylor (in press) list a few additional eastern species for this area.

The species listed below are thought to be newly reported for the state. All specimens cited were collected by John and Constance Taylor and are deposited in the Bebb Herbarium, University of Oklahoma, Norman.

We wish to express our sincere gratitude to Dr. G. J. Goodman for his advice and for placing the facilities of the Bebb Herbarium at our disposal.

Dulichium arundinaceum (L.) Britt. was collected in Bryan County (No. 2332) from 4.5 mi. NE of Bennington where it was very abundant in a hillside seep. The Three-Way Sedge is a species of marshes and stream margins ranging from California N to British Columbia, E to Newfoundland and S to Florida and Texas.

Rhynchospora capillacea Torr. This almost hair-like, tussock forming member of the sedge family was collected (No. 2461) in the Arbuckle Mt. area of Johnston Co., 4 mi. S of the town of Mill Creek from a damp, calcareous meadow near Bee Branch. It would seem that this species has not previously been known further south and west than southern Missouri, where Steyermark (1963) considers it a relict. Quite possibly its occurrence in the Arbuckle Mts. of Oklahoma may be explained in the same manner.

Tigridia purpurea (Herb.) Shinners. This combination follows Shinners (1964). We have this very beautiful member of the Iridaceae (formerly known under *Eustylis*) from two nearby locations in eastern Bryan County. No. 2220 was collected from a damp low lying area in an oak-pine forest, 5 mi. E and 2 mi. N of Bennington. Other specimens (No. 2269 and duplicates) were collected approximately 1 mi. S of this location from an upland forest that fringes a hillside seep. Apparently the rather rare Pinewoods Lily has previously been known only from Arkansas, Louisiana, and Texas.

Linum imbricatum (Raf.) Shinners has been collected from a sandy old field 3.5 mi. SW of Mead in Bryan County. This species has previously been known from as near as

Cook and Grayson Cos. across the Red River in Texas (Rogers, 1964), and is known only from east central Texas.

R. JOHN AND CONSTANCE TAYLOR
SOUTHEASTERN STATE COLLEGE, DURANT, OKLAHOMA

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CHAMAESARACHA VILLOSA NEW TO TEXAS — While identifying a rather large collection of specimens from the Chinati Mountains of west Texas, (as a research participant in botany under the NSF sponsored program at Oklahoma State University) I noticed a rather unusual specimen of *Chamaesaracha*. This specimen *(Scudday 372)* proved to be *Chamaesaracha villosa* Rydberg, as determined by Dr. U. T. Waterfall of Oklahoma State University. The specimen was found growing in gravelly alluvium and sand beside the Marfa-Ruidosa road about two and one-half miles north of Ruidosa. It is deposited in the herbarium of Oklahoma State University. Associated species collected from the same site were *Tetraclea Coulteri* Gray, *Physalis hederaefolia* Gray var. *hederaefolia,* and *Jatropha dioica* Sesse ex Cerv. var. *graminea* McVaugh.

This species of *Chamaesaracha* was described from collections made in Coahuila, Mexico (Rydberg, 1895). It is not included in the checklist of Texas plants (Gould, 1962). The addition of this species to the flora of Texas is hereby noted.

The author is grateful to Dr. U. T. Waterfall for determining the specimen of *Chamaesaracha.*

JAMES F. SCUDDAY
DEPT. OF BIOLOGY, SUL ROSS STATE COLLEGE, ALPINE, TEXAS.

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NOTES ON THE FLORA OF COÖS COUNTY, NEW HAMPSHIRE

The apearance of a new flora such as Professor Pease's *Flora of Northern New England* stimulates the desire to find new taxa in the area and thus renders the work obsolete as soon as possible. With this in mind, I did a limited amount of collecting in Coös County during the summer of 1964. The results are presented below together with a few changes which should be made in the Pease Flora.

Equisetum fluviatile L. The following townships may be added to the six in Pease. Wentworth location, along Magalloway River, *Harris 26789* (64); Errol, Bear Brook Logan, *Harris 26548* (64); Stratford, Stratford Bog Pond, *Harris 26758* (64).

Lycopodium clavatum L., var. *megastachyon* Fern. & Bissell, forma *furcatum* (Luerss.) Vict. Dummer, runout field Dummer Hill, *Harris 26575* (64). First collection for the County.

Larix laricina (DuRoi) K. Koch. Bean Grant, between Mts. Clinton and Pleasant, *Harris & Hans Stauffer 26535* (64). A small group of trees over two meters tall were found growing at the upper limit of timber on the Crawford Path.

Potamogeton natans L. Errol, Bear Brook Logan, *Harris 26553* (64). The fourth township to be represented.

Elodea Nuttallii (Planch.) St. John. Pittsburg, First Lake, *Harris 26745* (64); Wentworth Location, Magalloway River, *Harris 26797* (64); Berlin, Androscoggin River, *Harris 26634* (64). Adds three townships to the two listed in Pease.

Vallisneria americana Michx. Berlin, Androscoggin River, *Harris 26647* (64). Adds a fourth township to the representation of this species.

Eragrostis multicaulis Steud. Colebrook, roadside, *Harris 26732* (64). The Pease collection 29690 (42) cited under Colebrook in *E. pectinacea* should be moved to *E. multicaulis*.

Phleum pratense L., forma *viviparum* (S. F. Gray) Louis-Marie. Milan, pasture West Milan, *Harris 26610* (64).

Zizania aquatica L., var. *augustifolia* Hitchc. Wentworth Location, oxbow pond, *Harris 26786* (64). The fourth township for the County.

Setaria Faberi Herrm. The Pease collection cited under *S. viridis*, Berlin 30308 (43) should be changed to this species, a new record for the County.

Eleocharis obtusa (Willd.) Schultes, var. *jejuna* Fern. Berlin, shore of Androscoggin River, *Harris 26624* (64). The second collection from the County.

Lemna minor L. Stewartstown, pool in County Farm pasture, *Harris 26733* (64); Milan, pool in pasture West Milan, *Harris 26614* (64).

Previous records from three townships, all in the southern portion of the County.

Iris Pseudacorus L. Milan, bank of Upper Ammonoosuc River, West Milan, *Harris 26652* (64). New to the County.

Silene pumilio Wulf. Sargent Purchase, Ammonoosuc Ravine Trail near upper limit of trees, *Harris 26529* (64). This species native to the mountains on the boundary of Austria and Yugoslavia, and not too common there, was a most unexpected find. The small colony confined to a crack in a ledge had evidently been there for several years. Its establishment on Mount Washington cannot be accidental. Some practical joker must be attempting to spice up the mountain flora.

Ceratophyllum demersum L. Errol, Bear Brook Logan, *Harris 26555* (64). This collection substantiates the statement made in Pease that Provost reports that the species is abundant at this locality, the second township for the County.

Ranunculus acris L., var. *latisectus* G. Beck. Milan, pasture West Milan, *Harris 26611* (64). The second collection from the County.

Rubus pensilvanicus Poir. Dummer, old field Dummer Hill, *Harris 26558* (64). Known previously from three townships.

Lotus corniculatus L. Colebrook, berm U. S. rte. 3, *Harris 26729* (64); Berlin, roadside rte. 16, *Harris 26531* (64); Gorham, roadside rte. 16, *Harris 26530* (64). This is a new genus for the County. The species seems to be rapidly establishing itself over much of New England.

Linum catharticum L. Pittsburg, berm of highway two miles north of Idlewild, *Harris 26742* (64). This is apparently the first collection of the species in New Hampshire.

Daphne Mezereum L. Milan, spontaneous behind Steady Camp, Cedar Pond, *Harris 26806* (64). This is a new genus to the County. Mr. Steady has occupied the camp for many years and has never noticed the shrub until the past summer.

Myriophyllum verticillatum L., var. *pectinatum* Wallr. Berlin, Androscoggin River, *Harris 26645* (64). The third township for the County.

Myriophyllum tenellum Bigel. Stark, Christine Lake, *Harris 26600* (64). The fourth township for the County.

Hippurus vulgaris L. Stratford, Stratford Bog Pond, *Harris 26768* (64). The fifth township for the County.

Carum Carvi L. Low & Burbank Grant, abundant at Madison Hut, *Harris 26527* (64). This is the first collection of the species from above treeline in the County.

Moneses uniflora (L.) Gray. Bean Grant, coniferous woods southwest of summit of Mt. Clinton, *Harris & Hans Stauffer 26534* (64). The fourth township for the County and the only collection made above 4000 feet.

Lycopersicum esculentum Mill. Milan, waif on dump, West Milan, *Harris 26604* (64). A new genus for the County but of little moment.

Verbascum Blattaria L. Pittsburg, roadside two miles north of Idlewild, *Harris 26743* (64); Colebrook, berm of U. S. rte. 3, *Harris 26730* (64). Known previously from three southern townships.

Gratiola aurea Muhl. Stark, Christine Lake, *Harris 26599* (64). Third township for County.

Utricularia inflata Walt., var. *minor* Chapm. Errol, Bear Brook Logan, *Harris 26542* (64); Berlin, Androscoggin River, *Harris 26618* (64). Known previously from two townships.

Centaurea Jacea L. The collection Milan, *Harris & Humes 7688* (51) cited under *C. nigra*, var. *radiata* should be moved to this species. The second collection for the County.

Crepis capillaris (L.) Wallr. Colebrook, berm U. S. rte. 3, *Harris 26731* (64). The second township for the County.

Hieracium aurantiacum L. Low & Burbank Grant, Madison Hut, *Harris 26528* (64). The species is abundant about the Hut at 4800 feet and well above treeline.

STUART K. HARRIS
BOSTON UNIVERSITY.

AN EASTERN VARIETY OF CAREX FISSA (§MULTIFLORAE)

F. J. HERMANN

In 1960, specimens of a puzzling sedge from Lake and Seminole counties, Florida, were received for review from Richard J. Eaton. Mr. Eaton commented that although repeated attempts to key out the plant in Mackenzie's monograph (North American Flora, Vol. 18, 1931-1935), as well as in Fernald's treatment in Gray's Manual, ed. 8, (1950), and Gleason's in the New Britton and Brown Illustrated Flora (1952), lead invariably to the widespread and polymorphous *Carex annectens* Bickn. (Section Multiflorae), it was not in the least suggestive of that species in the field. My own attempts at identification produced the same result and it was not until I had seen an additional specimen *(Ray, Wood, Smith & Eaton 10750)*, collected the following year, that another possible affinity suggested itself, namely with the rare, or at any rate highly localized, *C. fissa* Mack. of eastern Oklahoma.

Further collections from Florida by R. J. Eaton, an extensive series obtained from several counties in the same state by R. K. Godfrey, and recent collections of *C. fissa* kindly made in the type locality by Professor U. T. Waterfall, were compared with the type specimen of *C. fissa*. The results indicated that in their fundamental characteristics the Florida plants agreed most closely with the presumed Oklahoma endemic. Pronounced differences were apparent, so that nomenclatorial recognition seemed imperative, but without exception the diagnostic characteristics were found to be inconstant, and so the eastern plant is here proposed as a geographic variety.

Carex fissa Mack. var. **aristata** F. J. Herm., var. nov., a varietate typica recedit ligula concava, vaginis ad apicem ventraliter saepe minus prolongatis, squamis foemineis longiaristatis, perigyniis ventraliter paucinervatis.

FLORIDA: SEMINOLE COUNTY: between roadside and moist margin of pine - Serenoa flatwood, 1 mile southeast of Oviedo, *Ray, Wood, Smith & Eaton 10750*, April 26, 1961 (GH-Type; NY; USFS; FSU; OKLA); near Slavia, *Cooley, Eaton & Ray 7459*, May 2, 1960 (GH; US; USFS; USF). LAKE COUNTY: near Howie-in-the-Hills, *Cooley & Eaton 7350*, April 29, 1960 (GH; USFS; USF). WAKULLA COUNTY: Live Oak Island, *R. K. Godfrey 56799*, May 21, 1958 (GH; USFS; FSU); and *62727*, May 3, 1963 (GH; FS; NY; BM; SFU; US; V); vicinity of Shell Island near St. Marks, *R. K. Godfrey 62734*, May 3, 1963 (GH; FS; FSU; US). NASSAU COUNTY: clearing of swamp, vicinity of O'Neil, *R. K. Godfrey 64096*, May 23, 1964, (FSU; USFS). MARIAN COUNTY: wet ditch along Alexander Springs River, near Alexander Springs, *R. K. Godfrey & R. D. Houk 62795*, May 11, 1963, (SFU; USFS). TAYLOR COUNTY: low wet area near river, Econfina Landing, *S. McDaniel & R. K. Godfrey 4299*, May 3, 1964 (FSU; USFS). OKLAHOMA: CREEK COUNTY: ditch, valley just north of Kiefer, *M. T. Waterfall 17016*, June 1, 1962 (GH; OKLA; USFS) (approaching var. *fissa*).

The following key may serve to distinguish *Carex fissa* var. *aristata* from var. *fissa* and from *C. annectens.*

Plant coarse in habit; culms thick (3-6 mm. wide at base); leaves wide (3-5 mm.); spikes congested into a short, broad head (2-4.5 cm. long, 8-15 mm. wide); perigynia large (3.25-3.9 mm. long), usually green at maturity, truncate to shallowly cordate at base.

- Ligule convex; sheaths conspicuously prolonged ventrally at the mouth; scales acuminate to cuspidate; perigynia ventrally nerveless or occasionally 1-2 nerved .... *C. fissa.*
- Ligule generally concave to V-shaped; sheaths generally less prolonged ventrally at the mouth; pistillate scales cuspidate to long-awned; perigynia usually with 1-4 ventral nerves .... *C. fissa* var. *aristata.*

Plant slender; culms not thick (2.5-4 mm. wide at base); leaves relatively narrow (2-4 mm. wide); spikes arranged in an elongated, relatively narrow inflorescence (3-8 cm. long, 5-10(12) mm. wide); perigynia small (2.3-2.9 mm. long), usually nerveless ventrally, yellowish to brownish at maturity, tapered at base .... *C. annectens.*

During the course of a preliminary study of his Florida collections and before asking me to make the taxonomic decision and publish my findings, Mr. Eaton had enlisted the indispensable aid of Prof. Waterfall and Dr. Godfrey in securing the many collections of plants pertinent to the problem. Both Mr. Eaton and I are deeply grateful for their invaluable cooperation, without which it is unlikely that any plausible conclusion could have been reached.

FOREST SERVICE HERBARIUM,
RANGE AND WILDLIFE HABITAT RESEARCH,
U. S. DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.

IPOMOEA AMNICOLA (CONVOLVULACEAE), A SOUTH AMERICAN WAIF IN MISSOURI. — Among some unidentified specimens of *Ipomoea* in the Herbarium of the Missouri Botanical Garden, received on loan through the kindness of Dr. Walter H. Lewis, was one which proved to be *Ipomoea amnicola* Morong, a native of Paraguay and parts of adjoining countries, well established as a weed in extreme southern Texas and adjacent Mexico (Tamaulipas). The specimen was collected by B. F. Bush (no. 9691) in waste ground at Sheffield (now part of Kansas City), Missouri, Sept. 26, 1921. In reporting the species from Texas (see Lilloa 29: 108 and 110, 1959), the late Carlos O'Donell assumed it to be native there and disjunct, with one intervening record in Colombia between the North American and main South American portions of its range. The earliest collection from Texas that I have seen was made in 1929; the plant occurs in disturbed habitats such as roadsides and fields and in towns; and it is steadily increasing its range. These facts all suggest an introduced species. The Missouri collection, eight years earlier than the oldest from Texas, is additional evidence of introduced rather than native status. The manner of its introduction is unknown. It behaves like another introduced *Ipomoea* at first taken to be native, *I. heptaphylla* (Roxburgh) Voigt (*I. Wrightii* Gray; *I. pulchella* of authors, not Roth), in showing a preference for heavier soils rather than sandy ones. The latter species, native to the Old World (probably originally from India), has been in Texas for more than 100 years, but although it has been collected in 17 central and southern counties with calcareous silt and clay, it is absent from the sandy eastern counties and from most of Louisiana. It reappears locally in southern and eastern Louisiana and in western Mississippi, where calcareous silts are present.

LLOYD H. SHINNERS
SOUTHERN METHODIST UNIVERSITY, DALLAS, TEXAS

A REVISION OF THE NORTH AMERICAN SPECIES OF HELIANTHEMUM (CISTACEAE)

(CONTINUED FROM P. 82)

H. S. DAOUD & ROBERT L. WILBUR

SYSTEMATIC TREATMENT*

HELIANTHEMUM [Tourn.] Mill., Gard. Dict. Abr. ed. 4. 1754.

Cistus L., Sp. Pl. 523-529. 1753 & Gen. Pl. 234. 1754. (in part).

Helianthemum sect. *Lecheoides* Dunal, DC. Prodr. 1: 269. 1824.

Crocanthemum Spach, Ann. Sci. Nat. 2nd ser. 6: 370. 1836. Lectotype: *C. carolinianum* (Walt.) Spach = *H. carolinianum* (Walt.) Michx.

Heteromeris Spach, Ann. Sci. Nat. 2nd ser. 6: 370. 1836. Lectotype: *H. canadensis* (L.) Spach = *Helianthemum canadense* (L.) Michx.

Taeniostema Spach, Ann. Sci. Nat. 2nd ser. 6: 371. 1836. Type: *T. micranthum* Spach = *H. glomeratum* (Lag.) Dun.

Anthelis subg. *Horanthes* Raf., New Fl. N. Am. 3: 30. 1836 [1838].

Horanthes (Raf.) Raf., Sylva Tell. 132. 1838.

Helianthemum subg. *Lecheoides* (Dunal) Reiche, Nat. Pflanzenfam. III. 6: 306. 1895.

Halimium sect. *Spartioides* Gross., Pflanzenreich 14 (IV. 193): 33. 1903.

Halimium sect. *Lecheoides* (Dunal) Gross., Pflanzenreich 14 (IV. 193): 33. 1903.

Crocanthemum sect. *Spartioides* (Gross.) Janchen, Nat. Pflanzenfam. ed. 2. 21: 305. 1925.

Crocanthemum sect. *Lecheoides* (Dunal) Janchen, Nat. Pflanzenfam. ed. 2. 21: 305. 1925.

Generic Description

Perennial herbs or small shrubs. STEMS one to many, decumbent to erect, arising from a woody caudex or rarely from an elongate, subterranean, woody rootstock. BASAL LEAVES, when present, either in a rosette or forming a mat. CAULINE LEAVES alternate, estipulate (an axillary tuft of leaves characteristic of several species sometimes mistaken for stipules), sessile to short-petioled, gradually reduced in size above: the blade entire or rarely subdenticulate with a conspicuous midvein and with the pinnate secondary veins varying from very obscure to prominently elevated beneath. PUBESCENCE typically present and usually abundant; trichomes predominantly stellate but

*The generic description and synonyms presented here are specifically intended to apply only to the North American species of *Helianthemum.*

occasionally intermixed with simple or glandular hairs. INFLORESCENCE: cymose, paniculate, or thyrsoid. FLOWERS either chasmogamous (petals 5; stamens 10 or more, anthers (1-) 1.5-2 times longer than wide and dehiscing laterally by means of longitudinal slits) or cleistogamous (petals lacking; stamens up to 8, anthers short and about as long as wide and dehiscing by means of rupture in the wall adherent to the stigma). Flowers either isomorphic (chasmogamous or cleistogamous) or dimorphic (both chasmogamous and cleistogamous). When dimorphic, either occurring together in the same cluster, or separately. Bracts linear, lanceolate, or somewhat spatulate.

CHASMOGAMOUS FLOWERS: SEPALS 5, the two outer ones linear, spatulate or lanceolate, mostly shorter than the ovate inner sepals. PETALS 5, yellow, fugacious. STAMENS 10-50, filaments slender, mostly exceeding the pistil in length; anthers oblong to linear, mostly (1-)1.5-2 times longer than wide and dehiscing laterally by means of longitudinal slits, neither cohering with one another nor adhering to the stigma at anthesis. OVARY ovoid, one-celled, glabrous or stellate-pubescent (in 2 species); style straight and erect, varying from almost wanting to 1 mm. in length (always shorter than the ovary); stigma capitate. CAPSULE loculicidally dehiscent, ovoid, ellipsoid, or ovoid-triquetrous, shorter than calyx, glabrous or stellate-pubescent on the upper half, unilocular, usually 3-valved (one species characteristically 2-valved). SEEDS 1-45(-135), mostly irregular, ovoid, somewhat flattened or rarely globose, smooth, reticulate, or papillate; the smooth seeds and the ones covered with white papillae having a thin separable membrane when moistened, (and then the embryo becoming somewhat visible), while the outer testa of the reticulate or dark papillate seeds not readily separable when wetted.

CLEISTOGAMOUS FLOWERS: SEPALS 5, the two outer ones linear, spatulate, or rudimentary and knob-like and then attached near the middle edge of the ovate inner sepals. PETALS lacking. STAMENS (3-)4-6(-8), filaments slender, equaling the pistil in length; anthers short and about as long as wide, mostly coherent, dehiscing by means of a rupture of the wall adherent to the stigma and often remaining attached to the stigma even in fruit. OVARY similar to that of the chasmogamous flower but smaller; its style shorter. CAPSULE ovoid to mostly ovoid-triquetrous, other characters similar to those of the chasmogamous capsule. SEEDS smaller and fewer (1-22) but otherwise resembling those of the chasmogamous fruit.

KEY TO THE NORTH AMERICAN SPECIES OF HELIANTHEMUM

1. Ovary and capsule densely stellate-pubescent at least in the upper third.
   2. Capsule 3-valved; plants mostly 20 cm. tall or less; inflorescence terminal and umbellate; inner sepals of largest flowers mostly

4-8 mm. long and in fruit over 5.5 mm. long; seeds mostly more numerous than 10/capsule; nw. Fla. to Miss. .... 5. *H. arenicola.*

2. Capsule 2-valved; plants mostly 20 cm. tall or more; inflorescence a terminal and/or lateral, cylindrical, leafy thyrse; inner sepals of the largest flowers mostly 3.5-5.0 mm. long and in fruit not longer than 5.5 mm. long; seeds mostly less numerous than 10/capsule; peninsular Fla. .... 6. *H. Nashii.*

1. Ovary and capsule glabrous throughout.
   3. Pedicels and branches of the inflorescence densely beset with coarse dark red trichomes 0.3-0.6 mm. long terminated by a small glandular knob; Channel Islands of s. Calif. .... 9. *H. Greenei.*
   3. Pedicels and branches lacking glandular trichomes.
      4. Leaves spatulate, less than 1 cm. long, broadest well above the middle; margins with ciliate trichomes half to as long as the width of the leaf; low woody shrub; Baja Calif. .. 11. *H. nutans.*
      4. Leaves various but not all spatulate and often exceeding 1 cm. in length, usually broadest at the middle or towards the base; leaf-margins eciliate or if trichomes present these never equalling in length half the width of the blade; herbaceous to shrubby.
         5. Median cauline leaves 2 mm. wide or less and less than 1 cm. long; Mexico or Calif.
            6. Flowers isomorphic, all petaliferous; pedicels 2-12 mm. long; foliage typically densely stellate-pubescent but varying to glabrate or rarely even glabrous; seeds 4-20/capsule; Calif., Baja Calif. and central Mexico.
               7. Median cauline leaves more than 8 times as long as broad; inner sepals up to 7 mm. long; outer sepals up to 4.5 mm. long; Calif. and n. Baja Calif. .... 10. *H. scoparium.*
               7. Median cauline leaves less than 8 times as long as broad; inner sepals not exceeding 4 mm. long; outer sepals 2.5 mm. or less in length; central Mexico. .... 12. *H. patens.*
            6. Flowers dimorphic, petaliferous and apetalous; pedicels of the apetalous flowers 1 mm. long or less; foliage finely but exceedingly densely pubescent (and the pubescence not apparently stellate); seeds 3 or fewer/capsule; central Mexico .... 20. *H. argenteum.*
         5. Median cauline leaves 2 mm. or more in width and mostly over 1 cm. long.
            8. Lower surface of leaf-blade with both prominently elevated secondary veins and a visible epidermis (i.e. the pubescence sparse enough so that the epidermis is not completely obscured.)
               9. Herbs up to 4 dm. high with persisting basal leaves; flowers 6 or fewer borne in a loose scorpioid cyme but

appearing solitary; outer sepals lanceolate, mostly more than 0.5 mm. wide (and often up to 1.5 mm.); seeds 50 or more/capsule and lacking a separable membrane when moistened; se. Coastal Plain of the U.S. .... 1. *H. carolinianum.*

9. Shrubs up to 10 dm. high and lacking basal leaves; flowers in dense corymbose clusters terminating branches; outer sepals linear, less than 0.5 mm. wide; seeds 10 or fewer/capsule and possessing a readily separable membrane when moistened; central and w. Mexico. .... 14. *H. concolor.*

8. Lower surface of leaf-blade either lacking prominently elevated veins and/or the pubescence so dense that the lower epidermis is completely obscured.

10. Lower half of stem densely beset with simple, villous trichomes as well as stellate pubescence; Mexico and Central America.

11. Secondary venation conspicuously elevated beneath; seeds lacking a hygroscopic membrane when wetted. .... 4. *H. Coulteri.*

11. Secondary venation obscure or at least not conspicuously elevated beneath; seeds with a readily separable, hygroscopic membrane when wetted.

12. Inner sepals merely stellate-pubescent and never with villous trichomes; chasmogamous and cleistogamous flowers borne together at the end of the branches .... 16. *H. Pringlei.*

12. Inner sepals stellate-pubescent and also bearing villous trichomes; chasmogamous and cleistogamous flowers borne separately (the chasmogamous terminating the main stem and major branches and the cleistogamous borne in 1-to few-flowered, often glomerate clusters on short axillary branches). .... 17. *H. chihuahuense.*

10. Lower half of stem merely stellate-pubescent to glabrate and never partly villous.

13. Cleistogamous flowers congested in a dense, terminal, corymbiform cyme and chasmogamous flowers, if present, long-pedicellate and overtopping the cluster; outer sepals and closely associated bracts narrowly spatulate and obtusely tipped; Coastal Plain of the se. U.S. (N.C. to Miss.) .... 13. *H. corymbosum.*

13. Cleistogamous flowers not borne in a dense, terminal, corymbiform cyme (although often in dense glomerules) and chasmogamous flowers, if present, not overtopping such an inflorescence, outer sepals and the

closely associated bracts linear and neither spatulate nor obtusely tipped.

14. Cleistogamous flowers (or fruit) lacking and secondary veins of leaf-blade not elevated beneath; Calif. and/or Mexico.

15. Leaves mostly 8-24 times as long as wide, their margins often revolute, often exceeding 1.5 cm. long; plants usually exceeding 2 dm. tall; Calif. and n. Baja Calif. .... 10. *H. scoparium.*

15. Leaves mostly less than 8 times as long as wide, their margins not revolute, usually less than 1 cm. long and not known to exceed 1.5 cm. long; plants mostly less than 2 dm. tall and not exceeding 3 dm.; central Mexico .... 12. *H. patens.*

14. Cleistogamous flowers (or fruit) present and/or secondary veins of leaf-blade noticeably elevated beneath.

16. Secondary veins of leaf not noticeably elevated beneath; seeds encompassed by a thin membrane that is readily separable when wetted; se. Coastal Plain of the U.S. or Mexico.

17. External sepals of the cleistogamous flowers less than 1.2 mm. long; internal cleistogamous sepals less than 2 mm. long; leaf-margin usually somewhat revolute; Coastal Plain from N.C. to e. Tex., also known from central Hispaniola. .... 19. *H. rosmarinifolium.*

17. External sepals of the cleistogamous flowers 1.2 mm. long or longer; internal cleistogamous sepals exceeding 2 mm. long; leaf-margin nonrevolute; Central America, Mexico, or extreme s. Tex.

18. Inflorescence a loosely racemose cyme of 2-5 ± chasmogamous and cleistogamous flowers borne on elongate branches from the upper quarter of the plant; pedicels inconspicuously jointed, articulate; plants typically herbaceous and color not ashy. .... 16. *H. Pringlei.*

18. Inflorescence in dense axillary and terminal glomerules with the chasmogamous flowers (when present) on elongate pedicels conspicuously overtopping the cleistogamous clusters; pedicels not jointed; plants suffru-

ticose and of an ashy color. .... 18. *H. glomeratum.*

16. Secondary veins of leaf noticeably elevated beneath; seeds either membraneous or enveloped by a readily separable thin membrane when wetted.
   19. Only chasmogamous flowers and/or fruit present on specimen.
      20. Chasmogamous flowers solitary and terminating the stem but later overtopped by lateral branches (or if, when immature, 2 flowers appear together, the upper surface of the upper leaves with apparently simple trichomes intermixed with the stellate pubescence); e. U.S. and Canada.
         21. Stems (0.5-)1.0-2.0(-3.0) dm. high with widely divergent branches and branchlets; pubescence of the upper surface of the midcauline leaves dense with the stellate pubescence so closely placed that the trichome-branches overlap; the upper epidermis hence obscured from view; Mass. to Long Island, N.Y. ...... 2. *H. dumosum.*
         21. Stems (0.8-)1.5-4.5(-6.5) dm. high with strongly ascending branches and branchlets; pubescence of the upper surface of the midcauline leaves relatively sparse with the stellate pubescence spaced so that the trichome branches rarely overlap, the upper epidermis hence readily visible; s. Canada to Ga. and w. to Mo. and Minn. .... 3. *H. canadense.*
      20. Chasmogamous flowers clustered in groups of 2 or more.
         22. Mature seeds with a separable membrane when wetted; calyces with only uniform short stellate puberulence; Coastal Plain from e. N.C. to n. Fla. and w. into Ark., s. Okla. and e. Tex. .... 15. *H. georgianum.*
         22. Mature seeds lacking a readily separable membrane after wetting; calyces often with elongate trichomes in addition to the short stellate puberulence; central and e. U.S. and s. Canada (Me. to n. Ga.

w. to the Dakotas and Col.) or from Mexico and/or Central America.

23. Midcauline leaves mostly less than 3.5 times as long as wide, leaves often broadly elliptic to somewhat obovate; Mexico and Central America .... 4. *H. Coulteri.*

23. Midcauline leaves mostly more than 3.5 times as long as wide, leaves usually oblanceolate to narrowly elliptic; central and e. U.S. and s. Canada.

24. Chasmogamous outer sepals fused with the inner sepals only near the base and the free portion more than half the length of the inner sepals, the free portion over 3.2 mm. long; stems arising from a multicipital caudex .... 7. *H. Bicknellii.*

24. Chasmogamous outer sepals fused for half to two-thirds the length of the inner sepals, the free portion less than 3.2 mm. long; stems arising from a horizontal rootstock .... 8. *H. propinquum.*

19. Cleistogamous flowers and/or fruits present on specimen (the chasmogamous may also be present).

25. Chasmogamous flowers, when present, borne on filiform pedicels greatly overtopping the nearly sessile, glomerate, cleistogamous flowers; seeds with a separable membrane when wetted.

26. Internal sepals of the cleistogamous or fruit averaging less than 1.8 mm. long; cleistogamous capsules rounded in cross-section; median cauline leaves mostly 6 times or more as long as wide; Santo Domingo and the Coastal Plain from N.C. to n. Fla. and w. to e. Tex. and Okla. .... 19. *H. rosmarinifolium.*

26. Internal sepals of the cleistogamous flowers or fruit averaging over 2.2 mm. long; cleistogamous capsules 3-angled in cross-section; median cauline leaves less than 6 times as long as wide; extreme sw.

Tex., Mexico, and Guatemala. ....
....18. *H. glomeratum.*

25. Chasmogamous flowers lacking or, if present, not borne on filiform pedicels overtopping the subsessile, glomerate, cleistogamous flowers; seeds lacking a separable membrane when wetted or with such a membrane only in *H. georgianum, H. glomeratum* and *H. rosmarinifolium.*
  27. Inner sepals of the cleistogamous flowers or fruits averaging less than 1.8 mm. long; the Coastal Plain from N.C. s. to n. Fla. and w. into e. Tex. and Okla. and also in the Dominican Republic .... 19. *H. rosmarinifolium.*
  27. Inner sepals of the cleistogamous flowers or fruits averaging more than 1.8 mm. long.
    28. Mature seeds present on specimen.
      29. Seeds with a hygroscopic, separable membrane when wetted.
        30. Cleistogamous flowers (and chasmogamous also, if present) loosely arranged and each separately borne on the ends of branchlets; seeds per cleistogamous capsule 12 or more; capsules globose to ovoid; coastal N.C. to n. Fla. and w. to e. Tex. .... 15. *H. georgianum.*
        30. Cleistogamous flowers in dense axillary and terminal glomerules (the chasmogamous, if present, overtopping the compact, cleistogamous clusters); seeds/cleistogamous capsule fewer than 12 and mostly 2-7; capsules triquetrous; the Big Bend area of Tex. s. throughout much of Mexico and Guatemala .... 18. *H. glomeratum.*
      29. Seeds lacking a hygroscopic, separable membrane when wetted.
        31. External sepals of the cleistogamous flowers averaging over 1.2 mm. long; Mexico and Central America .... 4. *H. Coulteri.*

31. External sepals averaging less than 1.2 mm. long; U.S. e. of the Rocky Mts. and Canada.

32. Seed per cleistogamous capsule more numerous than 4, seed-surface papillate.

33. Stems (0.5-)1.0-2.0(-3.0) dm. high with widely divergent branches and branchlets; pubescence of the upper surface of the midcauline leaves dense with the stellate pubescence so closely placed that the trichome-branches overlap obscuring the epidermis from view; mature cleistogamous capsules and their associated calyces solitary or rarely two together at the tips of the branchlets; external sepals 0.4-1.2 mm. long; Mass. s. to Long Island, N.Y. .. 2. *H. dumosum.*

33. Stems (0.8-)1.5-4.5(-6.5) dm. high with strongly ascending branches and branchlets; pubescence of the upper surface of the midcauline leaves often relatively sparse with the stellate pubescence so spaced that the trichome branches rarely overlap and hence the upper epidermis readily visible; mature cleistogamous capsules and their associated calyces one to few and glomerate, terminating the short axillary branchlets; external sepals 0.2-0.4 (-0.6) mm. long; s. Canada to Ga. and w. to Mo. and Minn. .... 3. *H. canadense.*

32. Seeds per cleistogamous capsule 1-3, seed-surface reticulate.

34. Stems usually clustered and upright, arising from an erect caudex; free portion of the

outer sepals of the cleistogamous flowers linear, (0.3-)0.6-1.2(-1.8) mm. long, about 3-5 times longer than wide; cleistogamous capsule sharply 3-angled in cross-section .... 7. *H. Bicknellii.*

34. Stems scattered, arising from a horizontal, elongate rootstock; free portion of the cleistogamous outer sepals rudimentary and knob-like, 0.2-0.5 mm. long, 1-2 times longer than wide; cleistogamous capsules somewhat rounded in cross-section .... 8. *H. propinquum.*

28. Mature seeds lacking on specimen.

35. Pedicels of cleistogamous flowers over 0.5 mm. long; flowers loosely arranged at the ends of the branches or at least not in few- to many-flowered glomerules.

36. Outer sepals of the cleistogamous flowers 0.3-0.7 mm. wide; Mexico and Central America .... 4. *H. Coulteri.*

36. Outer sepals of the cleistogamous flowers about 0.3 mm. wide; Coastal Plain from N.C. to n. Fla. and w. into e. Tex. .. 15. *H. georgianum.*

35. Pedicels of the cleistogamous flowers less than 0.5 mm. long, sessile or nearly so; flowers often borne in axillary clusters of 2 to many.

37. Leaves usually canescent and equally pubescent on both surfaces and hence of similar color; external sepals of cleistogamous flowers usually 1 mm. long or longer; extreme s. Tex. and in Mexico and Guatemala. .... 18. *H. glomeratum.*

37. Leaves neither canescent nor equally pubescent on both surfaces and usually of dissimilar color; external sepals of the cleistogamous

flowers usually less than 1 mm. long (or longer in *H. Bicknellii*); U.S. and Canada e. of the Rocky Mts.

38. Cleistogamous flowers few in number and not sharply differentiated from the chasmogamous, borne solitary or rarely two together at ends of branchlets; plants diffusely branched, 1-2(-3) dm. high; e. Mass. s. to Long Island, N.Y. ...... 2. *H. dumosum.*

38. Cleistogamous flowers typically numerous and sharply differentiated from the chasmogamous, often borne in axillary glomerules; plants erect, mostly 2-5 (-6.5) dm. high; e. N. Am.

39. External sepals of the cleistogamous flowers 0.6 mm. long or more; capsule sharply triangular in cross-section .... 7. *H. Bicknellii.*

39. External sepals of the cleistogamous flowers less than 0.6 mm. long; capsules weakly 3-angled or rounded in cross-section.

40. Stems arising from a horizontal rootstock, mostly less than 3 dm. tall; seeds 1-2(-3) per cleistogamous capsule; cleistogamous flowers few-numerous in each cluster .... 8. *H. propinquum.*

40. Stems arising from an erect caudex, mostly more than 2.5 dm. tall; seeds 5 or more/cleistogamous capsule; cleistogamous flowers one-few in each cluster .... 3. *H. canadense.*

1. Helianthemum carolinianum (Walt.) Michx.

Cistus carolinianus Walt., Fl. Car. 152. 1788. Walter's Herb. (BM), Photo: (GH!). Probably from eastern S. Carolina.

Helianthemum carolinianum (Walt.) Michx., Fl. Bor.-Am. 1: 307. 1803.

Crocanthemum carolinianum (Walt.) Spach, Ann. Sci. Nat. 2nd ser. 6: 370. 1836.

Halimium carolinianum (Walt.) Gross., Pflanzenreich 14 (IV. 193): 44. 1903.

Heteromeris caroliniana (Walt.) Ponzo, Nuovo Gior. Bot. Ital. n.s. 28: 171. 1921. (No basionym.)

Perennial herb (4)10-30(38) cm. tall with one to several stems arising from a caudex or rarely from subterranean rootstock. STEMS ascending to erect, covered with spreading, white, stellate pubescence up to 2.5 mm. long. BASAL LEAVES in a rosette; blade (3)10-35(60) mm. long, (3)5-18(28) mm. wide, otherwise similar to the cauline leaves. CAULINE LEAVES few and remote; petiole 1-4 mm. long; blade (8)18-36(55) mm. long, (3)5-16(26) mm. wide, spatulate to obovate to elliptic or even elliptic-lanceolate near the apex, green on both sides but turning brown upon drying, sparsely pubescent above (the trichomes up to 1 mm. long), sparsely and more shortly stellate-pubescent beneath; midvein and secondary veins prominent beneath; base of blade attenuate to cuneate, apex obtuse to acute; margin sub-denticulate, non-revolute. Inflorescence: a few-flowered, scorpioid cyme. Flowers mostly isomorphic (chasmogamous), very rarely dimorphic (chasmogamous and cleistogamous); the cleistogamous flowers, when present, one or two near the apex; bracts 2.5-6 mm. long, 0.5-1 mm. wide, lanceolate. Pedicel and calyx covered with spreading, white, pilose or 2-several-branched stellate pubescence (up to 1.5 mm. long) resembling the pubescence of the stem but often less-branched.

CHASMOGAMOUS FLOWERS: pedicels 4-15(24) mm. long, slender, ascending or sometimes curving upwards. OUTER SEPALS (free portion) (2.5)4-5.5(7.5) mm. long, (0.4)0.8-1.2(1.5) mm. wide, lanceolate, acute; INNER SEPALS (6)7.5-12(14) mm. long, (3)4-5.5(6.3) mm. wide, ovate, acuminate. COROLLA yellow, petals 8-18 mm. long, 8-16 mm. wide, broadly spatulate. STAMENS 20-35(50). PISTIL 1.9-2.7 mm. long; ovary 1.5-2.3 mm. long, 1.3-2.2 mm. in diameter, ovoid, glabrous; style 0.1-0.4 mm. long; stigma c. 1 mm. wide, capitate, papillate. FRUITING PEDICELS up to 28 mm. long; fruiting calyx 8.5-12(16.5) mm. long, 6-9 (11) mm. in diameter. OUTER SEPALS (free portion) 4-7(9) mm. long, lanceolate, up to 28 mm. long; fruiting calyx 8.5-12(16.5) mm. long, 6-9(11) mm. acute; INNER SEPALS 8.5-12(16.5) mm. long, 1.5-3-times longer than the outer sepals, 5.4-7.5(9) mm. wide, ovate, acuminate. CAPSULE 6-9 (10.5) mm. long, 4.5-9(10) mm. in diameter, ovoid, glabrous, 3-valved (very few capsules having 4 or even 5 valves); each valve 3.8-7 mm. wide, ovate, acute to subacute. SEEDS 80-92(135), ovoid, reddish to dark brown, papillate.

CLEISTOGAMOUS FLOWERS: lacking in about 99 per cent of the specimens examined; when present, pedicels 0.4-3.8 mm. long. OUTER

SEPALS (free portion) 1.6-2.8 mm. long, lanceolate; INNER SEPALS 3-4.5 mm. long, c. 1.6 mm. wide. STAMENS 4-6. PISTIL c. 1.5 mm. long; ovary c. 1.2 mm. long, c. 0.7 mm. in diameter, style c. 0.2 mm. long; stigma c. 0.4 mm. wide. CLEISTOGAMOUS FRUITS not seen.

FLOWERING: March-May. HABITAT: dry pine barrens, sandy open woodlands and fields. DISTRIBUTION: along the Coastal Plain from southeastern North Carolina into central Florida and westward into eastern Texas and southern Arkansas. (Map 1.)

Grosser (Pflanzenreich 14 (IV. 193): 45. 1903.) first described this species as possessing both chasmogamous and cleistogamous flowers. He was followed by Barnhart (in Small, Man. SE. Fl. 879. 1933.) who described it as having "petaliferous flowers with 25-35 stamens and 80 ovules, the apetalous with 5 stamens and 50-60 ovules." Usually this species has only chasmogamous flowers. However, a score or so specimens from Florida amounting to less than 1 per cent of the collections examined had one or two cleistogamous flowers borne near the apex late in the growing season. No cleistogamous fruits were observed.

Spach (Ann. Sci. Nat. 2nd ser. **6**: 370. 1836.) included *H. carolinianum* and *H. brasiliense* in his generic segregate, *Crocanthemum*. The basic criterion for this segregation was that both species have only petaliferous flowers. However, *H. carolinianum* very rarely has cleistogamous flowers while *H. brasiliense* typically has them. Therefore the basic characteristic employed by Spach to justify this segregation fails to hold. In addition, the two species do not form a particularly closely related group. For example, the seeds of *H. carolinianum* are papillate and without a separable membrane, while the seeds of *H. brasiliense* are smooth and possess a separable membrane.

REPRESENTATIVE SPECIMENS: NORTH CAROLINA: Robeson Co., 1.7 mi. n. of Lumberton, *Ahles 23716* (DUKE, NCU); Wilson Co., 1.4 mi. sw. of Black Creek, *Radford 35719* (DUKE, NCU). SOUTH CAROLINA: Hampton Co., 3.1 mi. nw. of Yemassee, *Ahles 12432* (DUKE, UNC); Horry Co., 2 mi. s. of Myrtle Beach, *Weatherby & Griscom 16585* (GH, NY). GEORGIA: Screven Co., about 1 mi. n. of Sylvania, *Harper 2081* (GH, MO, NY, US); Sumter Co., 1.5 mi. se. of Flintside, *Moore & Lawrence 671* (GA, SMU, UC). FLORIDA: Alachua Co., *Curtiss 225* (CU, F, KANU, NY, PH, UARK, US); Clay Co., Hibernia, March 1869, *Canby*

(F, MO, NY, PH, US); Duval Co., near Jacksonville, *Curtiss 5830* (FLAS, GH, ILL, ISC, MIN, NCU, NY, SMU, UC, US). ALABAMA: Covington Co., 13 mi. sw. of Andalusia, *Duncan & Hardin 14970* (GA); Mobile Co.: Mobile, *Benke 3370* (F). MISSISSIPPI: Harrison Co., Biloxi, *Tracy 5142* (IND, MIN, MSC, NY, OS); Wayne Co., 5 mi. s. of Buskatunna, *Shinners 27096* (SMU). ARKANSAS: Hot Springs Co., near Malvern, *Palmer 29689* (MO, UARK); Ouachita Co., Camden, *Demaree 16783* (SMU). LOUISIANA: Natchitoches Par., Natchitoches, *Palmer 7703* (NY, MO, US); Rapides Par., vicinity of Alexandria, *Ball 614* (GH, MO, NY, US); Vernon Par., 1 mi. s. of Mayo, *McVaugh & Harvill 8474* (GH, MICH). TEXAS: Harris Co., near Lindale n. of Houston, *Tharp & Barkley 171006* (COLO, CU, DUKE, FLAS, GH, ILL, ISC, MIN, OKL, PENN, TEX, US); Jasper Co., 3 mi. ne. of Evadale, *Cory 52727* (GH, SMU).

2. Helianthemum dumosum (Bickn.) Fern.

Crocanthemum dumosum Bickn., Bull. Torrey Club. **40:** 613. 1913. Type: *Bicknell,* 21 Sept. 1899 (NY!). Nantucket Island, Massachusetts.

Helianthemum dumosum (Bickn.) Fern., Rhodora **19:** 60. 1917.

Cespitose, perennial herb, (5)10-20(30) cm. tall, arising from a multicipital caudex. STEMS numerous, forming loosely ascending to depressed mounds, the pubescence pale and stellate, sometimes intermixed with minute, red, glandular hairs; unbranched at first flowering but soon becoming much branched with stiffly divergent to ascending branches. CAULINE LEAVES: petiole 1-2 mm. long; blade (7)12-17(26) mm. long, (2)3-5(10) mm. wide, elliptic to rarely oblanceolate; the blade's upper surface yellowish-green and densely stellate-pubescent but also sparsely intermixed (especially when young) with simple pilose hairs (0.5-1.0 mm. long) and occasionally with minute, red, glandular hairs; lower surface hoary stellate-tomentose; midvein and secondary veins prominent beneath; base of blade cuneate, apex acute; margin entire, mostly non-revolute. FLOWERS: dimorphic (chasmogamous and cleistogamous); maturing at different times during the growing season and at different positions on the plant. At first anthesis with terminal or subterminal, solitary (but sometimes at first appearing paired) chasmogamous flowers (but subsequent development leaving it in the angle of the bifurcated stem, or in the axil of the branch when one of the two branches fails to develop); mostly succeeded by few chasmogamous flowers intermediate in size of calyx and number of stamens between the early ones and the late cleistogamous flowers. Pedicel and calyx of the chasmogamous flowers stellate-pubescent intermixed with apparently simple, pilose trichomes (1.0-1.5 mm. long) and with minute, red glandular hairs. Cleistogamous flowers solitary (rarely two) at tips and forks of the leafy branchlets. Pedicels and calyces of cleistogamous flowers covered with stellate pubescence and simple pilose hairs (c. 1 mm. long) intermixed with red, glandular hairs.

CHASMOGAMOUS FLOWERS: pedicels 2.4-6.0 mm. long, mostly shorter than the calyx. OUTER SEPALS (free portion) 2-6 mm. long, 0.8-3.0 mm. wide, lanceolate to narrowly triangular, acuminate to acute, varying in extent of fusion with the edge of inner sepals from near the base to the middle of the inner sepals; INNER SEPALS 7-10 mm. long, 4.0-6.5 mm. wide, ovate, acute to acuminate. PETALS 5-15 mm. long, 3.6-13.0 mm. wide, yellow, obovate. STAMENS 12-36. PISTIL 2.4-3.5 mm. long; ovary 1.8-2.4 mm. long, 1.4-1.8 mm. in diameter, ovoid, glabrous; style 0.6-1.0 mm. long; stigma 1.2-2.0 mm. wide, capitate. FRUITING PEDICELS 3-9 mm. long. FRUITING CALYX 7-11 mm. long, 3.5-6.0 mm. in diameter, ovoid. OUTER SEPALS (free portion) 2.4-7.2 mm. long, 0.8-3.0 mm. wide; INNER SEPALS 7-11 mm. long, 4.0-6.5 mm. wide. CAPSULE 4-7 mm. long, 2.5-4.0 mm. in diameter, ovoid, glabrous, 3-valved, each 2.2-3.8 mm. wide, ovate, acute. SEEDS 16-53, ovoid to inequilateral, dark brown, papillate, without separable membrane.

CLEISTOGAMOUS FLOWERS: very few on the plant and formed late in the growing season, solitary (or rarely two), subsessile. FRUITING PEDICEL 1-3 mm. long. OUTER SEPALS (free portion) 0.4-1.2 mm. long, 0.3-0.6 mm. wide, rudimentary and knob-like to triangular and acute; INNER SEPALS 3-6 mm. long, 2.4-3.2 mm. wide, ovate, acute. STAMENS 5(8). CAPSULE 3.2-4.5 mm. long, 2.4-3.2 mm. in diameter, ovoid-triquetrous, glabrous, 3-valved; each valve 2.4-3.2 mm. wide, ovate-elliptic, acute. SEEDS 8-14, similar to the seeds of the chasmogamous flowers.

FLOWERING: chasmogamous flowers late May-June, cleistogamous flowers July-September. HABITAT: dry sandy barrens and open woods. DISTRIBUTION: eastern Massachusetts southward to Long Island, New York. (Map 9).

Helianthemum dumosum is very limited in distribution and consequently relatively little collected. It is apparently closely related to *H. canadense* and is often confused with it. The similarity and the differences between the two species are presented in the discussion of *H. canadense.* In addition, *H. dumosum* has leaves often smaller and more crowded on the divergent to ascending branches and branchlets and its chasmogamous outer sepals are relatively broader. According to Bicknell (Bull. Torrey Club **40**: 614. 1913.), it blooms earlier than *H. canadense* when both are growing in the same locality.

Usually, *H. dumosum* may be clearly distinguished by the above mentioned characters and those indicated under *H. canadense.* However, it is sometimes difficult to refer a specimen to one species or the other, especially if it was collected in the middle of the growing season when *H. dumosum* becomes somewhat more erect and approaches *H. canadense* in habit. A few perplexing specimens have been collected on Long Island. The temptation to treat *H. dumosum* as a subspecific variant of *H. canadense* was deemed unwarranted largely because the two when growing together, as they often do within the limited range of *H. dumosum*, maintain their distinguishing features, which implies some sort of effective isolating mechanism. Bicknell (Bull. Torrey Club **40**: 614. 1913.) in his original description of this species concluded that "*C. dumosum* is evidently a strongly established derivative of *C. canadense* even if it be not yet wholly disconnected from that species."

REPRESENTATIVE SPECIMENS: MASSACHUSETTS: Barnstable Co.: Harwich, *Fernald 383* (DS, DUKE, F, GA, IA, IND, ISC, KANS, MICH, MIN, MO, NCSC, NO, NY, OKL, PENN, PH, SMU, TENN, TEX, UARK, UC, UMO, US, WIS, WVA); Bristol Co.: Nonquitt, 6 June 1889, *Sturtevant* (MIN); Dukes Co.: near Terry's Pond, West Tisbury, *Seymour 1278* (DUKE, GH, NY, US); e. end of Island, Nashawena, *Fogg 3557* (MIN, PENN); Middlesex Co.: southerly slopes of Arlington Heights, *Fernald, Long & St. John 9945* (PH); Nantucket Co.: Nantucket Island, *Bicknell 5893* (NY, PH); Plymouth Co.: e. of Plymouth, Cape Cod, *Schuster A-3964* (DUKE). RHODE ISLAND: Newport Co.: Grace Point, Block Island, *Fernald, Long & Torrey 9941* (GH, ILL, PH). CONNECTICUT: New London Co.: Groton, 14 July 1929, *Janssan* (ISC). NEW YORK: Suffolk Co.: Montauk, Long Island, *Ferguson 1* (NY); Nassau Co.: Hempstead Plains, Long Island, 30 May 1906, *Bicknell* (GH, NY).

(TO BE CONTINUED)

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TAXONOMY OF HAPLOPAPPUS, SECTION ISOPAPPUS (COMPOSITAE)[1, 2]

EDWIN B. SMITH

Haplopappus divaricatus (Nutt.) Gray is a wide-ranging, herbaceous annual which is found in sandy soil throughout most of the Coastal Plain of the southern and southeastern United States. Because of differing chromosome numbers reported for *H. divaricatus* ($n = 4$, Turner & Ellison, 1960, as *Croptilon divaricatum* Raf.; $n = 5$, Jackson, 1959), a study of the taxon was undertaken in 1961. An aneuploid chromosome series was discovered in which the different chromosome numbers were found in morphologically recognizable entities (Smith, 1964). These are designated *Haplopappus divaricatus* ($n = 4$), *H. rigidifolius* ($n = 5$), *H. validus* subsp. *validus* ($n = 5$), *H. validus* subsp. *torreyi* ($n = 6$), and *H. validus* subsp. *graniticus* ($n = 7$). Formal taxonomic recognition of the new taxon and new combinations is given in a later section. A metaphase I configuration of *H. rigidifolius* is shown in Fig. 1. Configurations of the other taxa at M_1 have been presented earlier (Smith, 1964).

Haplopappus divaricatus and relatives have been recog-

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[2]I am indebted to Dr. R. L. McGregor and Dr. R. C. Jackson (U. of Kansas, Lawrence, Kansas) for their generous assistance in this study and their valuable suggestions concerning the manuscript. I thank Dr. B. L. Turner (U. of Texas, Austin, Texas) for critical review of the preliminary manuscript.

Figure 1. Meiotic metaphase I of *Haplopappus rigidifolius*. The vertical reference line = about 4 microns. Inked-in tracing from a photograph.

nized in several different genera, including *Inula*, *Chrysopsis*, *Croptilon*, *Diplopappus*, *Isopappus*, and *Aster*, as indicated in the synoymy given later. Recently, however, this group has been treated as either section *Isopappus* of *Haplopappus* (Hall, 1928) or as the separate genus *Croptilon* (Shinners, 1951). Hall's treatment included *H. divaricatus* (Nutt.) Gray and *H. occidentalis* Hall. The latter has since been recognized as *Benitoa occidentalis* (Hall) Keck (Keck, 1956). Blake (1932) referred a new species from Mexico, *Haplopappus bartlettii* (as "*Aplopappus*"), to section *Isopappus* but this entity was later transferred to *Heterotheca* by Johnston (1957). I have examined the holotype of *H. bartlettii (Bartlett 10046*, MICH), plus a second specimen (*Muller 2854*, MICH), and found that the entity differs in numerous details from other section *Isopappus* taxa. Its general appearance is characteristic *Heterotheca* and I would concur with Johnston's placement of it there, at least until considerably more information (biosystematic, cytogenetic) on it becomes available.

Shinners' treatment included the single species *Croptilon divaricatum* (Nutt.) Raf., with varieties *divaricatum*, *hirtellum* (Shinners) Shinners, and *hookerianum* (T. & G.) Shinners.

Although my own work has been at the specific and infraspecific level, I see no reason to treat the section as a separate genus and, for the present at least, I prefer to follow Hall (1928) in this regard.

METHODS AND MATERIALS

Field studies were made throughout the range of *Haplopappus divaricatus*, including Kansas, Oklahoma, Arkansas, Texas, Lousiana, Mississippi, Alabama, Florida, Georgia, South Carolina, and North Carolina. Live transplants and seeds were collected for hybridization studies, buds were fixed in a modified Carnoy's solution (95% ethanol, chloroform, propionic acid; 2:1:1) for cytological analysis, and herbarium specimens were taken for later examination and measurement. Meiotic chromosome counts were made from anther squashes in propio-carmine. Mitotic counts were made from root tip squashes in aceto-orceine, following a 3-5 minute hydrolysis in 15% HCl.

Hybridizations between pairs of the taxa were attempted in all combinations. The technique used in the crosses was the same as described by Jackson (1962), except the crossing of two particular heads was made only once and many different heads were used. All taxa in the section are self-incompatible.

The F_1, F_2, and backcross progeny were grown in the greenhouse. Pollen stainability of each plant was sampled by staining 20-30 minutes in Aniline Blue (0.1%) in lactophenol and counting a minimum of 300 grains per sample. Those grains staining deep blue were counted as stainable; grains not evenly stained were counted as non-stainable. Later, an apparently equally accurate and much more rapid stain was used: Aniline Blue (water soluble, c. 0.2%) in 90% propionic acid (propionic acid: water, 9:1). With this stain, counting can begin within 60 seconds after preparation of the slide.

RESULTS

Table 1 contains a synopsis of the major quantitative characters by which the taxa differ. Formal and more complete descriptions of the taxa are given in a later section. Table 2 shows chromosome counts from field collections of the different taxa made during 1962-64. Voucher specimens for at least one count of each taxon are in the University of Kansas Herbarium. Generally 1-2 (-14) counts were

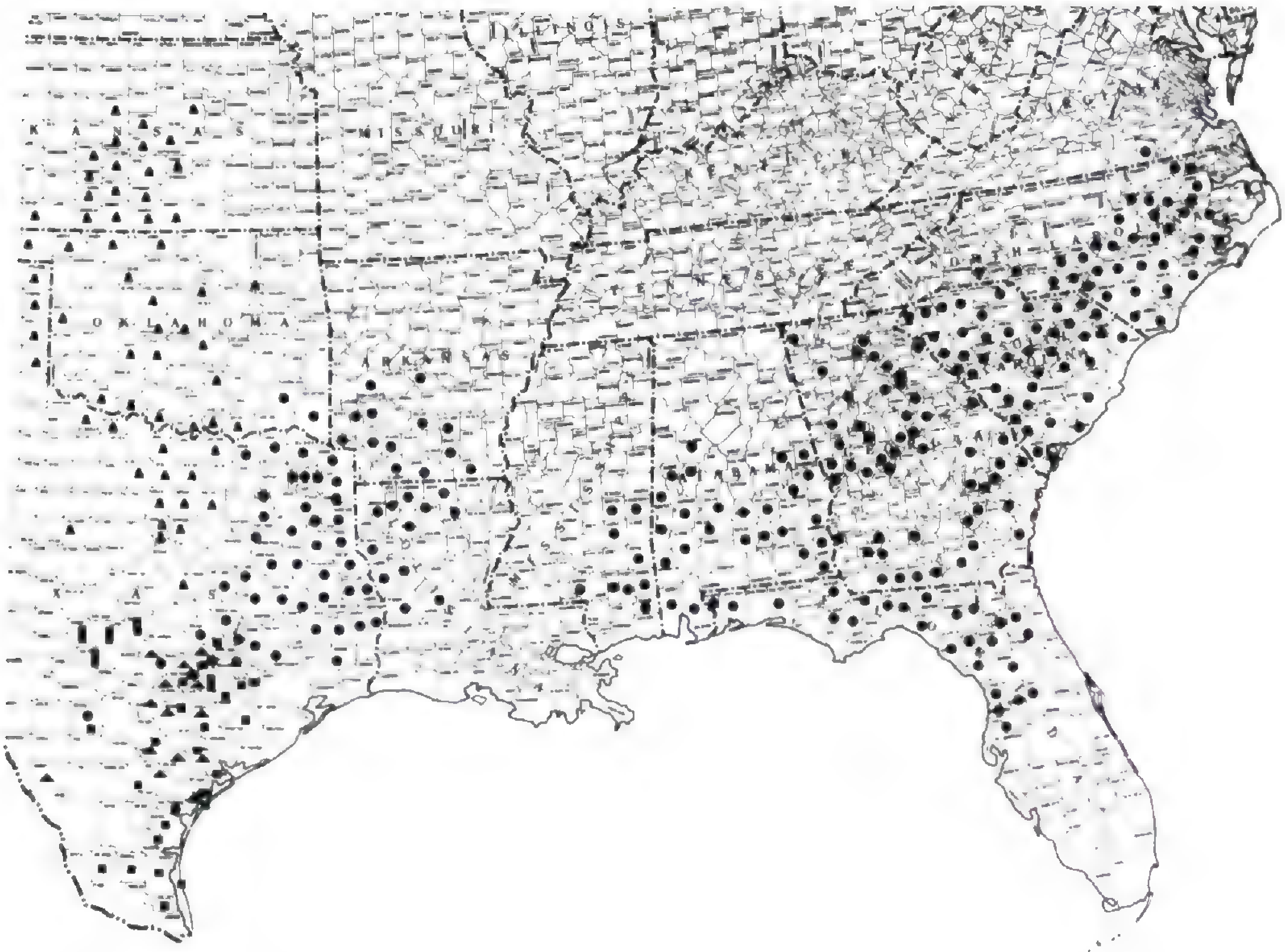

Figure 2. Known distribution by county of the taxa in section *Isopappus*. Circles = *Haplopappus divaricatus* ($n = 4$); squares = *H. rigidifolius* ($n = 5$); parabolas = *H. validus* subsp. *validus* ($n = 5$); triangles = *H. validus* subsp. *torreyi* (n = 6); rectagles = *H. validus* subsp. *graniticus* ($n = 7$).

made per population. Additional counts from first and second generation plants grown in the greenhouse from random seed collections of wild populations would make the total number of counts about double the number shown in Table 2.

The count under subsp. *graniticus* marked with an asterisk is the only evidence of euploidy found in the field in the section. A single plant of this makeup was found in 1962 and previously reported as "morphologically $n = 7$ with anomalous pairing" (Smith, 1964). Reexamination of permanent slides of meiotic material from the plant show it is a simple triploid.

Supernumerary chrosomes occur in a low frequency in subspecies of *Haplopappus validus*. Their absence in *H. rigidifolius* (Table 2) may be due to insufficient sampling, while in *H. divaricatus* they appear to be absent or rare. The supernumerary chromosomes are small and near-metacentric, presumably consisting only of a centromere and adjacent chromatin.

Figure 2 is a distribution map by county of the five taxa. Most of these locations were visited by the author. However, numerous locations were obtained from specimens from various herbaria, particularly the excellent collection of the University of North Carolina.

Table 1. Synopsis of key quantitative characters of taxa in the section *Isopappus*. The first number is the range, the second *(underlined)* is the arithmetic mean, the third is the standard deviation. Based on measurements from 25-40 individuals of each taxon. *divar.* = *H. divaricatus; rigid.* = *H. rigidifolius; validus* = *H. validus* subsp. *validus; torreyi* = *H. validus* subsp. *torreyi; granit.* = *H. validus* subsp. *graniticus.*

Character	*divar.*	*rigid.*	*validus*	*torreyi*	*granit.*
Hgt. to 1st head (cm)	30-97 *59.7* 18.8	6-97 *51.8* 22.8	20-81 *49.7* 14.3	19-88 *46.7* 13.3	16-51.5 *31.8* 8.8
Number of ray flowers	5-11 *8.1* 1.4	5-22 *14.6* 4.8	13-29 *19.7* 1.0	10-17 *14.4* 1.8	10-21 *16.6* 3.2
Number of disc flowers	9-26 *15.8* 3.9	6-60 *28.2* 15.7	33-108 *59.2* 15.9	23-51 *38.2* 7.2	20-79 *45.9* 16.9
Ligule length (mm)	3.9-6.0 *5.29* 0.59	4.0-7.4 *5.31* 0.90	6.0-12.0 *9.16* 1.42	5.7-11.0 *8.30* 1.28	6.3-14.0 *9.96* 2.04
Ligule width (mm)	1.9-3.2 *2.39* 0.34	1.7-2.6 *2.28* 0.28	1.8-3.1 *2.48* 0.31	2.4-3.3 *2.87* 0.25	2.7-5.0 *3.86* 0.58
Involucre height (mm)	5.0-7.0 *6 08* 0.53	4.5-8.0 *6.04* 0.99	5.5-8.0 *7.01* 0.59	5.0-9.5 *7.23* 0.84	5.5-10.0 *7.76* 1.28
Receptacle diameter (mm)	2 5-4.0 *3.01* 0.39	1.8-5.0 *3.54* 0.95	4.0-7.0 *5.35* 0.72	3.5-6.0 *4.83* 0.40	3.9-6.0 *4.89* 0.69

Table 2. Chromosome counts made from field collections of the different taxa during 1962-64. Designations for the taxa follow the scheme of Table 1. su = supernumerary univalent; sp = supernumerary pair; III = trivalent, II = bivalent, I = univalent.

Taxon	No. locations sampled	No. plants counted	Chromosome number
divar.	30	36	$n = 4$
rigid.	5	9	$n = 5$
validus	41	127	$n = 5$
	2	2	$n = 5$ + sp; $2n = 12$
	1	1	$2n = 11$
torreyi	18	35	$n = 6$
	1	1	$n = 6$ + su; $2n = 13$
granit.	16	69	$n = 7$
	2	3	$n = 7$ +su; $2n = 15$
	1	1	$n = 7$ + sp; $2n = 16$
	*1	1	$2n = 21$; 3III, 5II, 2I, etc.

The results of attempted hybridization between pairs of the taxa are shown in Figure 3. F_1 hybrids were generally vigorous and intermediate in most characters. They flowered somewhat later than the average time of the parental taxa. Minor aberrations, such as chlorotic spotting and striping, fused leaves, and abortion of the first few heads occurred at a low frequency in the F_1 hybrids. One voucher specimen of each successful F_1 hybrid conbination (Fig. 3) is in the University of Kansas Herbarium.

Only a few F_2 plants were produced from most of the different F_1's, despite numerous crosses. Table 3 gives the results of pollen stainability tests of the F_2. Essentially all crosses involving *Haplapappus rigidifolius* failed completely

Table 3. Pollen stainability of F_2 progeny. Designations for taxa follow the scheme of Table 1.

F_2	No. plants	Pollen stainability (%)	
		Range	Average
divar. × *validus*	20	11.9-99.3	69.3
divar. × *torreyi*	15	5.3-92.2	33.6
divar. × *granit.*	1	—	95.6
validus × *granit.*	6	39.3-70.3	54.6
torreyi × *validus*	3	42.4-63.7	53.0
torreyi × *granit.*	29	32.7-99.7	76.4

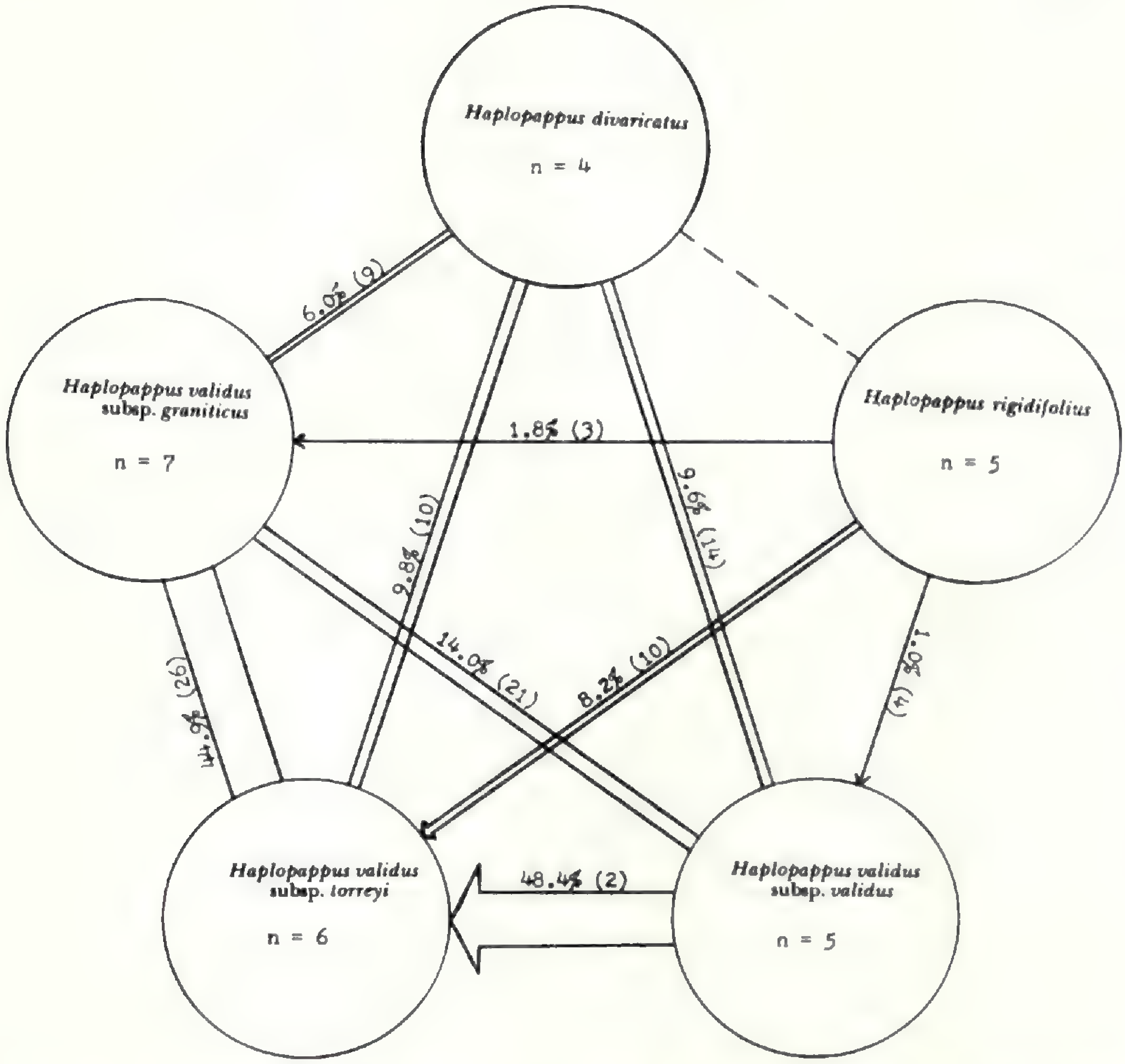

Figure 3. Crossing polygon, showing avenues for gene exchange among taxa in the section *Isopappus*, based on average pollen stainability of F_1 hybrids. The width of the avenues connecting the taxa is proportional to the average pollen stainability of the F_1 hybrids. Average pollen stainability is given, with the number of individuals tested following in parentheses. Arrows on the avenues point toward the pistillate parent in crosses in which successful F_1's were obtained in one direction only. F_1 seed was obtained in the cross subsp. *validus* (pistillate) × subsp. *torreyi* (staminate), but all resultant progeny died in the seedling stage. The dotted line indicates that the attempted hybridization failed in both directions.

in the F_2. One cross, *H. validus* subsp. *torreyi* × *H. rigidifolius*, is represented in the F_2 by a mere two seedlings presently growing in the greenhouse.

A small number of backcross progeny were obtained. However, since the number of these was low and their average pollen stainability did not differ significantly from that of the F_2, they are not included in Table 3.

Benitoa occidentalis would not hybridize with either *H. validus* subsp. *validus* or subsp. *graniticus*. This evidence while negative, lends genetic support to Keck's (1956) recognition on morphological grounds of *H. occidentalis* as the monotypic genus *Benitoa*.

DISCUSSION

The synopsis of quantitative characters separating the taxa in section *Isopappus* (Table 1) shows that there is considerable overlap for these characters. It is pertinent here to point out that, for the most part, plants from which the measurements were taken were selected to show the range of morphological variation found in the field and that the characters listed in Table 1 are influenced more or less strongly by environmental conditions. Available moisture influences the number of disc and ray flowers and thus head size, the width of the leaves, the amount of serration of the leaves, and the height of the plant. Thus, under drought conditions, the plants tend to be shorter, with fewer ray and disc flowers (hence, smaller heads), and narrower leaves which tend toward entire margins or serrulation apically. A similar effect is seen in late season forms with regard to head size. Collections of *H. validus* subsp. *validus* made after about mid-September and of *H. rigidifolius* after about mid-November tend to have much smaller heads (with reduced numbers of disc and ray flowers). Nevertheless, if collections are made during normal peak blooming period from populations under more or less normal environmental conditions, the overlap is relatively small. The quantitative characters (Table 1) combined with the qualitative characters of peduncular pubescence are generally sufficient to distinguish the taxa with ease.

Haplopappus rigidifolius is sharply delimited from the other taxa in the section by its lack of glandular stipitate pubescence on the peduncles. *H. divaricatus* is likewise easily distinguished in the vast majority of cases from *H.*

validus by its small heads. It is only in *H. validus* that the overlap becomes a problem, and that is precisely one of the reasons for placement of the entities *validus, torreyi,* and *graniticus* at the subspecific level. These three entities overlap in morphology but have different means, are separated at least partially by sterility barriers, and are mostly allopatric in their distributions (Fig. 2). Where they overlap geographically, or closely aproach one another, there is evidence of a low frequency of hybridization (at least between *validus* and *torreyi*).

The distributions of the taxa overlap somewhat in southern Texas (Fig. 2). This sympatry, however, is more apparent than real. All of the taxa generally occur in small, localized populations, covering several square acres to several square miles. Their distribution is generally not continuous. Thus, although the distribution of *Haplopappus divaricatus, H. validus* subsp. *torreyi,* and *H. rigidifolius* appears to be sympatric in Bastrop and Lee counties, Texas (Fig. 2), they are allopatric for the most part. In Lee County, *divaricatus* and *rigidifolius are* sympatric at Tanglewood, but subsp. *torreyi* was found about 7, 17, and 23 miles south of Tanglewood, with the areas between apparently devoid of the three taxa. *H. divaricatus* was found again about 4 miles southeast of the extreme southern population of subsp. *torreyi* in the county.

A similar situation prevailed in Bastrop County, where *divaricatus* was found about 10 miles northeast of Bastrop, subsp. *torreyi* about 2 miles southeast and *rigidifolius* about 5 miles southeast of Bastrop. While sympatry of two or more of the taxa appears to be indicated in 10 counties in Texas (Fig. 2), it was actually observed in only a few cases, and in these cases the sympatry involved only *H. rigidifolius* and either *H. divaricatus* or *H. validus* subsp. *torreyi.*

Where two or more taxa were found to be sympatric, such as at Tanglewood, Texas *(H. divaricatus & H. rigidifolius)* and at Palmetto State Park in Gonzales County, Texas *(H. rigidifolius & H. validus* subsp. *torreyi),* an attempt was made to locate hybrids between the taxa, but none were found. However, there is an area in northern Texas, discussed later, in which it appears likely that subspecies *validus* and *torreyi* have hybridized.

Artificial hybridizations between the taxa were successful in 9 of the 10 possible combinations. Reciprocal crosses were lumped and considered the same when it became apparent that no significant differences in morphology or sterility could be detected between them. This was true of all crosses except those involving *Haplopappus rigidifolius* as the pistillate parent and in *H. validus* subsp. *validus* (pistillate) × subsp. *torreyi* (staminate) (see Fig. 3). Probably the failure of the F_1 seedlings of the *validus* × *torreyi* cross and the few successful hybrids obtained in the reciprocal cross *(torreyi × validus)* was due to minor genetic differences accidentally introduced in the small size of the breeding stock used. Failure of crosses using *H. rigidifolius* as the pistillate parent, however, was consistent and presumably reflects a reciprocal difference, perhaps cytoplasmic in action. The relatively small number of hybridizations attempted (total of c. 40 heads crossed in each case) and the high sterility barrier, resulting in very few F_1's in the crosses that succeeded, do not allow any definite conclusions to be made.

Assuming that pollen stainability can be taken as an index of fertility, there is no great sterility barrier among the subspecies of *Haplopappus validus* (Fig. 3). While subsp. *graniticus* and *validus* would appear to be able to exchange genes directly only with difficulty, there is an avenue for gene exchange through the intermediate subsp. *torreyi*, at least in the direction of *validus* to *graniticus*. These three taxa hence form a natural group.

The remaining two taxa, *Haplopappus rigidifolius* and *H. divaricatus*, are strongly isolated from the *H. validus* group, *rigidifolius* being more strongly isolated than *divaricatus*. Also, the isolation of these two taxa is phyletically in differing directions. The only hybridization of the 10 possible combinations among the taxa which failed was that between *rigidifolius* and *divaricatus*. It should be emphasized that *H. rigidifolius* × *H. divaricatus* (and a few reciprocal) pollinations were performed many times in 1962, 1963, and 1964. The few achenes that did develop produced $2n = 10$ seedlings without exception. Whether these resulted from parthenogenesis or self-fertilization of *H. rigidifolius* is not known, but the latter is presumably the cause. "Selfing" is known in other self-incompatible *Haplopappus* taxa when stimulated by pollen from a related entity (Jackson, 1962).

Haplopappus rigidifolius is essentially totally isolated from all other members of the section, and is morphologically and cytologically the most distinct member of the section. It is not surprising that *rigidifolius* can occur sympatrically with *H. divaricatus* and *H. validus* subsp. *torreyi* with few or no hybridizations occurring.

In comparing the average pollen stainability of the F_2 hybrid combinations (Table 3) with the F_1 (Fig. 3), it can be seen that the average pollen stainability increases in the F_2. Indeed, a few F_2 plants in each category have regained nearly complete fertility. Most of these were, as far as chromosome number is concerned, reconstituted parental types. It is apparent that a minor amount of gene flow between all the taxa, including *Haplopappus rigidifolius,* is possible. But when one considers that (a) the taxa are mostly allopatric, (b) the reproductive effectiveness of the F_1 hybrids is rather sharply reduced (based on the low pollen stainability of the F_1 and the low number of F_2 obtained), and (c) the average fertility of the F_2 is considerably below normal, it would appear that the amount of such gene flow is, at most, minor. It would seem quite likely that competition from normal individuals in the population would preclude the survival of most of the progeny resulting from the occasional hybridizations that might occur. The *H. validus* group may be exceptional in this respect.

In the field, hybrids would be much more likely to backcross with one of the parents than cross with each other to produce an F_2. However, the few backcross progeny obtained indicate that average fertility in backcrosses would also be rather low.

There appear to be three natural groups among the taxa of section *Isopappus: H. validus, H. divaricatus,* and *H. rigidifolius.* Based on morphological differences, the geographical distributions, chromosome number differences, difficulty in obtaining F_1 and F_2 hybrids, and high sterility in the F_1 and F_2, appropriate names are formally proposed for the taxa.

SECTIONAL DESCRIPTION OF ISOPAPPUS

Mostly erect annual to weak perennial herbs, with alternate, spatulate, lanceolate, oblanceolate, to linear leaves, height to first head mostly about 25-65 cm. Leaves setose-ciliate basally and glandular stipitate on the margins up to about 1/3-1/2 their length, or, in one species *(rigidifolius)*, not glandular stipitate but ciliate nearly over entire margin and more or less on the flat of the blade. Margins of median leaves irregularly serrate or serruate apically, or as much as the upper 1/3-3/5 serrate, rarely entire (but commonly entire in *rigidifolius*). Stems striate, more or less glabrate basally. Peduncles with hispid or glandular stipitate, or both hispid and glandular stipitate pubescence; in one taxon *(rigidifolius)* sometimes with hirtellous, a low crisp-hairy pubescence, or even glabrous. Inflorescence a panicle, with heads of bright yellow or orangish-yellow flowers. Heads with fertile disc and ray flowers. Receptacle 1.8-7.0 mm. wide. Involucres turbinate or, infrequently, hemispherical or cylindric-turbinate. Phyllaries several-many, imbricated in several (c. 3) series, linear-attenuate to lanceolate, greenish, with scarious margins, strongly reflexed in age, with short glandular stipitate, hirtellous, glandular, or hispid and glandular stipitate pubescence on the back. Ray flowers 5-29, pistillate, with conspicuous ligules (ligules 3.9-14.0 mm long, 1.7-5.0 mm wide). Disc flowers 6-108, perfect, the corolla gradually enlarged above the tube. Achenes subulate, about 2.0-3.2 mm long, serecious-canescent, stramineous to brown or reddish-brown. Pappus a single series of equal (or nearly equal) capillary bristles, more or less ferruginous.

In the following key, and the descriptions which follow it, peduncle pubescence is based on the first 2.5 cm below the heads. Hispid pubescence at the base of bracts should be ignored. Floral measurements are based on fresh heads and on boiled heads from herbarium specimens.

KEY TO TAXA IN HAPLOPAPPUS, SECTION ISOPAPPUS

A. Peduncles hirtellous to hispid, with or without a lower, crisp-hairy pubescence intermixed, rarely glabrous, sometimes slightly glutinous; plants leafy to summit, decumbent to erect; cauline leaves spatulate to lanceolate, entire (sometimes serrulate apically) .... 1. *H. rigidifolius.*

A. Peduncles obviously or densely glandular-stipitate pubescent, with or without hispid pubescence; plants not leafy to summit (leaves decreasing in size up the stem to small bracts above), erect; cauline leaves lanceolate to linear, serrate to serrulate apically (rarely entire) .... B.

B. Number of ray flowers 6-9 (5-11); receptacle diameter about 3.0 mm (2.5-4.0) .... 2. *H. divaricatus.*

B. Number of ray flowers 13-21 (10-29); receptacle diameter 4.7-5.4 mm (3.5-7.0) .... C.

C. Peduncles with long-stiped, glandular-stipitate pubescence (longest hairs c. 0.4-0.5 mm, including gland), often slightly hispid just below the heads; ligule width 2.0-2.8 mm (1.8-3.1); taxon of northern Texas and northward to central Kansas .... 3a. *H. validus* subsp. *validus.*

C. Peduncles with short-stiped, glandular-stipitate pubescence (longest hairs c. 0.2-0.3 mm, including gland), never hispid; ligule width 2.6-4.2 mm (2.4-5.0); taxa of central and southern Texas .... D.

D. Ligule width 2.6-3.2 mm (2.4-3.3); occurs on sand and gravel of Coastal Plain from near Austin south to near the Gulf Coast (one exceptional population occurs near Carrizo Springs in Dimmit Co.) ...... 3b. *H. validus* subsp. *torreyi.*

D. Ligule width 3.2-4.2 mm (2.7-5.0); occurs exclusively in granite outcrop areas in and near the Central Mineral Region of Texas, rooted in cracks in the granite and in shallow sand deposits on the granite (one exceptional population occurs in coarse sand from c. 4-9 mi. se. of La Grange in Fayette Co.) .. 3c. *H. validus* subsp. *graniticus.*

1. **Haplopappus rigidifolius** Smith spec. *nov.*

Isopappus divaricatus (Nutt.) T.&G. var. *hirtellus* Shinners, Field & Lab. 18:157. 1950. (T: 10 mi. s. of Falfurrias, Brooks Co., Texas, *C. L. & A. A. Lundell 10813*, SMU!)

Croptilon divaricatum (Nutt.) Raf. var. *hirtellum* (Shinners) Shinners, Field & Lab. 19:134. 1951.

Annual to weak perennial herb, decumbent to sprawling, or erect; stem highly variable in length, striate, strongly branched, with the basal branches often equalling or even exceeding the main axis in diameter; leaves rather rigid (hence: *rigidifolius*), alternate, spatulate to lanceolate, entire (occasionally serrulate apically), ciliate nearly over entire margin and often on the flat surface of the blade, about 2.5-4.5 (2.0-5.8) cm long and 0.2-0.5 (0.2-0.8) cm wide; peduncles hirtellous to hispid, often with a lower crisp-hairy pubescence intermixed, sometimes slightly glutinous, rarely glabrous; heads several in a somewhat closed or compact panicle; receptacle diameter 2.9-4.0 (1.8-5.0) mm; phyllaries narrowly lanceolate, acuminate, c. 4.5-7.0 mm long and 1.0-1.6 mm wide; rays 9-21 (5-22); ligules 4.5-6.3 (4.0-7.4) mm long and 2.0-2.5 (1.7-2.6) mm wide; disc corollas 25-45 (6-60); achenes subulate, serecious-canescent, 2.0-2.4 mm long, stramineous to pale reddish-brown, sometimes mottled. Chromosome number $n = 5$.

Blooms September-November and later. Distinguished easily from other taxa in the section by its lack of glandular stipitate pubescence on the peduncles. Known from 23 counties in southern Texas (Fig. 2).

A new epithet is required for this species under *Haplopappus*, since the name *H. hirtellus* had previously been used for a species from Chile (Hall, 1928).

Haplopappus rigidifolius is highly variable, especially with regard to number of disc and ray flowers, as well as general size. Collections range from strictly decumbent, weak perennials with stems less than 10 cm long and small heads (Aransas and Victoria counties, Texas) to erect annuals with stems as much as 70 cm or more long and large heads (Live Oak and Refugio counties, Texas). There is some correlation of the above characteristics with distance from the ocean, but the variation is not strictly clinal. The coastal, decumbent population might be considered a seacoast ecotype, as in *Succisa pratensis, Matricaria inodora* (Stebbins, 1950), *Clarkia prostrata*, or *C. davyi* (Lewis & Lewis, 1955). Taxonomic recognition of the variation does not, however, appear justifiable, since there is considerable intergradation and, even in the same population, some heterogeneity for the characters mentioned.

Representative Specimens: TEXAS: ARANSAS Co., Goose Island State Park, *Smith 91*, KANU, *Johnston 53.280.174*, TEX; AUSTIN Co., 4.8 mi. s. of Kenney, *Smith 259*, KANU; BASTROP Co., 5.1 mi. se. of Bastrop, *Smith 553*, KANU; BEE Co., c. 21.2 mi. w. of junction of 202 & US 183, *Smith 635*, KANU, SMU, GA, FSU, & NCU; BURLESON Co., 1.1 mi. s. of Somerville, *Smith 260*, KANU; COLORADO Co., 3 mi. s. of junction of 71 & US 90A, *Smith 257*, KANU; GONZALES Co., near Palmetto State Park, *Smith 243*, KANU; KARNES Co., 2.5 mi. ne. of Kenedy, *Johnson 1354*, SMU, TEX; KENEDY Co., 0.5 mi. n. of Sarita, *Smith 92*, KANU, 5 mi. n. of Armstrong, *Turner 4474*, TEX; KLEBERG Co., King Ranch, *Johnston 54416*, TEX; LAVACA Co., 13 mi. n. of Hallettsville, *Shinners*

28701, SMU; LEE Co., at Tanglewood, *Smith 236*, KANU; MEDINA Co., near Devine, *Barkley 13947*, FSU, TEX; NUECES Co., 1 mi. s. of Flour Bluff, *Jones 745*, SMU; REFUGIO Co., c. 4 mi. w. of junction of 202 & US 183, *Smith 638*, KANU & TEX; VICTORIA Co., 2.0 mi. sw. of Inez, *Smith 252*, KANU, 8.3 mi. sw. of Victoria, *Shinners 25235*, SMU; WHARTON Co., 3.7 mi. s. of Nada, *Smith 256*, KANU; WILLACY Co., 4 mi. w. of Redfish Bay, *Johnston 54179*, TEX. Also known to occur on Padre Island.

2. **Haplopappus (Isopappus) divaricatus** (Nutt.) Gray, Explor. Railroad Route Miss. River to Pacific 4:99. 1856. (as "*Aplopappus*").

Inula divaricata Nuttall, Gen. 2:152. 1818. (T: vicinity of Savannah in Georgia, perhaps PH)

Chrysopsis divaricata (Nutt.) Elliot, Bot. Sketch 2:338. 1824.

Croptilon divaricatum (Nutt.) Raf., Fl. Tellur. 2:47. 1836.

Diplopappus divaricatus (Nutt.) Hook., Comp. Bot. Mag. 1:97. 1836.

Isopappus divaricatus (Nutt.) T. & G., Fl. N. A. 2:239. 1842.

Aster divaricatus (Nutt.) Kuntze, Rev. Gen. 1:318. 1891.

Annual herb, erect, virgate before fully in bloom; stem 4.0-7.0 (2.0-11.5) dm high, striate, glabrate basally, glandular stipitate at the apex, more or less ferruginous; leaves alternate, basal ones oblanceolate to spatulate, entire to irregularly serrate, setose-ciliate at the base, 9-12 (7-14) cm long, 1.5-2.0 cm wide; median leaves lanceolate, irregularly serrate, occasionally one or more doubly serrate, setose-ciliate at the base, glandular stipitate on the margins, 3-5 (2.8-8.0) cm long, 0.2-0.4 (0.15-1.5) cm wide; peduncles with mixed glandular stipitate and hispid pubescence, infrequently to rarely not hispid; heads many in an open panicle; receptacle diameter 2.8-3.4 (2.5-4.0) mm; phyllaries lanceolate, the largest c. 1×5 mm, short glandular stipitate and sparsely hispid on the back; rays 6-9 (5-11); ligules 4.5-6.0 (3.9-6.0) mm long and 2.0-2.6 (1.9-3.2) mm wide; disc corollas 14-22 (9-26); achenes c. 2 mm long, subulate, somewhat sparsely serecious-canescent, stramineous to reddish-brown. Chromosome number $n = 4$.

Blooms late August-October. Distinguished from *H. rigidifolius* by its glandular-stipitate pubescence on the peduncles, and from other members of the section by its small heads and low number of ray and disc flowers. Known from 266 counties in 11 states (Fig. 2).

A casual weed in most areas of occurrence, *Haplopappus divaricatus* becomes very abundant in sandy areas in Georgia and South Carolina. The distribution of *H. divaricatus* is apparently divided into an eastern and a western population by the broad band of river alluvium in the southern Mississippi River valley (see Baker, 1936; Plate 4). *H. divaricatus,* as well as other taxa in the section, appear to be poor competitors on soils high in clay or low in sand.

The infrequent to rare form with peduncles glandular-stipitate pubescent only (no hispid pubescence) appears to be localized in a few areas at the western and southwestern edge of the distribution and does not appear to be worthy of taxonomic recognition. *Haplopappus divaricatus* specimens lacking hispid pubescence on the peduncles are sometimes similar to depauperate specimens of *H. validus* subsp. *torreyi.*

Representative Specimens: ALABAMA: BUTLER Co., 6.1 mi. ne. of junction of US 31 & Ala. 10, *Smith 538,* KANU; CHAMBERS Co., 0.1 mi. sw. of junction of road 147 & US 431, *Smith 479,* KANU; HENRY Co., 8.3 mi. s. of Abbeville, *Smith 537,* KANU; LEE Co., 10.8 mi. w. of junction of 40 & 29 in Auburn, *Smith 478,* KANU; WASHINGTON Co., c. 0.5 mi. s. of Choctaw Co. line on US 17, *Smith 539,* KANU. ARKANSAS: CLEVELAND Co., 1.6 mi. w. of Kingsland, *Smith 457,* KANU; Dallas Co., just e. of Manning, *Smith 456,* KANU; LITTLE RIVER Co., 2 mi. n. & 2.6 mi. w. of Winthrop, *Smith 128,* KANU. FLORIDA: ALACHUA Co., just sw. of Archer, *Smith 529,* KANU; GILCHRIST Co., just outside of Wilcox, *Smith 527,* KANU; JACKSON Co., at Marianna Caverns State Park, *Mitchell 897,* FSU; LAKE Co., 16.3 mi. ssw. of Leesburg, *Smith 533,* KANU; LEON Co., vicinity of Silver Lake, *Godfrey 60356,* FSU. GEORGIA: BARTOW Co., 2.1 mi. s. 52° w. of Allatoona Dam, *Duncan 8887,* GA; CLARKE Co., vacant lot in Athens, *Cronquist 4132,* GA; DOUGHERTY Co., R.R. yards in Albany, *Thorne 5856,* GA; EMANUEL Co., 9 mi. e. of Adrian, *Wilbur 2923,* GA; GREENE Co., 3.7 mi. se. of Siloam, *Smith 492,* KANU. LOUISIANA: BIENVILLE Co., 2.2 mi. e. of Hagewood, *Smith 543,* KANU; DESOTO Co., 3.6 mi. nw. of Keatchie, *Smith 274,* KANU; NACHITOCHES Co., 2.1 mi. e. of Hagewood, *Smith 544,* KANU, SMU, & TEX; OUACHITA Co., 1 mi. e. of Calhoun exit on Interstate 20, *Smith 542,* KANU; SABINE Co., 3.9 mi. s. of Zwolle, *Smith 273,* KANU. MISSISSIPPI: JASPER Co., 2.7 mi. w. of junction of 504 & 503, *Smith 462,* KANU; LAUDERDALE Co., near Meridian, *Smith 464,* KANU; NEWTON Co., dry ridge thickets, *Demaree 36155,* FSU, 4.3 mi. nw. of junction of Miss. 504 & 503, *Smith 460,* KANU. NORTH CAROLINA: ANSON Co., 2.6 mi. se. of Morvin, *Smith 510,* KANU; BLADEN Co., s. of Elizabethtown, *Smith 513,* KANU; HARNETT Co., c. 4 mi. w. of Mamers, *Laing 251,* GA; LEE Co., 7.5 mi. e. of Sanford, *Smith 512,* KANU; MONTGOMERY Co., 1.3 mi. n. of Candor, *Smith 511*, KANU. OKLAHOMA: McCURTAIN Co., 0.5 mi. n. of Tom, *Waterfall 10496*, TEX; PUSHMATAHA Co., 7 mi. w. of Antlers, *Waterfall 11147*, TEX. SOUTH CAROLINA: AIKEN Co., 1.1 mi. n. of Aiken, *Smith 501*, KANU; CHARLESTON Co., 1.9 mi. e. of junction of S.C. 174 & US 17, *Smith 521*, KANU; FAIRFIELD Co., c. 5 mi. w. of Rockton, *Smith 507*, KANU; GREENWOOD Co., 0.2 mi. e. of Abbeville Co. line on S.C. 72, *Smith 499*, KANU; KERSHAW Co., 6.2 mi. w. of junction of S.C. 34 & US 1, *Smith 508*, KANU; LEXINGTON Co., 1.1 mi. n. of Aiken Co. line on S.C. 215, *Smith 502*, KANU. TEXAS: ANDERSON Co., 6 mi. nw. of Tennessee Colony, *Marsh 283*, TEX; BASTROP Co., 8.2 mi. sw. of junction of 21 & US 290, *Smith 554*, KANU; FANNIN Co., 1.4 mi. e. of Telephone, *Smith 286*, KANU; FREESTONE Co., 12 mi. ese. of Fairfield, *Turner 4438*, TEX; LEE Co., at Tanglewood, *Smith 237*, KANU; LEON Co., 5 mi. e. of Buffalo, *Gould 7276*, TEX; LIMESTONE Co., 5.5. mi. e. of Kosse, *Shinners 30574*, SMU; MILAM Co., 6.1 mi. se. of junction of 36 & US 79, *Smith 558*, KANU; MORRIS Co., 2 mi. se. of Daingerfield, *Whitehouse 17656*, SMU; NACOGDOCHES Co., Cushing, *Tharp & Brown 53-8*, TEX; RAINS Co., 5 mi. s. of Emory, *Smith 562*, KANU; ROBERTSON Co., 0.5 mi. sw. of Hearne, *Smith 560*, KANU, near New Baden, *Tharp & Barkley 13978*, TEX; TITUS Co., 1.6 mi. ese. of Mt. Pleasant, *Shinners 16079*, SMU; TRINITY Co., 1.9 mi. nw. of Groveton, *Smith 266*, KANU; UPSHUR Co., 1.5 mi. e. of Big Sandy, *King 2179*, TEX; VAN ZANDT Co., 5.7 mi. se. of Willis Point, *Shinners 8469*, SMU.

3a. **Haplopappus validus** (Rydb.) Cory Rhodora 38:406. 1936. (as "*Aplopappus*") subsp. **validus**

Isopappus validus Rydberg, Brittonia 1:100-101. 1931. (T: 6 mi. s. of Ellinwood, Barton Co., Kansas, *P. A. Rydberg & R. Imler 1309*, NY. Paratypes: *Rydberg & Imler 616 & 721* KANU).

Annual (facultative winter annual) herb, erect; stem 4.5-6.5 (3.0-7.5) dm high, striate, glabrate basally, glandular stipitate above; leaves alternate, basal ones oblanceolate to spatulate, entire to irregularly serrate, setose-ciliate at the base, 7-9 (6-10) cm long, 1.9-2.3 (1.2-3.0) cm wide; median leaves lanceolate, irregularly serrate, setose-ciliate at the base, glandular stipitate on the margins, 4.5-6.5 (3.0-8.0) cm long, mostly 0.3-1.2 cm wide; peduncles with glandular stipitate pubescence, the stipes rather long (0.4-0.5 mm, including gland), often sparsely hispid, especially just below heads; heads several in a somewhat rigid panicle; receptacle diameter 4.7-6.0 (4.0-7.0) mm; phyllaries lanceolate, the largest about 1.1 $\times$ 6.8 mm, short glandular stipitate, and sometimes sparsely hispid, on the back; rays 16-23 (13-29); ligules 7-10 (6-12) mm long and 2.0-2.8 (1.8-3.1) mm wide; disc corollas 55-70 (33-108); achenes 2.2-2.6 (2.0-3.0) mm long; subulate, serecious-canescent, stramineous to reddish-brown. Chromosome number $n = 5$.

Blooms July-early October. Distinguished from *Haplopappus validus* subsp. *torreyi* and subsp. *graniticus* by its narrower ligules, from *H. rigidifolius* by its glandular-stipitate pubescence on the peduncles, and from *H. divaricatus* by its larger heads. Known from 60 counties in Kansas, Oklahoma, and nothern Texas (Fig. 2).

This subspecies is mostly limited to relatively small populations in sandy areas along rivers and fence rows, except in the stationary sand dunes in the Big Bend area of Kansas where it assumes great abundance.

Marked seedlings have been observed to withstand prolonged subfreezing temperatures and grow to maturity the following summer. Seedlings of the outer taxa in the section are rapidly killed by the first severe frost.

Populations of subsp. *validus* in nothern Texas, east of the Panhandle, are almost uniformly atypical for the taxon. This is especially true of Parker, Johnson, Tarrant, Dallas, Wise, Denton, McLennan, and Callahan counties. They nearly all lack hispid pubescence on the peduncles and have smaller heads with fewer flowers than usual. It is believed that most populations in these counties are carrying one or more subsp. *torreyi* chromosomes, or at the very least, have picked up subsp. *torreyi* genes through hybridization. Numerous somatic chromosome counts from these populations were nearly all $2n = 10$. However, one $2n = 11$ and a few $2n = 12$ counts were made. One count of $2n = 10$ showed a heteromorphic pair, one homologue of which could have been from subsp. *torreyi*. It is hoped that further study, including genetic analyses, will confirm the hybrid nature of certain individuals in these populations.

Representative Specimens: KANSAS: DICKINSON Co., 2.9 mi. w. of Abilene, *Smith 122*, SMU; ELLSWORTH Co., 0.5 mi. e. of Terra Cotta, *Smith 121*, KANU; KIOWA Co., 3 mi. w. of Greensburgh, *McGregor 4041*, KANU; MCPHERSON Co., McPherson County State Park, *Smith 120*, TEX; RENO Co., 10 mi. w. of Hutchinson, *Wagenknecht 3124*, KANU; RICE Co., 8.8 mi. e. of Sterling, *Smith 118*, KANU. OKLAHOMA: CADDO Co., 5.9 mi. e. of junction of US 281 & Okl. 9, *Smith 605*, KANU; CANADIAN Co., 1.4 mi. n. of El Reno, *Smith 220*, KANU; GRANT Co., 1.7 mi. n. of junction of US 60 & US 81, *Smith 218*, KANU; JEFFERSON Co., 0.2 mi. n. of Red River off US 81, *Smith 227*, KANU;

MAJOR Co., 1 mi. e. & 1 mi. s. of Cleo Springs, *Richards 1093*, KANU, 1 mi. ne. of Orienta, *Waterfall 10354*, TEX. TEXAS: CALLAHAN Co., 15 mi. se. of Abilene, *Henderson 62-1182*, FSU (rather atypical), *Henderson 63-1772*, TEX; GRAYSON Co., 4 mi. ese. of Gainsville, *Smith 564*, KANU; HEMPHILL Co., 7 mi. ne. of Canadian, *Rowell 4259*, TEX; HOOD Co., 5.5 mi. ne. of Granbury, *Shinners 10330*, SMU; LIPSCOMB Co., 3.5 mi. sw. of Higgens, *Cory 50288*, SMU; MCLENNAN Co., n. of Gholson, *Smith 928*, TEX; MONTAGUE Co., 7.6 mi. e. of junction of US 82 & US 81, *Smith 565*, KANU; SOMERVELL Co., 2.8 mi. ne. of Glen Rose, *Shinners 13812*, SMU.

3b. **Haplopappus validus** (Rydb.) Cory subsp. **torreyi** Smith, subspec. *nov.*

Isopappus hookerianus T. & G., Fl. N. A. **2**:239. 1842. (T: near Gonzales, Gonzales Co., Texas, *Drummond 184*, K, photograph!) not *Haplopappus hookerianus* DC., 1838.

Aster hookerianus (T. & G.) Kuntze, Revis. Gen. **1**:318. 1891.

Croptilon hookerianum (T. & G.) House, N.Y. State Mus. Bul. 223-234:61. 1921.

Isopappus divaricatus (Nutt.) T. & G. var. *hookerianus* (T. & G.) Shinners, Field & Lab. **18**:157. 1950.

Croptilon divaricatum (Nutt.) Raf. var. *hookerianum* (T. & G.) Shinners, Field & Lab. **19**:134. 1951.

Haplopappus divaricatus (Nutt.) Gray var. *hookerianus* (T. & G.) Waterfall, Rhodora **62**:321. 1960.

Annual herb, erect; stem c. 3-6 dm high, striate, glabrate basally, glandular stipitate above; leaves alternate, basal ones oblanceolate to spatulate, entire to irregularly serrate, setose-ciliate at the base, 8-10 (6-12) cm long and 1.5-2.0 (1.2-2.5) cm wide; median leaves lanceolate to linear, irregularly serrate, setose-ciliate at the base, glandular stipitate on the margins, 4-8 (3.2-10.0) cm long and 0.3-0.8 (0.2-1.1) cm wide; peduncles not hispid, densely glandular stipitate, the stipes short (longest c. 0.2-0.3 mm, including gland); heads several in a spreading panicle, the peduncles sometimes reclinate; receptacle diameter 4.5-5.1 (3.5-6.0) mm; phyllaries lanceolate, the largest c. 1×6 mm, short glandular stipitate on the back, not hispid; rays 12-16 (10-17); ligules 7.0-9.2 (5.7-11.0) mm long and 2.6-3.2 (2.4-3.3) mm wide; disc corollas 33-47 (23-51); achenes c. 2.2 mm long, subulate, densely serecious-canescent, stramineous to pale brown. Chromosome number $n = 6$.

Blooms August-October. Distinguished from *Haplopappus rigidifolius* by its glandular-stipitate pubescence on the peduncles; from *H. divaricatus* and *H. validus* subsp. *validus* by its lack of hispid pubescence on the peduncles or phyllaries and its wider ligules; and from *H. validus* subsp.

graniticus by its narrower ligules and its ecology (never occurs in granite outcrop areas). Known from 15 counties in southern Texas (Fig. 2).

This subspecies is noteworthy for the paucity of individuals in most observed populations. Except for two populations in Refugio Co., Texas, it has not been observed to approach the abundance of other taxa in the section.

Representative Specimens: TEXAS: ARANSAS Co., Rockport, *Tharp 42-81*, TEX; BASTROP Co., 1.5 mi. se. of Bastrop, *Smith 79*, GA; CALDWELL Co., 4.8 mi. se. of Prairie Lea, *Smith 244*, KANU; GOLIAD Co., 9.5 mi. s. of Goliad, *Shinners 25210*, SMU; GONZALES Co., near Palmetto State Park road 11 exit, *Smith 242*, KANU, Gonzales, *Tharp* (no number), TEX; KARNES Co., 1.5 mi. e. of Harmony School near Ecleto Creek Crossing, *Johnson 996*, SMU, TEX; LEE Co., 2.3 mi. n. of Giddings, *Smith 240*, KANU, 0.8 mi. w. of Manheim, *Smith 557*, TEX; REFUGIO Co., 3.4 mi. w. of junction of 202 & US 183, *Smith 639*, KANU & NCU, 3 mi. e. of Woodsboro, *Jones 725*, SMU; VICTORIA Co., 2.8 mi. se. of Raisin *Smith 251*, SMU.

3c. **Haplopappus validus** (Rydb.) Cory subsp. **graniticus** Smith *subspec. nov.* (T: 1.9 mi. e. of Streeter, Mason Co., Texas, *E. B. Smith 624*, KANU. Isotype: SMU & NCU)

Herba annua, 3-6 dm alta; caulibus unicis, erectis, striatis, subtus in maturitate tomentosis vel glabratis et saepe ramosis, insuper stipito-glandulosis; foliis alternis, linearibus vel lanceolatis, serratis, subtus ciliatis, ad 8 cm longis et 1 cm latis, margininibus stipito-glandulosis; capitulis pluribus, paniculatis; disco dia. 4.5-5.5 (3.9-6.0) mm; phyllariis anguste lanceolatis, acuminatus, ca. 7.5 mm longis et 1.5 mm latis, dorsis sparse stipito-glandulosis; radiis (10-) 13-21; ligulis 8-12 (6.3-14.0) mm longis et 3.2-4.2 (2.7-5.0) mm latis; disci corollis 35-65 (20-79), 5.0-6.5 mm longis; achaeniis subulatis, pubescentis, 2.3-3.2 mm longis; pappis 2.5-4.0 mm longis.

Annual herb, 3-6 dm tall; stem solitary, erect, striate, tomentose to glabrate below in maturity and often basally branched, glandular stipitate above (peduncles); leaves alternate, linear to lanceolate, serrate, ciliate basally, up to 8 cm long and 1 cm wide, glandular stipitate on the margins; heads several in an open panicle; disc dia. 4.5-5.5 (3.9-6.0) mm; phyllaries narrowly lanceolate, acuminate, c. 7.5 mm long and 1.5 mm wide, sparsely glandular stipitate on the back; rays (10-) 13-21; ligules 8-12 (6.3-14.0) mm long and mostly 3.2-4.2 (2.7-5.0) mm wide; disc corollas 35-65 (20-79), 5.0-6.5 mm long; achenes subulate, pubescent (serecious-canescent), 2.3-3.2 mm long; pappus a single row of equal bristles, 2.5-4.0 mm long. Chromosome number $n = 7$.

Blooms August-October. Distinguished from *Haplopap-*

pus rigidifolius by having glandular-stipitate pubescence on the peduncles; from *H. divaricatus* and *H. validus* subsp. *validus* by its lack of hispid pubescence on the peduncles or phyllaries and its wider ligules; and from *H. validus* subsp. *torreyi* by its wider ligules and ecology (occurs almost exclusively in granite outcrop areas). Known from 5 counties in central Texas (Fig. 2).

The flowers of subsp. *graniticus* are a deeper yellow than those of other members of the section. However, the difference is not very noticeable until specimens are compared side by side.

Except for the Fayette Co. population mentioned in the key, subsp. *graniticus* is limited exclusively to granite outcrop areas in and near the Central Mineral Region of Texas (see Tharp, 1952) or granitic Central Basin (see Gould, 1962). The Fayette Co. population grows in coarse sand and resembles subsp. *torreyi*. Subspecies *torreyi* and *graniticus* overlap in morphology, but the overlap is greater in this population. While some members of the population key easily to subsp. *graniticus*, others key to subsp. *torreyi*. Cytological examination of numerous individuals from the population showed them all to be $2n = 14$ or $n = 7$. Therefore, the whole population is presumed to be subsp. *graniticus*. The fact that this population could not be placed, with certainty, in either subsp. *graniticus* or *torreyi* without cytological examination is one of the main reasons for placement of *graniticus* and *torreyi* at the subspecific level.

Representative Specimens: TEXAS: BURNET CO., Inks Lake State Park, 1.8 mi. s. of Park Headquarters, *Smith 76*, KANU; FAYETTE CO., 8.6 mi. se. of La Grange, *Smith 649*, KANU (somewhat atypical); LLANO CO., Enchanted Rock, *Whitehouse 10303*, SMU; MASON CO., 2 mi. s. of Air (also called Camp Air), *Smith 622*, KANU, GA, TEX, & FSU, and 3 ¼ mi. w. of Fredonia, *Cory 43052*, SMU, *Cory 43051*, TEX.

DEPARTMENT OF BOTANY, RUTGERS THE STATE UNIVERSITY, NEWARK, NEW JERSEY

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A NEW SPECIES OF SENECIO FROM COSTA RICA

R. M. KING

While collecting cytological material of Compositae in Costa Rica, during the summer of 1962, the author made a collection of *Senecio* which is apparently undescribed.

Senecio costaricensis King sp. nov.

Herba erecta 1.2-2 m alta, sine ramis. Folia alterna, pinnatifida usque ad 23 cm longa, usque ad 7 cm lata. Inflorescentiae laxe paniculatae corymbosae ca. 22 cm altae, 26 cm latae, bracteis lanceolatis pinnatifidis usque ad 8 cm longis, 4 cm latis. Capitula radiata, multiflora. Involucri bracteae ca. 12, lanceolatae uniseriatae. Flores radii ca. 5, corolla flavescens, ligulata, tubo ca. 3.3 mm longo, ca. 0.3 mm diam., limbo ca. 4.5 mm longo, 1.3 mm. lato. Flores disci ca. 15, perfecti, fertiles, regulares. Corolla hypocrateriformis 5-lobata, flava, 4 mm longa. Achaenia fulva, attenuata, ca. 1.2 mm longa, basi ca. 0.25 mm diam., apice 0.5 mm diam.

Coarse herb 1.2-2 meters tall; stem erect, green, chaffy, 7-8 mm in diameter, unbranched, striate; leaves alternate, sparingly short pubescent and dark green above, subglabrous and lighter green beneath, laciniately pinnatifid, sinuate dentate, up to 23 cm long, 7 cm wide; inflorescence a loose paniculate corymb, terminal, ca. 22 cm high and 26 cm wide; bracts laciniately pinnatifid, up to 8 cm long, 4 cm wide, sparingly short pubescent and darker green above, subglabrous and lighter green beneath; pedicels sparingly short-pubescent, many headed; phyllaries ca. 12, lanceolate, in one series, apex short-acute, sparingly short pubescent, dark brown, up to 4 mm high, ca. 1.5 mm broad; heads radiate, campanulate; ray florets 5-7, yellow, pistillate, tube ca. 3.3 mm long, ca. 0.3 mm in diameter, limb up to 4.5 mm long and 1.3 mm wide; scattered unicellular glands on outer surface of corolla tube up to 200 μ long; style branches 2, divergent, ca. 0.8 mm long, 200 μ in diameter, style tube 2.6-2.8 mm long, ca. 240 μ wide; stamens absent; disc florets 12-18, perfect, fertile, regular, 5 lobed, yellow; corolla salverform, up to 4 mm long; stamens 5; anthers ca. 1.5 mm long, ca. 100 μ wide; filaments 50-60 μ wide, 1.0-1.2 mm long, differentiated above into a prominent collar ca. 400 μ long, 80-100 μ wide, deeply channelled and with a broadly expanded cordate base, cells of collar regularly sub-quadrate (12×25 μ), smooth; achenes dark brown, tapered, ca. 1.2 mm long, base ca. 0.25 mm in diameter, apex 0.5 mm in diameter, ribs uneven, 7-9 (8), pappus bristles 35-40, gray-white, ca. 4.0 long, serrate; pollen spherical, spiculate, ca. 20 μ in diameter.

Chromosome number, $n = 20$ (Turner and King 1964).

Plate 1312. *Senecio costaricensis.* (Holotype: *King 5392*) Habit ca. × 1/3.

Holotype in the U.S. National Herbarium *R.M. King 5392* (2367999). Abundant, flowers yellow, steep mountain slopes of Cerro de la Muerte, Province of Cartago, Costa Rica. Elevation ca. 3000 meters. August 24, 1962. Isotypes: (MICH, TEX, and UC). Paratypes: *J. Cuatrecasas* and *J. Léon 26551*. Cordillera de Talamanca, Macizo del Buena Vista, Province of Cartago, Costa Rica. Elevation 3300-3400 meters. Nov. 8, 1961 (US). *Arthur Cronquist* and *A. F. Munos 8842*. Sphagnum bog along the Pan-American highway in the mountains south of Cartago, Province of Cartago, Costa Rica. Elevation about 2600 meters. Nov. 10, 1960 (NY).

Senecio costaricensis has the characters of the section Eremophili Greenman (1915) and shows considerable resemblance to *S. townsendii* Greenman. It differs from all members of the section in its generally larger habit, larger leaves, smaller bracts, larger inflorescences and fewer flowered heads.

Grateful acknowledgement is made to Dr. J. Cuatrecasas who first recognized this material as a new species and advised me during the course of my study. Special thanks also are due Dr. Harold Robinson for his very valuable assistance.

DEPARTMENT OF BIOLOGY
CATONSVILLE COMMUNITY COLLEGE
CATONSVILLE, MARYLAND

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SOIL ALGAE OF FORTY PONDS UNDER CONSTRUCTION AT ITHACA, NEW YORK[1]

GRACE D. LANCIANI[2] AND JOHN M. KINGSBURY

To allow experimental study of basic ecology of aquatic weeds and their control by herbicides, 92 ponds have been constructed at two locations in the Ithaca area. The purpose of this study was to determine the algal flora of the soil from which one group of 40 ponds was constructed. Such algae represent a major source of introduction for the algal populations that are expected to appear in the ponds when they are completed and filled.

Construction of the set of ponds used in this study was begun in July, 1962 and completed in November, 1963. Each pond is 66 feet square in the bottom dimension and 124 feet square in the top dimension when measured from center dike to center dike. The area covered by one pond is one-third of an acre at the top and one-tenth of an acre at the bottom. Proposed depths of the ponds when filled range from five to eight feet. The ponds were constructed from abandoned farm lands. The soil, Volusia silt loam, had not been recently disturbed when construction was begun.

The group of ponds under study is arranged in two rows of ten ponds each on each side of a supply canal; a second canal runs perpendicular to the first canal at the end region of the ponds (Fig. 1).

Alternate ponds and alternate banks of ponds with respect to the supply canal were sampled just after they had been given final shape. Three samples were taken from the soil at each pond: the top sample was obtained from the upper margin of the pond, the middle sample from approximately three to five feet down the slope of the pond, and the bottom sample from the floor of the pond. In each case, the top three

[1]Cooperative Northeast Regional Experiment Station Project, CRF-1, *The Development of Principles and Practices for the control of Submerged Aquatic Vegetation.*

[2]Based on a thesis submitted to Cornell University in partial fulfillment of the requirements for the degree of Master of Science.

Plate 1313

Figure 1. Ponds at time of sampling.

to six inches of soil was sampled in a way that yielded well-mixed 10 gm samples. Twenty ponds were sampled initially, 25 in all. Half of the initial samples were examined immediately and the other half refrigerated. Because the latter froze accidentally, new samples were collected two months later from the same locations.

Five media were used in culturing the samples: Modified Bristol's Solution (Bold, 1949) with trace elements (Chantanachat and Bold, 1962); Knop's Solution (Bold, 1942); Kratz and Myer's (1955) Medium D; Modified Detmer's Solution (Bold, 1942); Soil Extract Solution (Bold, 1942).

Culture vessels were 50 ml Delong culture flasks and 18 × 150 mm test tubes. Both flasks and tubes were capped with stainless steel closures (Bellco). Flasks contained 20 ml of media. Inocula consisted of one gram portions of soil.

Original isolations and subsequent transfers were placed in a culture room under standard conditions of twenty-four hour illumination at 250-450 foot candles (warm white fluorescent) on one shelf and 575-675 foot candles on another and temperature of 20°C. ± 2°C.

To facilitate identification, various techniques were employed for separating the original populations into subcultures containing fewer species each. By these procedures, debris was removed and cultures were obtained in which one or few algal species were isolated. No attempt was made to produce cultures free of bacteria.

Flasks were checked daily for presence of algal growth. Typically, the meniscus showed green color within one to two weeks. Flasks were subcultured by the methods of Bold (1942), Pringsheim (1946; 1950), Deason and Bold (1960), Chantanachat and Bold (1962), and Mattox and Bold (1962). These methods include micromanipulation with drawn-out Pasteur capillary pipettes, streaking on agar, and inoculation into fresh media. Transfers, using the above methods, were made into Bristol's liquid medium and on the same solidified with 1.5 per cent agar; into the original medium; and into soil water tubes (Pringsheim, 1950) made with tap water and sterilized by repeated steaming.

A method used by Warcup (1950) for isolating soil fungi was also employed for isolation of soil algae. This method involves distribution of soil particles throughout a thin layer of solid nutrient medium. Small amounts of soil were used as inocula directly and in dilutions (with water) of 1:25, 1:125 and 1:625.

A method involving dispersal of soil particles through liquid nutrient medium, proposed by Willson and Forest (1957), was also employed.

Transfers were made periodically to keep the algae in the best possible condition. Colonies from petri dishes were transferred to Bristol's liquid and 1.5 per cent agar media. Isolations were made from flasks and Willson-Forest Petri dishes by means of capillary pipettes or glass needles.

Fresh mounts in distilled water were used predominantly in identification of the algae. India ink and iodine were used as necessary. Aceto-carmine preparations (Deason and Bold, 1960) proved less satisfactory than the freshmount method.

Algae were identified to species using standard taxonomic references. For the majority of identifications, G. W. Prescott's *Algae of the Western Great Lakes Area* (1962) served as the primary source. Geitler's *Cyanophyceae* (1932) and Collins' *Green Algae of North America* (1928) were also used in particular instances. In addition, University of Texas *Phycological Studies*, I-III (Deason and Bold, 1960; Chantanachat and Bold, 1962; Mattox and Bold, 1962) proved useful because of their parallel nature.

Identification of species of *Bacillariophyceae* and certain *Chlorococcales* was not attempted; nevertheless, an attempt was made to estimate their numbers. Patrick's key to genera of *Bacillariophyceae* (1959) was helpful in this connection, and the following technique was used to aid in estimating the number of *Chlorococcales*.

Six flasks were chosen at random from a group of fifty flasks containing putative *Chlorococcales*, as determined by microscopic examination. Five successive 1 to 5 dilutions were made in sterile water from cells thrown down by centrifuging the original culture. These were plated out on 1.5 percent Bristol's agar in twenty-five Petri dishes. When growth was evident, fifty well-separated colonies were selected at random from the twenty-five Petri dishes and inoculated into Bristol's liquid medium. The tubes were returned to the culture room and examined approximately three to four weeks later when good growth was apparent.

Criteria used for determining the presence of differing entities among these isolates included presence or absence of green meniscus in test tube; presence and amount of sludge; presence or absence of flagellated entities in microscopic examination; and morphology of adult cells, including thickness of cell wall, number of pyrenoids, and shapes of chloroplasts (Deason and Bold, 1960; Chantanachat and Bold, 1962; Mattox and Bold, 1962; Herndon, 1958; and Starr, 1955).

RESULTS

Seventy-two species of algae have been identified from the soil samples. Divisions represented include *Cyanophyta* - 43 species, *Chlorophyta* - 29 species, and *Chrysophyta (Bacillariophyceae)*, species not identified. A taxonomic list of species is presented in Table I.

Data were examined for possible correlations of differences among the species of algae found in the top, middle, and lower levels of the pond walls and among their distributions horizontally from pond to pond. Vertical distribution of representative algae appearing frequently, relatively frequently, and rarely is given in Table II. Considerable range in frequency of occurrence was found in both distributions, but less definite patterns were noted in the horizontal distribution.

Among the *Chlorococcales* two members were identified as *Chlorococcum* and *Chlorella*, and two of the latter were keyed out further to species. Other genera and species could not be ascertained with security with the criteria available.

Members of the *Chlorococcales*, particularly species of *Chlorococcum*, appeared in every soil sample analyzed. Diatoms appeared in thirty-eight out of forty-five samples inoculated into the Delong culture flasks.

Of particular interest were four species of algae described from Texas soils (Deason and Bold, 1960; Chantanachat and Bold, 1962; Mattox and Bold, 1962): *Hormidium flaccidum*

Plate 1314

Figure 2. *Hormidium flaccidum*. One-month-old filaments.

Plate 1315

Figure 3. *Ulothrix belkae.* Germling.

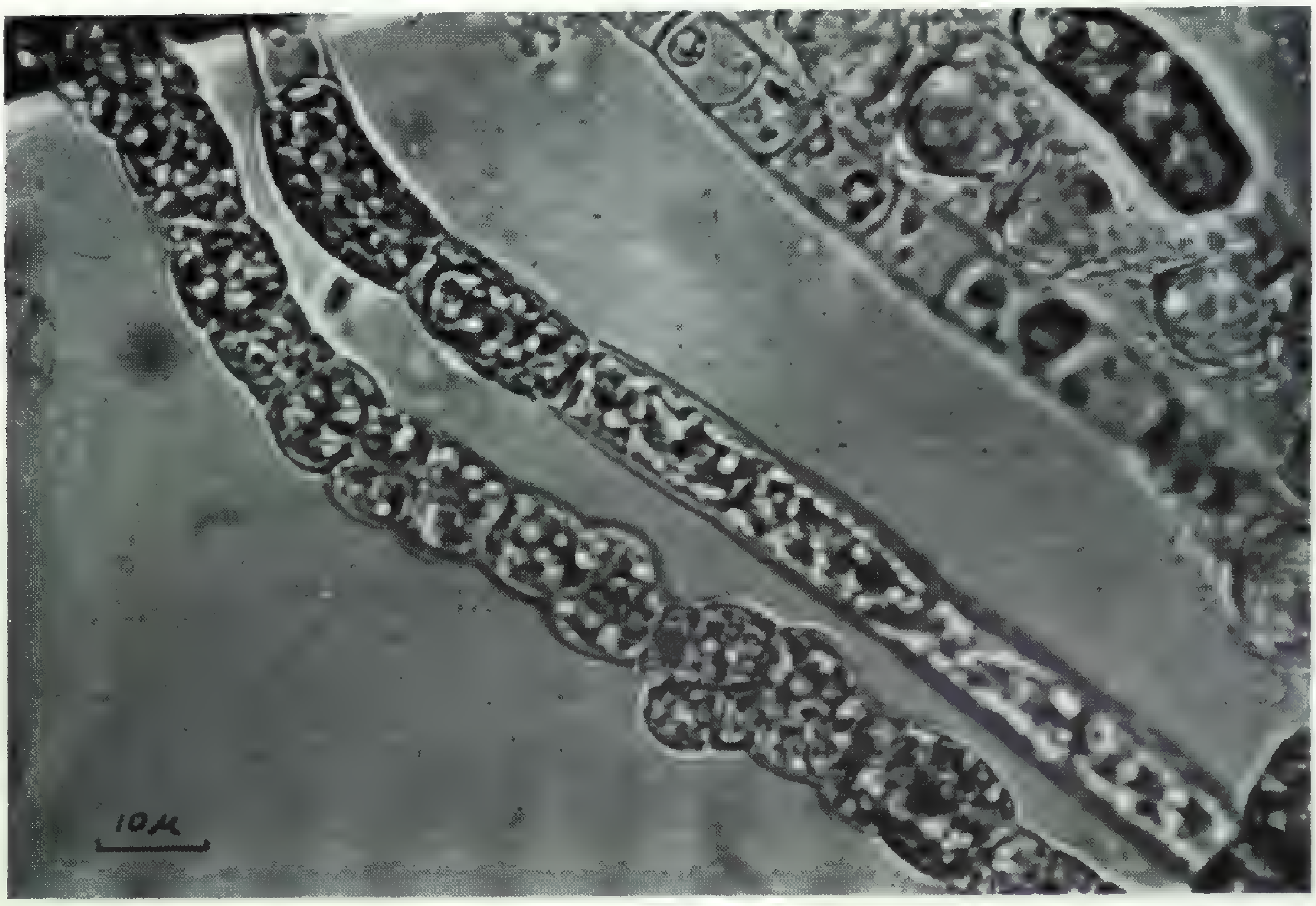

Plate 1316

Figure 4. *Ulothrix belkae.* Two-month-old filaments.

(Fig. 2), *Ulothrix belkae* (Fig. 3, 4), *Chlamydomonas aggregata,* and *Chlamydomonas typica.*

Chlamydomonas appeared frequently in the samples in both vertical and horizontal distributions but could not always be keyed out to species.

One species of *Chlorosarcinopsis* was recovered from the soil samples. On the basis of descriptions by Herndon (1958), it was identified as *Chlorosarcinopsis eremi.*

DISCUSSION

The five media used in this experiment proved to be selective to some degree. Bristol's solution was least selective, and for the most part, the algae grew well in this medium. For this reason, Bristol's solution was used predominatly as the medium for transfer. Knop's solution appeared selective for certain green algae, specifically *Chlorococcales,* although some blue-green algae were also isolated from this medium. Kratz and Myer's medium yielded an abundance of blue-green algae, with a large number of *Chlorococcales* also. In general, the soil-extract solution produced poor growth and appeared to support only a few diatoms, *Chlorococcales,* and blue-greens, the latter being mostly in the state of fragmented filaments. Detmer's medium appeared to select for diatoms and blue-greens.

Members of the Division *Cyanophyta* predominated in the samples. Of seventy-two species identified, forty-three species were blue-green algae. Thirty-five of the species of *Cyanophyta* were filamentous in structure; seven were coccoid (unicellular or colonial) ; and one was a species of *Spirulina.* Of the filamentous blue-greens, twelve were species of *Oscillatoria,* and six each were species of *Anabaena* and *Nostoc.* Other genera were represented by fewer species.

Blue-green algae grew well in Kratz and Myer's Medium D, pH 8.0. The pH of the soil samples also was slightly basic (7.4).

Diatoms were found in high frequency in the soil samples which also contained a large number of blue-green algae. These results differ from those of Bristol (1920) who reported that soils rich in blue-green algae usually contained only few species of diatoms, and vice-versa.

The large amount of *Chlorococcum* reported in this study agrees with observations of Smith (1944) who likewise found an abundance of *Chlorococcum (humicolum)* in four different soil types analyzed in a study of soils from Florida.

Another genus frequently encountered in this study was *Chlamydomonas.* Lund (1947) also reports the common occurrence of species of *Chlamydomonas* in soil, presenting ten new species in his survey. The taxonomy of *Chlamydomonas* is complicated by the very large number of described species and the frequent appearance of new species descriptions.

Isolation methods were not equally successful. Isolation by streaking out on 1.5 percent Bristol's agar and by means of micromanipulation with drawn-out Pasteur capillary pipettes proved to be most often satisfactory. The Willson-Forest plating method proved excellent for the isolation and growth of blue-greens. An outstanding advantage of this method is the fact that filamentous forms could be transferred from dried-out plates and, in fresh media, growth was generally good. The modified serial-dilution and plating technique was satisfactory. Well-isolated colonies on the Petri dishes frequently yielded uni-algal cultures. The Warcup method, although it eliminated the need for such serial-dilution techniques as those proposed by Bold (1942), Skinner (1932), and Bristol-Roach (1962), is limited to the use of extremely small inocula, and the plates are prone to rapid contamination with bacteria and fungi.

Several conclusions may be drawn regarding the frequency of occurrence and distribution of species among the samples taken at different levels from the ponds. In general, most species were found relatively frequently and were equally distributed in the three levels. More than 75 percent of the species were found in all three levels. However, somewhat fewer isolations could be obtained from lower levels than from higher. One hundred seventy-nine species isolations were obtained from soil samples taken at the top level;

160 at the middle level; and 141 at the lower level. Some exceptions to the generality that most species were found in all three levels are noted in Table II. It shows that some species occurred with equal frequency in the top two levels but with lower frequency in the bottom level. On the other hand, some species appeared with equal frequency in the top two levels yet at a higher frequency in the bottom level. Few species occurred exclusively in the top, middle, or lower level.

Because the ponds were still under construction at the time of sampling and were subject to frequent mechanical disturbance, it is assumed that the populations were not well established. However, some differences in habitat among the three levels were clear. The lower level of the ponds was subject to more mixing and also to moistening with rain water which remained in the new pond bottoms for long periods of time. This alone could account for the difference in frequency of occurrence of species as compared to the top two levels. Reasons for the appearance of a few species one or few times may be that occasional air-borne forms were involved, that the media were not always inducive to good growth of certain species, or that occasional resistant forms became vegetative.

The ability to persist in dormant condition under periods inimical to growth was probably a factor in determining the types of algae found and the period in culture before they appeared. Growth of members of the *Chlorophyta* was rapid, with visible green color appearing in one to two weeks. Likewise, when transfers to fresh media were made, zoosporulation usually occurred within a few days to a week. Certain species, however, did not appear for several weeks to several months, probably because they required the prior germination of resistant structures. Blue-green algae, in general, appeared later than the majority of green algae but were present in most samples eventually and remained viable longer.

The samples that were accidentally frozen while being stored were used in the Warcup and Willson-Forest isolation techniques. In general, blue-greens were the predominant forms isolated. The species of blue-greens which were isolated from the frozen samples compared closely with those recovered from non-frozen samples.

Smith (1951) reported that the bulk of species of soil algae are generally made up of *Myxophyceae* (blue-green algae) and *Bacillariophyceae*, with *Chlorophyceae* third, and *Xanthophyceae* and *Euglenophyceae* contributing a much smaller number. Blue-green algae predominated in this study, but members of the *Chlorophyceae* and *Bacillariophyceae* appeared with almost equal frequency, while no species of *Xanthophyceae* or *Euglenophyceae* were found, perhaps because the media did not select for them.

DEPARTMENT OF BOTANY
CORNELL UNIVERSITY
ITHACA, NEW YORK

TABLE I

TAXONOMIC LIST OF ALGAE IDENTIFIED

CHLOROPHYTA

CHLOROCOCCALES
CHARACIACEAE
Characium obtusum A. Braun
CHLOROCOCCACEAE
Chlorococcum spp.
COELASTRACEAE
Coelastrum microporum Naegeli
OOCYSTACEAE
Chlorella ellipsoidea Gerneck
Chlorella vulgaris Beyerinck
Oocystis crassa Wittrock
Oocystis parva West and West
Trochiscia reticularis (Reinsch) Hansgirg
PROTOSIPHONACEAE
Protosiphon botryoides (Kützing) Klebs
SCENEDESMACEAE
Gloeocystis vesiculosa Naegeli
Palmella mucosa Kützing
ULOTRICHALES
ULOTRICHACEAE
Hormidium flaccidum A. Braun
Stichococcus bacillaris Naegeli
Ulothrix belkae Mattox and Bold
Ulothrix subtilissima Rabenhorst
MICROSPORACEAE
Microspora stagnorum (Kützing) Lagerheim
CHAETOPHORACEAE
Protoderma viride Kützing
ULVALES
SCHIZOMERIDACEAE
Chlorosarcinopsis eremi Herndon
VOLVOCALES
CHLAMYDOMONADACEAE

Scenedesmus hystrix Lagerheim
Scenedesmus obliquus (Turpin) Kützing
Scenedesmus quadricauda (Turpin) de Brebisson
TETRASPORALES
PALMELLACEAE
Gloeocystis ampla (Kützing) Lagerheim
Gloeocystis gigas (Kützing) Lagerheim
Chlamydomonas aggregata Deason and Bold
Chlamydomonas snowii Printz
Chlamydomonas typica Deason and Bold
Sphaerellopsis fluviatilis Pascher
VOLVOCACEAE
Gonium pectorale Mueller
ZYGNEMATALES
DESMIDIACEAE
Cosmarium spp.

CYANOPHYTA

CHROOCOCCALES
CHROOCOCCACEAE
Aphanocapsa elachista West and West
Chroococcus minor (Kützing) Naegeli
Dactylococcopsis smithii Chodat and Chodat
Synechococcus aeruginosa Naegeli
Synechocystis aquatilis Sauvageau
Synechocystis crassa Woronichin
Synechocystis sallensis Skuja
HORMOGONALES
NOSTOCACEAE
Anabaena affinis Lemmermann
Anabaena cylindrica Lemmermann
Anabaena flos-aquae (Lyngbye) de Brebisson
Anabaena oscillaroides Bory
Anabaena subcylindrica Borge
Anabaena torulosa (Carmichael) Lagerheim
Anabaenopsis elenkinii Miller
Cylindrospermum catenatum Ralfs
Cylindrospermum marchicum Lemmermann
Nodularia harveyana Thuret
Nodularia spumigena Mertens
Nostoc commune Vaucher
Nostoc linckia (Roth) Bornet and Thuret
Nostoc muscorum C. A. Agardh
Nostoc paludosum Kützing
Nostoc sphaericum Vaucher
Nostoc verrucosum Vaucher
OSCILLATORIACEAE
Lyngbya limnetica Lemmermann
Lyngbya martensiana Meneghini
Lyngbya versicolor (Wartmann) Gomont
Oscillatoria acutissima Kufferath
Oscillatoria agardhii Gomont
Oscillatoria amoena (Kützing) Gomont
Oscillatoria amphibia C. A. Agardh
Oscillatoria angusta Koppe
Oscillatoria angustissima West and West
Oscillatoria limnetica Lemmermann
Oscillatoria rubescens De Candolle
Oscillatoria splendida Greville
Oscillatoria subbrevis Schmidle
Oscillatoria tenuis C. A. Agardh
Oscillatoria terebriformis C. A. Agardh
Phormidium minnesotense (Tilden) Drouet
Schizothrix calcicola (Agardh) Gomont
Spirulina major Kützing
RIVULARIACEAE
Calothrix stagnalis Gomont

TABLE II

Vertical distribution of representative algae found frequently, less frequently, and rarely in soil samples.

FREQUENCY OF OCCURRENCE	NUMBER OF OCCURRENCES		
	TOP	MIDDLE	LOWER
FREQUENT			
Oscillatoria limnetica	13	13	13
Synechocystis aquatilis	14	14	13
Chlamydomonas spp.	11	9	6
Oscillatoria angusta	8	8	12
LESS FREQUENT			
Scenedesmus quadricauda	5	4	2
Anabaena cylindrica	4	4	5
Nostoc commune	4	3	4
Oscillatoria agardhii	2	2	6
RARE			
Spirulina major	0	0	1
Anabaena oscillaroides	0	0	1
Phormidium minnesotense	1	0	0
Anabaenopsis elenkinii	1	0	0
Oscillatoria splendida	0	1	0
Anabaena flos-aquae	0	1	0

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A REVISION OF THE NORTH AMERICAN SPECIES OF HELIANTHEMUM (CISTACEAE)

(CONTINUED FROM P. 216)

H. S. DAOUD & ROBERT L. WILBUR

3. Helianthemum canadense (L.) Michx.

Lechea major L., Sp. Pl. 90. 1753. Type: *Clayton* (in the British Museum), not seen. Photo (GH!). "Habitat in Canadae aridis." but actually from Point Comfort, southeastern Virginia.

Cistus canadensis L., Sp. Pl. 526. 1753. Type: *Kalm* (in the Linnaean Herbarium), not seen. Photo (GH!). "Habitat in Canada."

Helianthemum canadense (L.) Michx., Fl. Bor.-Am. 1: 308. 1803. As to basionym only; Michaux's specimens were *H. Bicknellii* according to Fernald's annotated copy of Michaux's Flora at the Gray Herbarium.

Helianthemum ramuliflorum Michx., Fl. Bor.-Am. 1: 307. 1803. Type: *Michaux.* (P, not seen). "In Georgia et Carolina." Fernald's notes in the interleaved copy confirm the long-standing suspicion that this species is a synonym of *H. canadense.*

Heteromeris canadensis (L.) Spach, Ann. Sci. Nat. 2nd ser. **6**: 370. 1836.

Heteromeris Michauxii Spach, Comp. Bot. Mag. 2: 291. 1837. *Nom. illegit., H. ramuliflorum* Michx. cited in synonymy.

Helianthemum majus (L.) BSP., Prel. Cat. N.Y. 6. 1888.

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Crocanthemum canadense (L.) Britt. & Brown, Ill. Fl. ed. 2. 2: 540. 1913.

Heteromeris major (L.) Ponzo, Nuovo Gior. Bot. Ital. n.s. **28**: 169. 1921. (No basionym and probably not the species meant by Ponzo.)

Helianthemum canadense (L.) Michx. var. *sabulonum* Fern., Rhodora **43**: 615. 1941. Type: *Fernald & Long 4044* (GH!) "sand dunes south of False Cape, Princess Anne County, Virginia."

Perennial herb, (6)15-45(65) cm. tall with few to many stems arising from a multicipital caudex. STEMS ascending to erect, stellate-pubescent but occasionally becoming glabrate, mostly unbranched at first anthesis, later producing numerous ascending floriferous branches. CAULINE LEAVES: petiole 1-2(3) mm. long; blade (7)18-30(38) mm. long, (3)5-7(10) mm. wide; oblance-elliptic to narrowly elliptic near the top of the stem; upper surface green and somewhat lustrous, sparsely stellate-pubescent and mostly intermixed with simple pilose hairs 0.5-1.0 mm. long, lower surface hoary and stellate-tomentose; midvein elevated and secondary veins prominent beneath; base of blade attenuate to cuneate, apex rarely obtuse, subacute to acute; margin entire, non-revolute at first anthesis, later the upper leaves become slightly revolute. FLOWERS: dimorphic (chasmogamous and cleistogamous; maturing at different times during the growing season and occupying different positions on the plant). At first anthesis with a terminal (or subterminal), solitary, chasmogamous flower (but subsequent development of the plant leaves it in the angle of the bifurcated stem or sometimes one of the branches fails to develop and the flower appears in the axil of the branch, or even more occasionally a second or a third chasmogamous flower borne some distance above the first). Pedicel and calyx of the casmogamous flower stellate-pubescent intermixed with apparently simple pilose hairs 0.5-1.2 mm. long and occasionally with very few red glandular hairs. Cleistogamous flowers much smaller, sessile to subsessile, (1)-few in glomerules terminating the ascending branches and also in 1-few glomerate clusters terminating the short branchlets in the leaf-axil. Pedicel and calyx of the cleistogamous flowers stellate-tomentose.

CHASMOGAMOUS FLOWERS: pedicels (1.5)4.0-9.5(17) mm. long. OUTER SEPALS (free portion) (1.2)3-5(7) mm. long, 0.5-1.0(1.2) mm. wide lanceolate or nearly so, acute; INNER SEPALS (5)6-9(10) mm. long, (3)3.5-5.0(5.6) mm. wide, ovate, acute. PETALS 8-15 mm. long, 6-14 mm. wide, yellow, obovate. STAMENS 20-35. PISTIL 1.8-3.0 mm. long; ovary 1.5-2.4 mm. long, 1-2 mm. in diameter, ovoid, glabrous; style 0.3-0.5 mm. long; stigma 0.6-1.2 mm. wide, capitate. FRUITING PEDICELS (1.5)7-12(18) mm. long. FRUITING CALYX (5)7.0-9.6(11.5) mm. long; (4.5)6-8(9) mm. in diameter, ovoid. OUTER SEPALS (free portion) (1.2)3.6-6.0(7) mm. long, (0.5)0.7-1.4(1.7) mm. wide, lanceolate or nearly so, acute; INNER SEPALS (5.0)7.0-9.6(11.5) mm. long, (3)5-7(7.7) mm. wide, ovate, acute. CAPSULE (4)6-7(8.5) mm. long, 4-7 mm. in diameter, ovoid, somewhat angled, glabrous, 3-valved (few capsules seen with 4 or 5 valves); each valve 3.5-6.6 mm. wide, ovate, acute. Funiculi and placentae persisting after the separation of valves and seeds. SEEDS 35-46, ovoid, to inequilateral, dark brown, papillate, lacking a separable membrane.

CLEISTOGAMOUS FLOWERS: either sessile or on pedicels up to 0.5 mm. long. FRUITING PEDICELS (0.5)1-2(4) mm. long. FRUITING CALYX (2.4) 2.8-3.5(4.3) mm. in diameter, subglobose to globose. OUTER SEPALS (free portion) 0.2-0.4(0.6) mm. long, 0.2-0.4 mm. wide, rudimentary, knob-like, and attached to the middle edge of the inner sepals; INNER SEPALS (2.4)2.8-3.5(4.3) mm. long, (2.4)2.8-3.4(3.8) mm. wide, obliquely obovate, concave, imbricate. STAMENS 3(5). CAPSULE (2)2.3-3.0(3.8) mm. long, (2)2.5-3.0(4) mm. in diameter, ovoid-triquetrous, somewhat depressed, glabrous, 3-valved (few capsules seen with 4 valves); each valve (2)2.5-3.0(4) mm. wide, ovate-elliptic, slightly concave, sometimes laterally folded at maturity. SEEDS 5-9(12), similar to the seeds of the chasmogamous flowers.

FLOWERING: Chasmogamous flowers, late March-July; cleistogamous flowers, May-September. HABITAT: sandy flats, dunes, "barrens", open dry woodlands, prairies, and rocky wooded slopes. DISTRIBUTION: scattered north as far as southern Nova Scotia; and from southern Maine south to southern Georgia and westward into eastern Minnesota, Iowa, and Missouri. (Map 4.)

Helianthemum canadense was the first New World species of *Helianthemum* to be described and for a very long time was thought to include as well the three other northeastern species, *H. dumosum, H. Bicknellii,* and *H. propinquum.* Even after their recognition as distinct entities, it has often been confused with them. *Helianthemum canadense* appears much more closely related to *H. dumosum* than to *H. Bicknellii* or *H. propinquum.* The major characteristics shared by *H. canadense* and *H. dumosum* which distinguish them from *H. Bicknellii* and *H. propinquum* are compared below.

H. canadense & *H. dumosum*	*H. Bicknellii* & *H. propinquum*
1. Early chasmogamous flowers typically solitary, terminal or subterminal, soon overtopped by the lateral branches.	1. Early chasmogamous flowers 2-18, rarely overtopped by the lateral branches.
2. Upper surface of cauline leaves stellate-pubescent and mostly sparsely intermixed with simple, pilose hairs 0.5-1.0 mm. long (best observed on younger leaves).	2. Upper surface of cauline leaves stellate-pubescent only.
3. Cleistogamous capsule (2.0) 2.4-3.5(4.0) mm. in diameter each with 5-14 papillate seeds.	3. Cleistogamous capsule 1.5-2.0 (2.4) mm. in diameter each with 1-2(3) reticulate seeds.

It is not surprising to find that *H. dumosum* was the last species to be separated from *H. canadense.* Both species have fairly uniform floral morphology (especially in the chasmogamous flowers), similar seeds, and generally similar pubescence. The major distinctions between *H. canadense* and *H. dumosum* are as follows:

H. canadense	*H. dumosum*
1. Stems ascending to erect at first anthesis, and later in the growing season up to 65 cm. tall, with ascending branches and branchlets.	1. Stems relatively compact, loosely ascendent or divergent, and the plants often bushy at first anthesis, and later in the growing season up to 30 cm. tall.
2. Upper surface of cauline leaves somewhat lustrous and less densely stellate-pubescent.	2. Upper surface of cauline leaves non-lustrous and densely stellate-pubescent.
3. Cleistogamous flowers (1)-few in glomerules at the top of the ascending branches and on the short axillary branchlets.	3. Cleistogamous flowers solitary, rarely two at the forks and tips of the divergent to ascending branchlets.

Helianthemum canadense and the other northeastern species, *H. dumosum, H. Bicknellii,* and *H. propinquum,* vary greatly in their morphological appearance during the period from first anthesis to maturity. These extreme variations cause considerable difficulty in identification. Hooker (Fl. Bor.-Am. 1: 72. 1830.) pointed out the remarkable dissimilarity between the chasmogamous and cleistogamous phases of this species which had led previous workers, including Linnaeus, to describe the latter phase as a *Lechea.* It is to be remembered though that part of the great diversity that so impressed the elder Hooker was due to the inclusion of all four northeastern or widespread eastern species within the concept of *H. canadense.*

Linnaeus included this species twice, once in its petaliferous phase as *Cistus canadensis* and again in its cleistogamous state as *Lechea major.*

Other than the remarkable floral differences, this species is morphologically rather uniform throughout its range. A few specimens, representing not more than one percent of the total number of collections examined, possessed stems branching from near the base and with the tips of the branches crowded with cleistogamous flowers. Some of these fruiting specimens had relatively longer pedicels and slightly larger capsules. Their elliptic-obovate leaves were also more crowded. Fernald (Rhodora 43: 615. 1941.) designated some specimens with these features as the new variety *sabulonum*. Description of Fernald's variety as it appeared in Gray's Manual is quoted below in full:

Var. *sabulonum* Fern. (of sands). — Stems few, *decumbent* or *loosely ascending; leaves oblong-elliptic,* often canescent above; *cleistogamous flowers* mostly *long-pedicelled,* in *loose corymbs terminating upper branches, uniform, in maturity* 4-5 mm. *in diameter.* — Dunes and open sands, local, se. Mass. and Oneida L., N.Y., to se. Va.

However, the four herbarium sheets designated by Fernald as "var. *sabulonum*" show plants with 2-15, ascending to erect stems; elliptic-obovate leaves; with cleistogamous flowers borne in glomerules or rarely even in raceme-like cymes which when fruiting possess pedicels 1-4 mm. long and with capsules ranging from 2-4 mm. in diameter. In addition to the localities cited in the original description by Fernald, specimens with similar characteristics from the following localities have been examined:

St. Joseph Co., Ind., *Deam 34817* (IND); Concord, Middlesex Co., Mass., *Bartram* (PH); Manistee Co., Mich., *Schumacher* (MICH); Atlantic Co., N. J., *Fogg 13726* (PENN); Burlington Co., N. J., *Fogg 5671* (PENN); Burlington Co., N. J., *Fender 926* (PENN); Cumberland Co., N. J., *Dreisbach* (PH); Lancaster Co., Pa., *Tanger 4020* (PENN); Nansemond Co., Va., *Heller* (MIN); Isle of Wight Co., Va., *Heller* (MIN); Dane Co., Wis., *Davis* (PH); Walworth Co., Wis., *Wadmond 3133* (MIN).

Therefore, it seems that such variation occurs sporadically throughout the range of the species and that it does not represent an entity worthy of formal recognition.

REPRESENTATIVE SPECIMENS: CANADA: NOVA SCOTIA: Queens Co., Greenfield, *Weatherby & Weatherby 7120* (GH, US). ONTARIO: Comté de Carleton, Baie Constance, *Marie-Victorin, Rolland-Germain & Rouleau 6296* (FSU, MO, SMU, USF). QUEBEC: Comté de Pontiac, Ile Calumet, *Marie-Victorin, Rolland-Germain & Rouleau 58045* (GH). UNITED STATES: MAINE: Cumberland Co., Standish, *Fernald & Long 14109* (NY, PH). NEW HAMPSHIRE: Carroll Co., Conway, *Johnson 127* (ILL, UC). VERMONT: Rutland Co., Rutland, *Eggleston 1047* (GH). MASSACHUSETTS: Barnstable Co., Harwich, *Fernald 378* (COLO, DS, DUKE, F, GA, GH, IA, IND, ISC, KANU, MICH, MIN, MO, MSC, NCSC, NCU, NO, NY, OKL, PENN, SMU, TENN, UARK, UC, UMO, US, WIS, WVA); *Fernald 379* (DS, DUKE, F, GA, GH, IA, IND, ISC, MICH, MIN, NCSC, NO, NY, OKL, PENN, SMU, TENN, TEX, UARK, UC, UMO, US, WIS, WVA). RHODE ISLAND: Providence Co., Providence, June 1874, *Bennett* (CU). CONNECTICUT: Windham Co., Thompson, *Weatherby*

4926 (NCSC). NEW YORK: Queens Co., Peat Bog near Parsons Blv. & Union Turnpike, *Monachino 142* (CHRB, CU, DUKE, ISC, OKL, SMU). PENNSYLVANIA: Bucks Co., Buckingham Mountain, ne. of Buckingham Valley, *Long 66801* (PH). NEW JERSEY: Cape May Co., Anglesea, *Fender 3242* (DUKE, PENN). MARYLAND: Washington Co., Warm Spring Ridge, *Shreve & Jones 824* (US). DELAWARE: Sussex Co., 1 mi. e. of Lewes, *McVaugh 6580* (F, GH, NY). DISTRICT OF COLUMBIA: Near Takoma Park, 27 May 1900, *Steele* (US). VIRGINIA: Isle of Wight Co., near Franklin, *Heller 917* (CU, DS, F, GH, MIN, NY, PENN). NORTH CAROLINA: Hoke Co., 6.5 mi. nw. of Raeford, *Fox & Beaman 4657* (NCSC, GH, NY, PH). SOUTH CAROLINA: Marlboro Co., 10.5 mi. n. of Bennettsville, *Radford 12686* (NCU). GEORGIA: Burke Co., 1 mi. w. of Shell Bluff, *Pyron & McVaugh 2460* (GH). WEST VIRGINIA: Hampshire Co., Loom, *Core 3195* (SMU). KENTUCKY: Harlan Co., Pine Mountain, *Kearney 220* (F, GH, ISC, MIN, MO, MSC, NY, US). OHIO: Lucas Co., 7 mi. nw. of Maumee, *Kriebel 9128* (PUR). MICHIGAN: Cheboygan Co. near the Biological Station, *Gleason & Gleason 28* (GH, IND, ISC, NY, SMU, WVA). INDIANA: Jasper Co., 2.4 mi. s. of Demotte, *Friesner 17503* (GH, NY, UC, WVA). ILLINOIS: LaSalle Co., Starved Rock, *Greenman, Lansing & Dixon 84* (F, GH, IA, NY, UC). WISCONSIN: Dane Co., about 4 mi. sw. of Madison, *Shinners 1261* (UC). MINNESOTA: Washington Co., 2 mi. s. of Afton, *Moore & Moore 13546* (GH, ISC, MIN, SMU). IOWA: Winneshiek Co., 1 mi. ne. of Hasper Twp., *Davidson & Thorne 11161* (IA). MISSOURI: Maries Co., 3-4 mi. sw. of Belle, *Steyermark 27590* (F).

4. Helianthemum Coulteri S. Wats.

Helianthemum arenicola sensu Hemsl., Biol. Centr.-Amer. Bot. 1:47. 1879. *Coulter 743* (KEW) but not of Chapman, Fl. S. U.S. 35. 1860.

Helianthemum Coulteri S. Wats., Proc. Am. Acad. **17**: 323. 1882. Type: *Coulter 743* (GH!). Zimapán, Hidalgo, Mexico.

Cistus Virginianus Sessé & Moç., Fl. Mex. 130. 1894. Type: MA loaned to F! "in Pratis Sancti Antoni Oppid; jurisdiccionis Ixtlahuacae."

Halimium Coulteri (S. Wats.) Gross., Pflanzenreich 14 (IV. 193): 46. 1903.

Halimium Berlandieri Briq., Ann. Conser. Jard. Genève **10**: 99: 1907. *Berlandier 332.* (G!) Between Tampico and Real del Monte, Mexico.

Crocanthemum Berlandieri (Briq.) Janchen, Nat. Pflanzenfam. 2 ed. 21: 305. 1925.

Perennial herb or somewhat suffruticose, 4-38 cm. tall with few to many stems arising from a caudex or occasionally a subterranean rootstock. STEMS decumbent to erect, shortly stellate-pubescent or occasionally appearing villous with simple and branched trichomes up to

1 mm. long. BASAL LEAVES mostly lacking, when present 6-24 mm. long, 2-7 mm. wide, obovate-spatulate. CAULINE LEAVES: petiole 0.6-2.0 mm. long; blade 7-45 mm. long, 2-15 mm. wide; obovate-elliptic or merely elliptic, the upper surface dark green to grayish and stellate-pubescent (sometimes sparsely intermixed with simple or stellate-pilose hairs up to 1.2 mm. long) and hoary stellate-tomentose beneath; midvein and secondary veins conspicuous and elevated beneath; base of blade attenuate to cuneate, apex obtuse to acute; margin entire, non-revolute. FLOWERS: dimorphic (chasmogamous and cleistogamous), 3-22 in number borne in a congested cyme or loosely arranged in a racemose cyme. Number of cleistogamous flowers varying in each cyme from none (in which case probably not yet formed) to eight. Bracts 1-6 mm. long, 0.2-0.8 mm. wide, linear to lanceolate. Pedicel and calyx stellate-pubescent, sometimes sparsely to densely intermixed with simple hairs up to 1 mm. long, and also with red glandular hairs occasionally present on the calyx.

CHASMOGAMOUS FLOWERS: pedicels 2.0-12 mm. long, mostly shorter than calyx. OUTER SEPALS (free portion) 2.0-4.2 mm. long, 0.4-1.0 mm. wide, linear to lanceolate; INNER SEPALS 4.0-6.5 mm. long, 3-5 mm. wide, ovate, acuminate to mucronate. PETALS 3.4-10.0 mm. long, 3.2-9.0 mm. wide, obovate, "bright yellow." STAMENS 16-30. PISTIL 1.2-3.2 mm. long; ovary 1.0-2.4 mm. long, 0.8-2.0 mm. in diameter, ovoid, glabrous; style almost wanting or up to 0.3 mm. long; stigma 0.8-1.2 mm. wide, capitate. FRUITING PEDICELS 2-12 (17) mm. long. Fruiting calyx 5-12 mm. long, 3-7 mm. in diameter, ovoid. OUTER SEPALS (free portion) 2.5-5.0 mm. long, 0.4-1.0 mm. wide, linear to lanceolate; INNER SEPALS 5-12 mm. long, 3-7 mm. wide, ovate, acuminate to mucronate. CAPSULE 3.5-7.5 mm. long, 3-6 mm. in diameter, ovoid-triquetrous, glabrous, 3-valved; each valve 3-6 mm. wide, ovate, acute, slightly concave. SEEDS 16-56, inequilateral, papillate or reticulate but then on the edges papillate, lacking a separable membrane.

CLEISTOGAMOUS FLOWERS: pedicels 1-3 mm. long, usually shorter than calyx. OUTER SEPALS (free portion) 1.2-3.0 mm. long, 0.3-0.7 mm. wide, linear; INNER SEPALS 3.0-4.5 mm. long, 2.3-2.8 mm. wide, ovate, acute. STAMENS 5(8). PISTIL 1.6-2.0 mm. long; ovary ovoid, glabrous. FRUITING PEDICELS 2-6 mm. long. FRUITING CALYX 4-7 mm. long, 3-4 mm. in diameter, ovoid. OUTER SEPALS (free portion) 2.0-4.2 mm. long, 0.3-0.7 mm. wide, linear; INNER SEPALS 4-7 mm. long, 3-4 mm. wide, ovate, acute. CAPSULE 3.0-4.5 mm. long, 2.8-4.2 mm. in diameter, ovoid-triquetrous, glabrous, 3-valved; each valve 2.8-4.2 mm. wide, ovate, acute. SEEDS 8-22, similar to the seeds of the chasmogamous flowers.

FLOWERING: March-December. HABITAT: grassy knolls, pine forest openings, dry barren open forested hilltops and moist thickets. DISTRIBUTION: southern Nuevo Léon to central Veracruz in Mexico and also collected in Guatemala, Honduras and Nicaragua. (Map 12.)

The characteristic features of this species are the hoary lower surface of the leaf-blade with conspicuously elevated midvein and secondary veins, the dimorphic flowers borne in a terminal, congested cyme or racemose-cyme, and the lack (or nearly so) of the style on the chasmogamous pistil. It is the only Mexican or Central American species with papillate to reticulate seeds and also the only species from this area lacking a separable membrane.

Only three Mexican and Central American species of *Helianthemum*, *H. concolor*, *H. Coulteri*, and sometimes *H. glomeratum*, have leaves with prominent secondary veins on the lower surface. When Riley (Kew. Bull. 1923: 107.) described *H. concolor*, he indicated that it was closely related to *H. Coulteri*. However, the two species are separated geographically and they are very distinct morphologically. *Helianthemum concolor* can be readily distinguished from *H. Coulteri* by its leaves which appear bright green on both surfaces and whose lower surface is sparsely stellate-pubescent and hence the surface of the epidermis is readily visible. In contrast the densely hoary, stellate lower surface of *H. Coulteri* completely obscures the epidermis. In *H. concolor* the cleistogamous flowers are numerous in contrast to eight or fewer/cyme in *H. Coulteri*, and the inflorescence of *H. concolor* is densely covered with white but coarse stellate pubescence while that of *H. Coulteri* is covered with soft stellate pubescence intermixed with simple hairs. The seeds of *H. concolor* are smooth with a separable membrane while those of *H. Coulteri* are papillate to reticulate and lack a separable membrane.

In the southern part of its range (Guatemala, Honduras and Nicaragua), *H. Coulteri* has been either confused with *H. glomeratum* or the specimens left unidentified. *Helianthemum glomeratum* may be readily distinguished from this species by its glomerate axillary and terminal cleistogamous flowers, by its chasmogamous flowers overtopping the cleistogamous ones which are usually solitary at the tip of the branches and branchlets, and by its smooth seeds which possess a thin, separable membrane when moistened.

Watson (Proc. Am. Acad. 17: 323. 1882.) in his original description of this species indicated that Hemsley (Biol. Centr.-Amer. Bot. 1: 47. 1879.) had referred it to Chapman's *H. arenicola.* However, the latter species is endemic to the Gulf Coast region of the United States. The lower surface of the leaf-blade of the Gulf Coast species has obscure secondary veins and its ovary and capsule are stellate-pubescent in contrast to the prominently veined leaves and glabrous ovary of *H. Coulteri.*

Helianthemum Coulteri varies in height, shape and size of leaves, size and number of flowers, size of fruit, and sculpture of seeds through its range. Additional collections are needed before we can evaluate the significance of these variations.

The type of *Halimium Berlandieri* Briq. (G), which was most kindly loaned by the late Professor Charles Baehni, proves to be *Helianthemum Coulteri* and neither *Halimium patens* as questionably indicated by Standley (Contr. U.S. Nat. Herb. 23: 834. 1923.) nor even apparently a close relative of *Halimium Pringlei* with which Briquet compared it.

REPRESENTATIVE SPECIMENS: MEXICO: HIDALGO: between Acaxochitlán & Puebla border on road to Huauchinango, *Moore 2852* (GH, UC); District Zacualtipán Zacualtipán *Moore 2359* (GH); between Pachuca & Real del Monte, *Goodman 3408* (F, ISC). MEXICO: Sierra de las Cruces, *Pringle 6672* (F, GH, ISC, MICH, MIN, MO, MSC, ND, UC). NUEVO LEON: Sierra Madre Oriental, Alanaca to Taray, about 15 mi. sw. of Galeana, *Mueller & Mueller 980 a* (GH, MICH, TEX); Cienaguillas to Puerto Santa Ana, about 15 mi. sw. of Galeana, *Mueller & Mueller 902* (GH, MICH, TEX). PUEBLA: Honey Station, *Pringle 8804* (F, GH, MIN, MO, MSC, PH, UC); about Honey Station, *Pringle 10007* (F, GH, MIN, MO, PH, UC). SAN LUIS POTOSI: K. 50 road between San Luis Potosi & Rio V., *Layman 4169* (PH); Alvarez, Sierra de Alvarez, *Pennell 17832* (PH). VERACRUZ: Below Las Vigas, Perote, *Balls 4792* (GH). GUATEMALA: CHIMALTENANGO: Barranco de La Sierra, southeast of Patzún, *Standley 61531* (F). QUICHÉ: mountains nw. of Quiché, *Grant 699* (F, GH, MICH). HONDURAS: Morazán: western slopes of Cerro de Uyuca, along trail from Las Flores toward Tatumbla, *Standley 22712* (F, UC); Piedra Herrada, lower slopes of Cerro de Uyuca, *Standley 11911* (F); open slopes near Haya Grande Drainage of the Rio Yeguare, at about Long. 87° W. & Lat. 14°N., *Williams & Molina R. 13278* (F, GH); Mt. Uyuca, drainage of the Rio Yeguare, at about Long. 87° W. & Lat. 14°N., *Glassman 1930* (F, ILL, MIN, OKL). NICARAGUA: southwest of Jinotega, along road to Cantera & Los Piños, *Standley 10076* (F).

5. Helianthemum arenicola Chapm.

Helianthemum arenicola Chapm., Fl. S. U.S. 35. 1860: Lectotype: *Chapman* (US #6889!). Isolectotypes: (GH, MO #788712!). "West Florida," Apalachicola.

Helianthemum canadense (L.) Michx. var. *obtusum* Wood, Class-Book 246. 1861.

Halimium arenicola (Chapm.) Gross., Pflanzenreich 14 (IV. 193): 49. 1903.

Crocanthemum arenicola (Chapm.) Barnh. in Small, Man. SE. Fl. 879. 1933.

Perennial herb 5-15(20) cm. tall with several stems arising from ascending to erect subterranean woody portion of an old stem. STEMS often partly buried in the loose sand, spreading to erect, covered with a depressed, canescent stellate pubescence. CAULINE LEAVES: petiole 0.5-2(2.4) mm. long; blade (4)8-17(28) mm. long, (1)2-4(10) mm. wide; oblanceolate to oblong to lanceolate, sometimes the lowermost spatulate; cinerous and densely stellate-pubescent, hoary and stellate-tomentose beneath; midvein elevated but the secondary veins obscure beneath; base of blade cuneate-obtuse, apex obtuse to acute. FLOWERS dimorphic (chasmogamous and cleistogamous), 2-10 in typically terminal or occasionally lateral umbellate clusters or rarely the lateral cluster reduced to a single flower. Bracts 1-3.5 mm. long, 0.3-0.6 mm. wide, linear. Pedicel and calyx stellate-canescent.

CHASMOGAMOUS FLOWERS: pedicels (2.5)5-10(16) mm. long. OUTER SEPALS (free portion) 2-4 mm. long, about 0.5 mm. wide, linear; INNER SEPALS 4-8 mm. long, 3.5-4.8 mm. wide, ovate or ovate-elliptic, acute. COROLLA yellow, petals 8-9.5 mm. long, 7.5-9 mm. wide. STAMENS 17-29. PISTIL 1.2-1.5 mm. long; ovary 1-1.2 mm. long, 0.7-1.1 mm. in diameter, ovoid, stellate-pubescent on the upper half, style 0.1-0.3 mm. long; stigma c. 0.6 mm. wide, capitate. FRUITING CALYX 5.6-8(10) mm. long, 3.6-4(5.2) mm. in diameter, ovoid-ellipsoid. CAPSULE 3.6-5.4 mm. long, 2.4-3.6 mm. in diameter, ovoid-ellipsoid, greenish, stellate-pubescent near the top, glabrous beneath, 3-valved; each valve 1.8-2.8 mm. wide, elliptic, acute, slightly concave. SEEDS 14-17, dark brown, irregular, pebbled to somewhat papillate, without a separable membrane; cohering together in a globular or ellipsoidal mass by interwoven funiculi.

CLEISTOGAMOUS FLOWERS: pedicels 1-2 mm. long. OUTER SEPALS (free portion) 1-2 mm. long, c. 0.4 mm. wide, linear; INNER SEPALS 3.6-5.6 mm. long, 2.2-2.8 mm. wide, ovate, acute. STAMENS 4-6(8). PISTIL 1.1-1.4 mm. long; ovary ovoid, stellate-pubescent on the upper half. FRUITING CALYX 4-5.6 mm. long, 3-3.7 mm. in diameter, ovoid-ellipsoid. CAPSULE 3-4.6 mm. long, 2.4-3.4 mm. in diameter, ovoid, greenish, stellate-pubescent near the top, the lower part glabrous, 3-valved; each valve 2.2-2.7 mm. wide, ovate, acute, slightly concave. SEEDS (6)9-14, similar to those of the chasmogamous flowers.

FLOWERING: March-April. HABITAT: open, sandy scrub barrens and sand-dunes. DISTRIBUTION: near or along the beach from western Florida to Mississippi. (Map 7.)

The stellate-pubescent ovary and capsule and the typically terminal (or sometimes lateral) umbellate clusters composed of dimorphic flowers readily distinguish this species from all other North American species of *Helianthemum.*

Helianthemum arenicola is most closely related to *H. Nashii;* the two species possess the following characteristics in common: (1) the ovary and capsule stellate-pubescent; (2) the seeds dark brown, mostly coherent, pebbled to somewhat papillate and lacking a separable membrane.

In 1861 when Wood described this species as *H. canadense* var. *obtusum,* he was unaware of the previous description of Chapman's *H. arenicola,* and indicated that "It may prove distinct." In 1871 he accepted Chapman's epithet, recognizing its specific distinction and cited his variety as a synonym.

During this study four collections* were examined that seemed possible hybrids between *H. arenicola* and *H. corymbosum.* The flowers of these specimens had calyces bearing abundant simple hairs (a condition unknown in typical *H. arenicola* but characteristic of *H. corymbosum*). The chasmogamous outer sepals of these collections were relatively broad approaching those of *H. corymbosum* instead of linear as they are in *H. arenicola.* The ovaries and capsules were more nearly glabrous instead of stellate-pubescent and their cleistogamous flowers were apparently more numerous than the few that characterize *H. arenicola.* One herbarium sheet [*Biltmore Herbarium 5741* (NY)] has specimens of both the putative hybrid and *H. corymbosum* while Godfrey's collection from Franklin County has both the possible hybrid and the typical *H. arenicola* represented among its numerous sheets. It must be admitted that evidence of hybridization or introgression is slight and perhaps this variation is normal within the species. Field observations can do much in resolving this question. The variation appears quite comparable to the phase of *H. Nashii* that has been called *H. thyrsoideum.*

*FLORIDA: Franklin Co.: very abundant, evergreen scrub-oak sand pine barrens, 1.5 miles e. of St. Theresa, 30 April 1960, *Godfrey 59485b* (DUKE); Pine palmetto woods, ½ mi. s. of Panacea, 20 March 1955, *Adams 4* (GA). Dry sands, near the Coast, Florida, *Biltmore Herbarium 5741* (NY). Drifting sands, near the coast of West Florida, March-April, *Biltmore Herbarium 4028* (GH).

REPRESENTATIVE SPECIMENS: FLORIDA: Escambia Co., Pensacola, 24 Apr. 1898, *Baker* (NCU, NY); Franklin Co., near the beach, Alligator Point, *Godfrey 53202* (DUKE, FSU, GA, IA, NCSC, NCU, NY, USF, VDB); near Appalachicola, *Curtiss 226* (F, FLAS, GA, GH, KANU, MIN, MO, NY, OKL, PH, SMU, UARK); Gulf Co., near Port Saint Joe, *Perkins & Hall 2440* (CU); Okaloosa Co., ½ mi. w. of Mary Esther, *Godfrey 56668* (FSU, IA, UC, USF). ALABAMA: Baldwin Co.; Fort Morgan, *Tracy 7787* (F, GH, ISC, MIN, MO, MSC, NY, OS, PENN, US); Mobile Co., Mobile, 20 March 1883, *Mohr* (GH). MISSISSIPPI: Harrison Co.: near Handsboro, *Channell 1301* (VDB); Jackson Co., Horn Island, *Godfrey & Channell 53713* (FSU, GH, NY).

6. Helianthemum Nashii Britt.

Helianthemum Nashii Britt., Bull. Torrey Club **22**: 147. 1895. [as *H. Nashi*] Lectotype: *Nash 815* (NY!). Isolectotypes: (CU, F, GH, MIN, MO, MSC, UC, US!). Vicinity of Eustis, Lake Co., Florida.

Halimium Nashii (Britt.) Gross., Pflanzenreich 14 (IV. 193): 49. 1903.

Helianthemum thyrsoideum Barnh. in Small, Fl. SE. U.S. 797, 1335. 1903. Type: *Barnhart 2740* (NY!). Sutherland, Florida.

Crocanthemum thyrsoideum (Barnh.) Janchen, Nat. Pflanzenfam. ed. 2. 21: 307. 1925.

Crocanthemum Nashii (Britt.) Barnh. in Small, Man. SE. Fl. 879. 1933.

Perennial herb (14)25-30(41) cm. tall with few to numerous decumbent to ascending or more commonly erect, depressed stellate-tomentulose stems arising from a caudex or from a subterranean horizontal rootstock. CAULINE LEAVES: petioles (0.6)1-2(3) mm. long; blade (5)23-27(38) mm. long, (0.9)3.8-5.7(8.4) mm. wide; oblance-elliptic on the lower half of the stem and becoming elliptic-lanceolate near the apex; densely stellate-canescent above and hoary and stellate-tomentose beneath; midvein elevated and the secondary veins but very slightly to moderately elevated beneath; base of blade cuneate, apex obtuse to acute; margins entire, slightly revolute. INFLORESCENCE: an elongate, leafy thyrse. FLOWERS dimorphic (chasmogamous and cleistogamous) in each cymule. Bracts 1-3.2 mm. long, 0.2-0.6 mm. wide, linear-lanceolate. Pedicels and calyx stellate-canescent or stellate-canescent intermixed with abundant hirsute trichomes about 0.7-1.5 mm. long.

CHASMOGAMOUS FLOWERS: pedicels (2)3-8(10) mm. long. OUTER SEPALS (free portion) 1-2.5(3) mm. long, 0.2-0.4 mm. wide, linear; INNER SEPALS 3.5-5.0 mm. long, 2.7-3.7 mm. wide, obliquely ovate-elliptic. COROLLA yellow, petals 5-9.4 mm. long, 3-6.6 mm. wide, broadly cuneate. STAMENS 12-18. PISTIL 1-1.8 mm. long; ovary 0.8-1.5 mm. long, 0.8-1.3 mm. in diameter, ovoid, stellate-pubescent; style 0.2-0.3 mm. long; stigma 0.4-0.7 mm. wide, capitate, FRUITING PEDICELS 3.6-7.2(12) mm. long. FRUITING CALYX 4-5.5 mm. long, 3.8-4.6 mm. in diameter, ovoid to nearly globose. CAPSULE 3-4.8 mm. long, 2.4-3.8 mm. in diameter, broadly ovoid, elliptic in cross-section, apex blunt, stellate-pubescent on the upper half, gradually becoming glabrous on the lower half, 2-valved; each valve 2.4-3.8 mm. wide, broadly ovate, obtuse, concave. SEEDS 6-10, dark brown, irregular, cohering together into a globular mass by the interwoven funiculi, pebbled to somewhat papillate and lacking a separable membrane.

CLEISTOGAMOUS FLOWERS: pedicels 0.5-2.4 mm. long. OUTER SEPALS (free portion) 0.5-1.2 mm. long, c. 0.5 mm. wide, linear; INNER SEPALS 0.5-3.4 mm. long, 1-2.3 mm. wide, obliquely ovate-elliptic. STAMENS 5(7). OVARY ovoid, stellate-pubescent. FRUITING PEDICELS 1.5-4.5 mm. long. FRUITING CALYX 3-3.6 mm. long, 2.4-3.6 mm. in diameter, ovoid. CAPSULE 3-4 mm. long, 2.4-3.5 mm. in diameter, otherwise similar to the chasmogamous capsule. SEEDS 5-8, similar to those of the chasmogamous flowers.

FLOWERING: March-June. HABITAT: sand dunes and dry sandy pine woods and scrub. DISTRIBUTION: peninsular Florida. (Map 7.)

The elongate, leafy, thyrsoid inflorescence and the bicarpellate, stellate-pubescent ovary and capsule make *H. Nashii* most distinctive.

This species and *H. arenicola* are the only New World species of *Helianthemum* with stellate-pubescent ovaries and capsules. It appears that *H. Nashii* is the only species of *Helianthemum* with a typically 2-valved capsule (or in any event, it is certainly the only North American species). Apparently all other species of Cistaceae characteristically have a 3 or 5-10-valved capsule.

Barnhart (in Small, Fl. SE. U.S. 797, 1335. 1903.) described *H. thyrsoideum* as a new species. In 1933 (in Small, Man. SE. Fl. 880.) he transferred it to the segregate genus *Crocanthemum* overlooking the fact that Janchen had made the transfer eight years earlier. The species was there described as follows:

> "6. *C. thyrsoideum* Barnhart. Plant similar to *C. Nashii* in habit, but the inflorescence less widely branched, and the sepals densely hirsute."

We have seen perhaps a dozen specimens fitting these characteristics including the type of Barnhart's species. The only difference noted between *H. thyrsoideum* and *H. Nashii* was the presence of the hirsute hairs on the calyx of the former species. The variant with a hirsute calyx is known from Orange, Pinellas, Polk and Seminole Counties where the form with short-pubescent calyces is also to be found. There is no distinct geographic or ecologic range of these forms and both have been collected within the same stand. Therefore Barnhart's species, *H. thyrsoideum,* is here treated as a synonym of *H. Nashii.* There is a similar variant of the closely related *H. arenicola,* but in that species there seems to be some slight evidence that the hirsute calyces might be due to introgression from *H. corymbosum.* In *H. arenicola,* that possibly was introgressed by *H. corymbosum,* the ovary or capsules were less pubescent and the bracts seemed to vary somewhat in the direction of *H. corymbosum.*

REPRESENTATIVE SPECIMENS: FLORIDA: Brevard Co., west of Eau Galle, *Hood 4305* (FLAS); Collier Co., Marco Island, 15 April 1954, *West, Arnold & Cooley* (FLAS); Duval Co., Jacksonville and vicinity, 1875, *Hogg* (NY); Hernando Co., at Weekiwachee Springs, *Cooley & Eaton 6602* (FSU, USF); Highlands Co., Avon Park, *Small 12662* (USF); Lake Co., Vicinity of Eustis, *Nash 815* (CU, F, GH, MIN, MO, MSC, NY, US); Levy Co., Cedar Key, *Godfrey 56603* (IA, FSU, UC, USF, VDB); Manatee Co., Bradentown, 10 May 1936, *Cuthbert* (FLAS); Martin Co., near Darkeytown, 31 Jan. 1917, *Atwood* (CU); Orange Co., Windermere, *Blanton 6506* (US); Osceola Co., Kissimmee, *Singeltary 218* (DUKE, NCSC); Palm Beach Co., just n. of Delray, 18 March 1945, *Fox* (NCSC, WVA); Pinellas Co., Gulfport, *Schallert 3995* (SMU); Polk Co., Dear Lake scrub, *McFarlin 5177* (MICH); Putnam Co., south end of Reserve Welaka, 19 June 1941, *Laessle* (FLAS); Seminole Co., at Sanford, *Godfrey, Eaton & Ray 7547* (USF).

7. Helianthemum Bicknellii Fern.

Helianthemum canadense (L.) Michx. var. *Walkerae* Evans, Bot. Gaz. **15**: 211. 1890. Lectotype: *Walker* (US!) Douglas Co., Colorado.

Helianthemum majus in sense of Bickn., Bull. Torrey Club **21**: 259. 1894 but not of the basionym *Lechea major* L., Sp. Pl. 90. 1753, whose type was found to be conspecific with *Cistus canadensis* L.; nor *Helianthemum majus* (L.) BSP., Prel. Cat. N.Y. 6, 1888, a nomenclatural transfer (covering all northeastern entities) based on page priority.

Halimium majus in sense of Gross., Pflanzenreich 14 (IV. 193): 50. 1903.

Crocanthemum majus Britt. in Britt. & Brown, Ill. Fl. ed. 2. 2: 540. 1913.

Helianthemum Bicknellii Fern., Rhodora **21**: 36. 1919. Type: *Fernald*, 7 August 1908 (GH!). Bangor, Maine.

Heteromeris major in sense of Ponzo, Nuovo Gior. Bot. Ital. n.s. **28**: 169. 1921. (No basionym cited.)

Crocanthemum Bicknellii (Fern.) Janchen, Nat. Pflanzenfam. ed. 2. 21: 307. 1925.

Helianthemum Walkerae (Evans) Lyon, [as *Walkedae* and without basionym or even indication that a new combination was being made], Am. Midl. Nat. **12**: 278. 1927.

Perennial herb, (12)20-46(67) cm. tall with many clustered stems arising from a multicipital caudex. Stems ascending to erect, stellate-pubescent, simple or sparsely branched at first anthesis; branches moderately ascending to appressed, restricted to the upper third of the stem, later in the growing season becoming densely leafy and crowded with cleistogamous flowers. CAULINE LEAVES: petiole 1-3(4) mm. long; blade (8)18-32(40) mm. long, (2)4-7(10.5) mm. wide; oblance-elliptic to elliptic, green and stellate-pubescent above, hoary stellate-tomentose beneath; base of blade cuneate, apex subacute to acute; margin entire, the upper cauline leaves slightly revolute; midvein and secondary veins prominent beneath. FLOWERS dimorphic (chasmogamous and cleistogamous); maturing at different times during the growing season and upon different positions on the plant. At first anthesis with (2)6-10(18) chasmogamous flowers terminating the stem and the uppermost branches in a cymose cluster and these rarely surpassed by the lateral branches at maturity. Pedicel and calyx of the chasmogamous flowers densely covered with stellate pubescence and with apparently simple (although mostly unequally stellate), pilose hairs. Bracts 3-7 mm. long, 0.5-1 mm. wide, lanceolate. Later in the growing season the lateral, ascending to depressed, leafy branches becoming crowded with sessile to subsessile cleistogamous flowers in axillary and terminal glomerules. Pedicels and calyces of the cleistogamous flowers stellate-pubescent.

CHASMOGAMOUS FLOWERS: pedicels (1.2)3-8(12) mm. long, mostly shorter than calyx. OUTER SEPALS (free portion) (2.4)3.5-4.5(8) mm. long, nearly as long as the inner ones, 0.4-1.0 mm. wide, linear, acute; INNER SEPALS (3.4)5-7(8) mm. long, 2.4-4.0 mm. wide, ovate-elliptic, acute. PETALS 8-12 mm. long, 5-10 mm. wide, obovate. STAMENS (18)26-38. PISTIL 1.5-2.6 mm. long; ovary 1.0-1.6 mm. long, 0.8-1.4 mm. in diameter, ovoid, glabrous; style 0.4-0.8 mm. long; stigma 0.6-0.8 mm. wide, capitate. FRUITING CALYX (4.5)5.2-7.2(9.6) mm. long, (3.4)4.0-5.5(6.5) mm. in diameter, ovoid. CAPSULE (2.4)3.5-5.0(5.6) mm. long, (2.2)3.0-4.0(5.0) mm. in diameter, ovoid-triquetrous, sometimes abruptly short-pointed; 3-valved (but a few capsules seen with 4 or 5 valves); each valve (2.2)3.0-4.0(4.4) mm. wide, ovate-elliptic, acute, slightly concave. SEEDS 12-26, ovoid to inequilateral, brown-spotted and indistinctly reticulate with very slight relief.

CLEISTOGAMOUS FLOWERS: sessile to subsessile. FRUITING PEDICELS 0.4-0.7(1.3) mm. long. FRUITING CALYX 1.7-2.5(3.0) mm. long, 1.6-2.2(2.5) mm. in diameter, ovoid. OUTER SEPALS (free portion) (0.3)0.6-1.2(1.8) mm. long, 0.2-0.3 mm. wide, linear; INNER SEPALS 1.7-2.5(3.0) mm. long, 1.5-2.3 mm. wide, ovate-elliptic, acute. STAMENS 3(5). CAPSULE 1.5-2.2(2.8) mm. long, 1.2-2.0(2.4) mm. in diameter, ovoid-triquetrous, apiculate, glabrous, 3-valved (few capsules seen with 4-valves); each valve 1.2-2.0(2.4) mm. wide, ovate-elliptic, acute, slightly concave, mostly dehiscing for about two-thirds distance towards base and spreading at maturity. SEEDS 1-2(3), globose(when one seed per capsule), half globose (when two), or three-sided with the outer convex (when three per capsule), obscurely reticulate with low relief and reddish brown.

FLOWERING: chasmogamous flowers, June-July; cleistogamous flowers, July-September. HABITAT: sandy and rocky shores, sand dunes or barrens, open dry sandy fields or prairies, and open mountain tops. DISTRIBUTION: Maine to northern Georgia and westward into Minnesota, eastern Wyoming, and Colorado. (Map 6).

H. Bicknellii has a wider distribution and has been more extensively collected than any North American *Helianthemum.* This species is rather uniform throughout its range excepting perhaps some specimens from Colorado which show somewhat wider cauline leaves on the lower half of the stem. However, this species has a remarkably different appearance from first anthesis, when the chasmogamous flowers terminate the stem and whose fruits drop as soon as they mature, to the end of the growing season when the branches are crowded with the mature cleistogamous fruits. This extreme variation causes difficulty in identification.

The species with which *H. Bicknellii* is most easily confused is *H. propinquum* and they were in fact judged conspecific by Blake (Rhodora **20**: 50. 1918.). Fernald (Rhodora **21**: 36-37. 1919.), after considerable field study was finally convinced of their specific differences. *Helianthemum propinquum* shares with *H. Bicknellii* the following characteristics: (1) chasmogamous flowers in a terminal cymose cluster; (2) cleistogamous flowers sessile to subsessile and borne on the branches in axillary and terminal glomerules; (3) cleistogamous capsules 1.5-2.0(2.4) mm. in diameter each with 1-2(3) reticulate seeds.

Despite the close similarity between the two, they may be readily distinguished as follows:

H. Bicknellii	*H. propinquum*
1. Chasmogamous outer sepals fused with the inner sepals near the base and its free portion more than half the length of the inner sepals.	1. Chasmogamous outer sepals fused for up to two thirds of the length of inner sepals and its free portion half of the length or less of the inner sepals.
2. Base of leaf-blade cuneate.	2. Base of leaf-blade attenuate.
3. Usually stems arising from a multicipital caudex.	3. Stems arising from subterranean rootstocks.
4. Fruiting cleistogamous outer sepals more than 3-times longer than wide.	4. Fruiting cleistogamous outer sepals about twice longer than wide (knob-like and attached to the middle edge of the inner ones).
5. Cleistogamous capsule ovoid-triquetrous.	5. Cleistogamous capsule ovoid or nearly so.

There has been much confusion concerning the nomenclature of this species and it therefore seems desirable to discuss it briefly. Prior to 1894 the taxon now known as *H. Bicknellii* had been erroneously equated with *H. canadense* or treated as a named or unnamed variant. Gray (Man. Bot. N. U.S. 47-48. 1848.) treated plants belonging to this species under *H. canadense* as follows: "A variety is more hoary, and with a stronger tendency to multiply the minute clustered flowers." Evans (Bot. Gaz. **15**: 211. 1890.) described this taxon as *H. canadense* var. *Walkerae* basing his description upon specimens from Colorado. Bicknell (Bull. Torrey Club **21**: 257-260. 1894.), studying the genus in the vicinity of New York, recognized two distinct species. The first was *H. canadense* and the second and the more common species of the two, he referred to "*H. majus* (L.)" stating:

"As a matter of fact, however, the apetalous state of true *H. Canadense* Michx., as here defined, does not closely resemble a *Lechea,* while the corresponding state of the newly recognized species is, in a marked degree, suggestive of a plant of that genus. . . . It would appear, therefore, not at all improbable that the *Helianthemum* described by Linnaeus as *Lechea major* was in reality the plant here in view, and that his *Cistus Canadensis* was after all a different plant. An examination of the type specimens in the Linnaean herbarium can alone settle the question, and may prove that the plant here called *majus* requires a different name; but for the purpose of more easily handling the plants in this note, I adopt provisionally the name *H. majus* (L.), for the newly recognized plant. . . ."

Therefore from 1894 to 1918 this species was known as *Helianthemum majus* or *Crocanthemum majus*. Blake's (Rhodora **20**: 49+50. 1918.) examination of the Linnean specimens demonstrated that *Lechea major* L. was conspecific with *Cistus canadensis* as had already been suggested by Elliott, Torrey and Gray, and Hooker. Blake concluded that the plant to which Bicknell applied the name was conspecific with *H. propinquum*. Fernald (Rhodora **21**: 36+37. 1919.) indicated that *Helianthemum majus* in the sense of

Bicknell (not *H. majus* (L.) BSP, a synonym of *H. canadense* maintained under the American Code due to page priority) was a "good" species amply distinct from *H. propinquum* and he provided the new name *Helianthemum Bicknellii.*

Specimens from northeastern Sonora reported by White (Lloydia **11**: 287. 1948.) as this species (under the name *H. majus)* are *H. Pringlei.*

REPRESENTATIVE SPECIMENS: CANADA: MANITOBA: Brokenhead, 12 mi. north of Beausejour, *Scoggan 11550* (MIN). ONTARIO: Essex Co., Windsor, *Macoun 34070* (GH, MO, NY, US). UNITED STATES: MAINE: Penobscot Co., Orono, *Fernald 336* (A, GH, MIN, MO, MSC, NY, PH, US, WIS). NEW HAMPSHIRE: Cheshire Co., Walpole, *Fernald 88* (GH). VERMONT: Bennington Co., Pownal, 10 Oct. 1857, *Ames* (MICH). MASSACHUSETTS: Barnstable Co., Harwich, *Fernald & Long 382* (DS, DUKE, F, GA, GH, IA, IND, ISC, KANU, MICH, MIN, MO, NO, NY, OKL, PENN, SMU, TENN, TEX, UARK, UC, UMO, US, WIS). RHODE ISLAND: Washington Co., Prudence Island, Narragansett Bay, *Mearns 384* (US). CONNECTICUT: New London Co., behind dunes, Bluff Point, Groton, *Travis 2022* (PENN). NEW YORK: Cayuga Co., sandy crest of Salmon Creek Ravine, Genoa, *Wiegand 10304* (CU, GH). PENNSYLVANIA: Lancaster Co., about the mouth of the Tucquan, 24 July 1901, *Heller* (CU, F, GH, IND, MO, US). NEW JERSEY: Passaic Co., Wanaque, *Mackenzie 2710* (MO, NY). DELAWARE: New Castle Co., Serpentine e. of Mount Cuba, *Pennell 1499* (PENN). MARYLAND: Cecil Co., drainage of Octoraro Creek, e. of Rocksprings, *Long 28484* (GH, PH). VIRGINIA: Arlington Co., Tarrison, *Steele 391* (F, NY). NORTH CAROLINA: Ashe Co., near top of Nigger Mountain, *Fox & Godfrey 3347* (FSU, GA, GH, NCSC, US); Buncombe Co., summit of Cedar Cliff Mountain, *Biltmore Herb. 5740b* (F, GH, MO, NY, US). GEORGIA: Towns Co., on summit at Enotah Bald Mountain, Brasstown Bald, *Pyron 521* (GA). OHIO: Wayne Co., Shreve, *Duvel 804* (NCU, OS). KENTUCKY: Meade Co., without exact locality, 1842, *Short* (PH). TENNESSEE: Blount Co., edge of "bald", Gregory Bald, *Wilson 1941* (TENN); Knox Co., Knoxville, *Moldenke 10705* (NY). MICHIGAN: Menominee Co., Menominee, *Grassl 2886* (MICH, NY). INDIANA: Lagrange Co., 3 mi. e. of Mongo, *Yuncker & Welch 10782* (COLO, GH, SMU). WISCONSIN: Greene Co., 5 mi. ese. of Monticello, *Iltis & Greene 6720* (MIN, WIS). ILLINOIS: Lake Co., n. of Waukegan and e. of the glacial Glenwood Ridge, *Gates 2752* (F, ILL, MICH). MINNESOTA: Hubbard Co., roadside to Park Rapids, *Moyle 759* (CU, GH, IND, NY, US). IOWA: Guthrie Co., 12 mi. n. of Adair, *Fay 5310* (KANU, UC, US). MISSOURI: Barry Co.: Eagle Rock, *Bush 197* (GH, MO, NCU, NY, US). ARKANSAS: Hempstead Co., Washington City, *collector unknown* (MO). SOUTH DAKOTA: Custer Co., Black Hills, *Rydberg 542* (NY, US). NEBRASKA: Brown Co., Long Pine, *Clements 2940* (CU, ISC, NY, US). COLORADO: El Paso Co., Black Forest, *Livingston 640* (DUKE).

8. Helianthemum propinquum Bickn.

Helianthemum propinquum Bickn., in Britton Man. Fl. N. U.S. ed. 2. 1069. 1905. Type: *Bicknell*, August 1903 (NY!). Valley Stream, Long Island, New York.

Helianthemum georgianum sensu Britt. in Britt. & Brown, Ill. Fl. ed. 2. 2: 540. 1913.

Crocanthemum propinquum (Bickn.) Bickn., Bull. Torrey Club **40**: 615. 1913.

Perennial herb, 8-27(35) cm. tall with few to many stems arising usually singly at intervals (or sometimes few together) from a horizontal, subterranean rootstock. STEMS slender, ascending to erect, stellate-tomentose, somewhat reddish when young, mostly simple at first anthesis; branches ascending, mostly restricted to the upper half of the stem, densely leafy late in the season and becoming congested with cleistogamous flowers. CAULINE LEAVES: petioles (1)2-4(5) mm. long; blade (5)12-28(37) mm. long, (1.5)3-6(10) mm. wide; oblanceolate to narrowly oblance-elliptic; dark green and stellate-pubescent above, hoary stellate-tomentose beneath; midvein and secondary veins prominent beneath; base of blade attenuate, apex obtuse to acute; margin entire, sometimes the upper leaves slightly revolute. FLOWERS dimorphic (chasmogamous and cleistogamous); maturing at different times during the growing season and upon different positions on the plant. At first anthesis with 2-6 chasmogamous flowers terminating the stem in a cymose cluster and these surpassed by the lateral, ascending, leafy branches densely crowded with sessile to subsessile cleistogamous flowers in axillary and terminal glomerules. Bracts subtending chasmogamous flowers 1.5-3.5 mm. long, 0.2-0.4 mm. wide, lanceolate. Pedicel and calyx covered with appressed, densely matted, elongate stellate-pubescence.

CHASMOGAMOUS FLOWERS: pedicels (2)8-14(22) mm. long, mostly longer than calyx. OUTER SEPALS: fused with 1/2-2/3 of the edge of the inner sepals, free portion (0.7)1.5-3.0(4.0) mm. long, 1/3-1/2 the length of the inner sepals, 0.4-0.9 mm. wide, linear; INNER SEPALS (4)5.0-7.5(8) mm. long, 2.3-4.5 mm. wide, ovate, acute. PETALS 7.5-10.0(13.5) mm. long, 6-12 mm. wide, obovate. STAMENS 24-30, "anthers orange" *(fide Fernald 17160)*. PISTIL 2.0-2.6 mm. long; ovary 1.5-1.8 mm. long, 1.0-1.4 mm. in diameter, ovoid, glabrous; style 0.5-0.8 mm. long; stigma 0.6-0.8 mm. wide, capitate. FRUITING CALYX (5)6-8(9.7) mm. long, 3.5-7.0 mm. in diameter, ovoid. CAPSULE 3.7-5.3 mm. long, 3-4 mm. in diameter, ovoid-triquetrous, glabrous, 3-valved (but a few capsules seen with 4 or even 5 valves); each valve (1.2)2.2-3.7 mm. wide, ovate-elliptic; capsules usually overtopped by the upper branches and mostly falling promptly after maturity. SEEDS 12-15, ovoid to inequilateral, brown-spotted, reticulate or sometimes somewhat papillate at the edges only.

CLEISTOGAMOUS FLOWERS: sessile to subsessile. FRUITING PEDICELS up to 1.5 mm. long. FRUITING CALYX 2.0-2.5(2.7) mm. long, 1.5-2.2(2.5) mm. in diameter, ovoid to subglobose. OUTER SEPALS (free portion) 0.2-0.5 mm. long, 0.2-0.3 mm. wide, rudimentary, knob-like, attached at the middle edge of the inner sepals; INNER SEPALS 2.0-2.5(2.7) mm. long, 1.5-2.2 mm. wide, ovate, acute, somewhat lustrous. STAMENS 3-4. CAPSULE 1.5-2.2 mm. long, 1.3-2.0 mm. in diameter, ovoid and usually rounded in cross-section (rarely weakly ovoid-triquetrous), glabrous, 3-valved; each valve 1.1-1.8 mm. wide, ovate-elliptic, subacute to acute, never spreading at maturity. SEEDS 1-2(3), globose (when one seed per capsule), half globose (when two), and three-sided with the outer side convex (in three-seeded capsule), brown-spotted and reticulate.

FLOWERING: Chasmogamous flowers, late May-early July; cleistogamous flowers, July-September. HABITAT: fields, sandy places and dry, open woods. DISTRIBUTION: Eastern Massachusetts southward through eastern Pennsylvania to northern Virginia; also collected from the mountains of North Carolina, Tennessee and northern Georgia. (Map 5.)

Previously, *H. propinquum* was believed to occur only from eastern Massachusetts southward to the District of Columbia. However, this species also occurs in the mountains of western North Carolina, eastern Tennessee and northern Georgia where it has usually been misidentified as *H. Bicknellii.*

The species with which *H. propinquum* is most likely to be confused is *H. Bicknellii,* as was done by Blake (Rhodora **20**: 49 + 50. 1918.). The characteristics which these species have in common, as well as those which serve to distinguish them from each other, are indicated under the discussion of *H. Bicknellii.*

Prior to its original description in 1905, *H. propinquum* was referred to as a stunted form of *H. canadense.* The clustered, chasmogamous flowers with calyces covered with appressed stellate pubescence, the 1-2(3)-seeded, cleistogamous capsule, and the stem which arises from subterranean rootstock, readily distinguish this species from both *H. canadense* and also from *H. dumosum.* However, *H. propin-*

quum resembles *H. canadense* in having somewhat lustrous cleistogamous fruiting calyces and in having outer sepals which are rudimentary or knob-like and attached to the middle edge of the inner sepals.

Britton (in Britt. & Brown, Ill. Fl. ed. 2. 2: 540. 1913.) equated this species with *H. georgianum* which is morphologically quite unlike it and which has a very different range.

REPRESENTATIVE SPECIMENS: MASSACHUSETTS: Barnstable Co., Harwich, *Fernald 380* (DS, DUKE, F, FLAS, FSU, GA, GH, IA, IND, ISC, KANU, MICH, MIN, MO, MSC, NCSC, NCU, NO, NY, OKL, PENN, SMU, TENN, UARK, UC, UMO, US, WIS, WVA); Brewster, *Fernald 381* (DS, DUKE, F, FLAS, GA, GH, IA, IND, ISC, KANU, MICH, MIN, MSC, NCSC, NCU, NO, NY, OKL, PENN, SMU, TENN, TEX, UARK, UC, UMO, US, WIS, WVA). CONNECTICUT: Hartford Co., Southington, *Bissell 88* (GH). NEW YORK: Nassau Co., Valley Stream, August 1903, *Bicknell* (NY). PENNSYLVANIA: Bucks Co., Turkey Hill, *Long 21299* (PH). NEW JERSEY: Morris Co., Succasunna, *Mackenzie 4104* (MO, US). DELAWARE: Sussex Co., e. of Ellendale, *Pennell 12884* (MINN, US). MARYLAND: Cecil Co., 2 mi. w. of Elkton, *Randolph & Randolph 128* (CU, GH). DISTRICT OF COLUMBIA: Pinehurst, 3 June 1919, *Steele* (F, GH, NY). VIRGINIA: Arlington Co., Arlington Forest, *Balls 7804* (US). NORTH CAROLINA: Ashe Co., Bald, Nigger Mountain w. of West Jefferson, *Radford 41133* (NCU); Avery Co., 0.6 mi. ne. of Avery-Mitchell Co. line on US 19E., *Ahles & Duke 43433* (NCU); Buncombe Co., Biltmore, *Biltmore Herbarium 1217* (CU, MIN, US); Henderson Co., Flat Rock, *Schallert 8645* (DUKE); Stokes Co., 1.5 mi. n. of Belews Creek, *Radford 34511* (NCU); Transylvania Co., behind Pisgah Inn, Mt. Pisgah, *Oosting 1779* (DUKE, FLAS, PH). TENNESSEE: Coffee Co., 10 mi. ne. of Tullahoma, *Hardin 15761* (TENN); Cumberland Co., near Crossville, *Rhoades 19* (CU); Monroe Co., near Mt. Vernon, *Ford & Russell 2097* (SMU, TENN). GEORGIA: without locality "Northern Georgia, chiefly of the Mts. & upper Country, 1878" *Vassey* (PH).

9. Helianthemum Greenei Robins.

Helianthemum occidentale Greene, Bull. Calif. Acad. Sci. 2: 144. 1886. Type: *Greene*, July & August 1886 (ND!), isotype (NY!) "on dry summit in the central part of the Island of Santa Cruz, Santa Barbara Co., California; not Nym., Consp. Fl. Eur. 72. 1878.

Helianthemum Greenei Robins., Syn. Fl. N. Am. 1(1): 191. 1895. (*nom. nov.* for Greene's later homonym).

Halimium occidentale (Greene) Gross., Pflanzenreich 14 (IV. 193): 35. 1903.

Crocanthemum occidentale (Greene) Janchen, Nat. Pflanzenfam. ed. 2. 21: 305. 1925.

Suffruticose perennial, often somewhat spartioid, 14-30 cm. tall with few stems arising from a woody caudex. STEMS: ascending to erect, moderately branched, and varying from sparsely to densely finely stellate-pubescent; the pubescence below the inflorescence usually of dark, capitately glandular trichomes about 0.4-0.6 mm. long. LEAVES sessile or with petioles up to 3 mm. long; blade 7-30 mm. long, 0.8-4.0(5.0) mm. wide, oblanceolate-elliptic to linear-lanceolate near the top of the plant, green and stellate-pubescent on both surfaces; midvein prominent and secondary veins obscure beneath; base of blade attenuate to cuneate, apex acute; margin entire and sometimes slightly revolute. INFLORESCENCE: corymbose to short-paniculate. FLOWERS isomorphic (all chasmogamous). Inflorescence with sparse to dense stellate pubescence intermixed with coarse, red, glandular hairs mostly 0.4-0.6 mm. long. Bracts 3-10 mm. long, 0.5-1.5 mm. wide, lanceolate and nearly same shape as the outer sepals.

CHASMOGAMOUS FLOWERS: pedicels 0.5-4.0(6.0) mm. long, usually shorter than calyx. CALYX with simple, white, villous trichomes about 0.8-1.5 mm. long intermixed with fewer, shorter (c. 0.2-0.4 mm.) dark reddish, capitately glandular trichomes. OUTER SEPALS (free portion) 2.5-4.0 mm. long, 0.5-1.0 mm. wide, lanceolate; INNER SEPALS 4.5-7.0 (8.0) mm. long, 3-4 mm. wide, ovate, acuminate. PETALS 5-8 mm. long, 3-4 mm. wide, obovate, yellow. STAMENS 20-25. PISTIL 1.8-2.2 mm. long; ovary 1.2-1.4 mm. long, 0.8-1.0 mm. in diameter, ovoid, glabrous; style 0.5-0.7 mm. long; stigma 0.4-0.6 mm. wide. FRUITING CALYX 4.5-8.0 mm. long, 3.5-4.0 mm. in diameter, ovoid. CAPSULE 4.3-6.0 mm. long, 3.0-3.5 mm in diameter, ovoid, glabrous, 3-valved, each 3.0-3.5 mm. wide, ovate-elliptic, acute. SEEDS c. 15, inequilateral and the thin membrane readily separating when seeds moistened.

FLOWERING: April-May. HABITAT: dry rocky ridges. DISTRIBUTION: Known only from certain islands off the southern California coast. (Santa Catalina, Santa Cruz and Santa Rosa Islands). (Map 10.)

This species is readily distinguished from the closely related *H. scoparium* by its inflorescence which is densely covered with both simple villous and red glandular hairs and by its lanceolate outer sepals.

There is some evidence that limited hybridization has occurred between this species and at least one form of the bafflingly variable *H. scoparium.* Certain plants (*Abrams & Wiggins 155* [UC] and *Hoffman* 15 June 1930 [SBM], which in most other respects would have been quickly relegated to the last mentioned species, proved exceptional in possessing at least a moderate sprinkling of glandular trichomes very similar to those possessed by *H. Greenei.* At least three recognizable variants of *H. scoparium* are to be found within the confined range of *H. Greenei.* These are the so-called varieties *scoparium, vulgare,* and a comparatively rare form, possessing extremely mealy-pubescent stems and foliage, which has never been formally named and which occurs apparently only on Santa Cruz Island and the adjacent mainland of Santa Barbara and Ventura Counties. A few of the insular specimens of this unnamed variant possess some glandular trichomes of the sort found in *H. Greenei* which apparently grows in close proximity. Extensive field work within the Californian complex would doubtless prove most profitable.

Grosser (Pflanzenreich 14 IV. 193: 33. 1903.) assigned this species, *H. scoparium,* and the endemic Chilean *H. spartioides* to the section *Spartioides* of the segregate genus *Halimium.* Those three species were distinguished by him from other New World species of *Helianthemum* by their spartioid habit and isomorphic (chasmogamous) flowers. The floral characteristic for such separation has lost some of its value inasmuch as *H. nutans* and *H. patens* also have only isomorphic (chasmogamous) flowers and yet they are non-spartioid. This interesting disjunction pattern has recently been the subject of a stimulating symposium (Quart. Rev. Biol. 38: 109-177. 1963.)

REPRESENTATIVE SPECIMENS: CALIFORNIA: Los Angelos Co., Santa Catalina Island, ne. side of Black Jack Mt., *Blakley 5433* (SBBG); Santa Barbara Co., Santa Cruz Island, July & August 1886 *Greene* (ND, NY), April 1888 *Brandegee* (GH, UC), *Abrams & Wiggins* 156 (F, UC), *Clokey 5007* (GH, UC); Santa Barbara Co., Santa Rosa Island, *Epling & Erickson* 8 Aug. 1937 (LA).

10. Helianthemum scoparium Nutt.

Helianthemum scoparium Nutt. in Torrey & Gray, Fl. N. Am. 1: 152. 1838. Type: *Nuttall,* not seen. "Dry hills around Monterey, California."

Linum trisepalum Kellogg, Proc. Calif. Acad. Sci. 3: 42. 1863. Type: not seen. *Bolander,* "on the White Hills back of Oakland."

Helianthemum Aldersonii Greene, Erythea 1: 259. 1893. Lectotype:

Alderson, June 1893. (JEPS!) "Mountains of the southern borders of San Diego Co., Calif."

Halimium scoparium (Nutt.) Gross., Pflanzenreich 14 (IV. 193) :35. 1903.

Helianthemum mendocinensis Eastwood ex Gross., Pflanzenreich 14 (IV. 193) : 35. 1903. nom. illegit. Art. 34(4) ; mistakenly published in synonymy of *Halimium occidentale* (Greene) Gross., a synonym of *H. Greenei* Robins.

Halimium Aldersonii (Greene) Standl., Contr. U.S. Nat. Herb. **23** (3): 832. 1923.

Crocanthemum scoparium (Nutt.) Millsp., Field Mus. Publ. Bot. **5**: 175. 1923.

Helianthemum scoparium var. *vulgare* Jepson, Man. Fl. Pl. Calif. 641. 1925. Lectotype: *Jepson* July 3, 1896, Coulterville [Mariposa Co., California]. (JEPS!)

Crocanthemum Aldersonii (Greene) Janchen, Nat. Pflanzenfam. ed. 2. 21: 305. 1925.

Helianthemum scoparium var. *Aldersonii* (Greene) Munz, Man. South. Calif. 316. 1935.

Helianthemum suffrutescens Schreiber, Madroño 5: 81. 1939. Type: *Schreiber 2243* (UC!). Isotype: (GH!). Amador Co.: dry slope 5.5 miles west southwest of Bisbee Peak, elevation 500 feet.

Suffruticose perennial, usually spartioid, (5)12-42(65) cm. tall with many stems arising from a woody caudex. STEMS spreading to erect, usually green and sparsely stellate-pubescent to glabrate (rarely covered with a dense stellate tomentum). LEAVES sessile or on petioles up to 3 mm. long; blade (4)7-26(43) mm. long, (8)10-15(24)-times longer than wide, (0.5)0.8-2.0(6.0) mm. wide, sometimes elliptic but usually narrowly oblanceolate to linear, green and sparsely stellate-pubescent to glabrate on both surfaces (occasionally covered with dense stellate tomentum); midvein prominent and secondary veins obscure beneath; base of blade attenuate, apex obtuse to acute; margin entire, mostly revolute. FLOWER: isomorphic (chasmogamous), few to many, paniculate to racemose or sometimes even appearing solitary at the tip of the very short branch (of the current year's growth). Pedicels and calyces glabrous to moderately stellate-pubescent (or more rarely covered with a dense stellate tomentum).

CHASMOGAMOUS FLOWERS: pedicels 2-12 mm. long, ranging from shorter to three-times longer than the length of the calyx. OUTER SEPALS (free portion) 0.5-4.5 mm. long, 0.1-0.8 the length of the inner sepals, 0.2-0.4 mm. wide, linear; INNER SEPALS 2.5-7.0 mm. long, 2.0-3.5 mm. wide, ovate, acuminate. PETALS 3-11 mm. long, 3-8 mm. wide, obovate, yellow. STAMENS 12-47. PISTIL 1.4-2.0 mm. long; ovary 0.8-1.2 mm. long, ovoid, glabrous; style 0.5-0.8 mm. long, sometimes nearly as long as the ovary; stigma 0.3-0.5 mm. wide. FRUITING

CALYX 3-8 mm. long, 2-3 mm. in diameter, ovoid. CAPSULE 2.5-4.0 mm. long, 1.8-2.7 mm. in diameter, ovoid, glabrous, 3-valved, each 1.8-2.7 mm. wide, ovate, acute. SEEDS 4-10, inequilateral, when moistened the thin membrane separable and with white papillae and the embryo visible.

FLOWERING: March-July. HABITAT: dry sandy or rocky soil of hills and ridges. DISTRIBUTION: along the Californian coast from Mendocino Co. southward into northwestern Baja California and along the Sierra Nevada mountains from El Dorado Co. southward into Fresno Co.; also known from several off-shore islands (Santa Rosa, Santa Cruz and Santa Catalina). (Map 11.)

Helianthemum scoparium is an unusually variable species, which may be deduced in part from the fact that since it was first described, two proposed species and several varieties have been segregated from it. In addition, several collections were designated as new entities in herbaria but apparently never published. Even this indicated diversity fails to express the observed variation.

The variation is particularly pronounced in respect to the habit, pubescence, number of flowers per inflorescence, size of inflorescence, length of both inner and outer sepals and the petals, and in the size as well as shape of the leaves. All of these variable characters have been used as criteria in specific or varietal segregation. Considerable time has been spent by us in examining more than 750 herbarium specimens in an attempt to determine what importance should be assigned to these characters, as well as to feasibility of specific and/or varietal segregation.

The plants collected along the immediate coast from Mendocino Co. southward into Santa Barbara Co. have a low, spreading to ascending habit, with but few comparatively large flowers either solitary at the tip of the very short branchlets to few in leafy racemose cymes. Their outer sepals are mostly 3-5 mm. long. The type of the species was based upon such plants.

Plants of the so-called var. *vulgare* are relatively taller than those mentioned above and are mostly ascending to erect, with more numerous but smaller flowers and with outer sepals less than half as long as the inner ones. Such plants occur almost throughout the entire range of the species but are especially abundant along Coastal Ranges from Lake County south into northern Baja California.

The third previously recognized variant is a typically tall plant with an open panicle and with relatively longer petals. Plants possessing these features range from western San Bernardino Co. south into northern Baja California. Greene (Erythea **1**: 259. 1893.) described such plants from the "mountains of the southern border of San Diego Co." as *H. Aldersonii.* Robinson (in Gray's Syn. Fl. N. Am. 1(1): 191. 1895.) treated Greene's *H. Aldersonii* as a synonym of *H. scoparium* stating "If Prof. Greene's species is represented as appears from character by Dr. Palmer's No. 18 from the same region, it is with little doubt merely a southern and more leafy form of *H. scoparium,* at least such was Dr. Gray's view."

The features employed by Munz to characterize var. *Aldersonii* do not appear distinctive when a large series of specimens is examined. It is certain that numerous specimens occur with the open inflorescence of *Aldersonii* but with smaller petals which fall within the range of *vulgare.* Specimens with characteristics designated by Munz for var. *Aldersonii* are found along the coast as well as in the inland area attributed to it. In many respects numerous plants from the lower slopes of the Central Sierra are intermediate between var. *vulgare* and var. *Aldersonii* in possessing the smaller petals of the former and the more open inflorescence of the latter.

Schreiber (Madroño 5: 81. 1939.) described plants from the foothills of the Central Sierra calling the proposed taxon *H. suffrutescens.* Schreiber's type was from Amador County but plants with these features were seen from four nearby counties.

The suggested differentiating characters prove variable even among specimens designated by Schreiber as *H. suffrutescens.* In addition, a comparison of the leaves of *H. suffrutescens* and *H. Aldersonii* shows them to be often similar in size and shape although the leaves of Schreiber's plants were more pubescent. The greater degree of pubescence alone does not appear worthy of formal recognition. Schreiber herself admitted that there are no floral or seed differences between her species and *H. scoparium* var. *vulgare*.

A key is presented below based largely upon that published by Schreiber supplemented by the more recent treatment by Munz summarizing the differences supposedly distinguishing these taxa.

1. Leaves narrowly linear, green, sparsely stellate-pubescent to glabrous, deciduous in summer.
   2. Plants low and divaricate, matted, with ultimate twigs erect; flowers few; inflorescence usually very leafy; inner sepals 4-5 mm. long; petals 5-7 mm. long (coastal from Mendocino Co. to Santa Barbara Co.). .... *H. scoparium* var. *scoparium*.
   2. Plants tall and rush-like; flowers numerous; inflorescence sparsely leafy; inner sepals 2-6 mm. long; petals 4-12 mm. long.
      3. Panicle usually narrow; petals about 4-6 mm. long; inner sepals 2-3.5 mm. long (from Lake Co. south into northern Baja California and on the lower slopes the Sierra from Placer Co. to Mariposa Co., also found on both Santa Catalina and Santa Cruz Islands.) .... *H. scoparium* var. *vulgare*.
      3. Panicle extremely open; petals 8-12 mm. long; inner sepals 5-6 mm. long (from southwestern San Bernardino Co. south into northern Baja California). .. *H. scoparium* var. *Aldersonii*.
1. Leaves linear-lanceolate or oblanceolate, densely stellate-pubescent; not deciduous in summer (foothills of the Sierra in Amador Co.). .... *H. suffrutescens*.

At the present state of our knowledge we do not feel that the variation noted within this complex can best be treated by the recognition of formal infraspecific categories. The present system as illustrated by the above key is in our opinion unsatisfactory. For example, the erect var. *vulgare* apparently contains populations that have small flowers (as is called for by the key) and other populations whose large flowers closely approximate those of var. *scoparium*. Perhaps as many as one-fifth of the specimens examined possess a combination of characters which would make it difficult to refer them to any of the so-called varieties or species. Such plants occur nearly throughout the range of the species but are most abundant and perplexing in the foothills of the central Sierras, southern California and the offshore islands.

The present unsatisfactory treatment can best be resolved by extensive observation of populations in their natural habitats together with transplant studies. The progeny of a few plants collected in the wild and grown at the Rancho Santa Ana appear to be quite different from their seed parent. We have pointed out under *H. Greenei* the presence of an unpublished variant of this species which occurs on several of the Channel Islands and to a limited extent upon the adjacent mainland that is rendered conspicuous by its mealy pubescence. We can only conclude that the entire complex is most deserving of intensive field study and that the problem does not lend itself to solution by reference to the herbarium.

REPRESENTATIVE SPECIMENS: UNITED STATES; CALIFORNIA: Amador Co., Ione, *Hoover 2415* (UC); Calaveras Co., 2.5 mi. nw. of Harmon Peak, *Roseberry 209* (UC); Contra Costa Co., Mount Diablo, Ridge south of Uncle Sam Canyon (on Eagle Point Ridge), *Bowerman 1598* (UC); El Dorado Co., Sweetwater Creek, June 1907, *Simpson* (UC); Fresno Co.: Chaparral, at n. end of the sw. facing Big Sandy Bluffs, 2 June 1935, *Quibell* (COLO); Lake Co.: hills west of Mirabel Mine, *Mason 8324* (UC); Los Angeles Co.; dry ridges and hill sides, Mandeville Canyon, Santa Monica Mountains, *Clokey & Templeton 4490* (F, GA, GH, ILL, MIN, MO, NO, PENN, UC, US, WIS); Santa Cataline Island, *Nuttall 154* (UC); Marin Co., Mt. Tamalpais, *Heller 5721 a* (F, GH, MO, PH, US); Mariposa Co., Devil's Gulch, 4 July 1892, *Congdon* (MIN); Mendocino Co.: about Mendocino, *Brown 785* (F, MIN, MO, UC); Monterey Co., from type locality along the railroad near seaside (beyond Del Monte), *Heller 6751* (COLO, F, GH, IND, ISC, MIN, MO, UC, US, WIS); Napa Co., Sarco Creek 4 mi. above Napa, *Ewan 8825* (NO, SMU); Orange Co., Santa Ana River Canyon, *Munz & Johnston 5307* (UC); San Benito Co., 10 mi. below San Benito, *Fosberg S4992* (GH, KANU); San Bernardino Co., Etiwanda, *Abrams 2664* (DS, GH, MO, PH, UC, US); San Diego Co., La Jolla, *Clements & Clements 40* (ARIZ, COLO, F, GH, ILL, PENN, PH, MIN, MO, UC); San Francisco Co., without exact locality, *Michener & Bioletti* (GH); San Luis Obispo Co., 1.5 mi. sw. of Los Berros, *Lee 411* (UC); San Mateo Co., Pilarcitos Lake and Canyon, *Davy 1157* (UC); Santa Barbara Co., Santa Cruz Island, *Clokey 5006* (GH, ILL, MIN, PENN, UC, US); Carpinteria, 26 March 1958, *Pollard* (ARIZ, TEX); Santa Rosa Island, June 1888, *Brandegee* (GH, UC); Santa Clara Co., foothills west of Los Gatos, *Heller 7350* (F, GH, ILL, IND, ISC, MO, PH, UC, US, WIS); Santa

Cruz Co., Pine Mt. Trail, Big Basin, *Mason 2247* (UC); Sonoma Co., Vine Hill, w. of Santa Rosa, *Heiser 1744* (UC); Ventura Co., near North Signal Street, 17 April 1945, *Pollard* (GH). MEXICO: BAJA CALIFORNIA: Burned over hills about 20 mi. e. of Ensenada, *Wiggins 11867* (DS, UC); Tecate, n. Baja California, *Fosberg 8346* (DS, MO, PENN).

11. Helianthemum nutans T. S. Brandeg.

Helianthemum nutans T. S. Brandeg., Proc. Calif. Acad. ser. 2. 2: 129. 1889. Type: *Brandegee*, 7 May 1889 (UC!). Isotypes: (A, F, NY, US!). "very abundant in rocky soil about the plains of San Julian" Baja California.

Halimium nutans (T. S. Brandeg.) Standl., Contr. U.S. Herb. 23(3): 834. 1923.

Crocanthemum nutans (T. S. Brandeg.) Janchen, Nat. Pflanzenfam. ed. 2. 21: 207. 1925.

Bushy shrub, 10-30 cm. tall with few to numerous stems arising from a thick woody root. STEMS woody, gray, ascending, much branched. BRANCHES ascending, woody, with numerous, bushily arranged ultimate branchlets; those of the current growth light green and densely, short stellate-pubescent. LEAVES only on current season's growth, sessile; blade 5-8 mm. long, 0.8-1.5 mm. wide; spatulate-oblanceolate, broader above the middle; light green and very densely short stellate-pubescent on both surfaces and also ciliate with 1-3 simple hairs (1-1.5 mm. long) along both margins of the blade; midvein but slightly elevated and secondary veins obscure beneath; leaf-blade tapering to the base, apex obtuse to somewhat acute; margin entire, non-revolute. (The old branches covered with axillary fascicles of small leaves that persist long after the principal leaves have fallen). FLOWERS isomorphic (chasmogamous), few on each branchlet, borne in a sympodial inflorescence but appearing solitary, either alternating with or opposite the leaves. Pedicel and calyx stellate-puberulent, sometimes the calyx with few simple, elongate trichomes resembling those of the leaf margin.

CHASMOGAMOUS FLOWERS: pedicels 7-15 mm. long, somewhat curved, and articulate at the base. OUTER SEPALS (free portion) 2-4 mm. long, 1/3-1/2 the length of the inner sepals, 0.2-0.3 mm. wide, linear; INNER SEPALS 5.5-7.0 mm. long, 2.8-3.2 mm. wide, ovate-lanceolate, twice longer than wide, acute, bright green. COROLLA bright yellow; petals 7-9 mm. long, 5-7 mm. wide, broadly cuneate. STAMENS 25-32. PISTIL 1.6-2.0 mm. long; ovary 1.2-1.4 mm. long, 0.8-1.0 mm. in diameter, ovoid, glabrous; style 0.4-0.6 mm. long; stigma 0.4-0.6 mm. wide, capitate. FRUITING CALYX 6-8 mm. long, 3.0-3.5 mm. in diameter, narrowly ovoid. CAPSULE 4.8-5.2 mm. long, 2.4-2.7 mm. in diameter, narrowly ovoid-triquetrous, about twice as long as wide, glabrous, 3-valved, each valve 2.4-2.7 mm. wide, narrowly ovate, acute, slightly concave. SEEDS 20-26, inequilateral, the thin seed membrane with numerous white papillae especially on the edges of the seed; the membrane separable when moistened and then the embryo becoming somewhat visible.

FLOWERING: February-April. HABITAT: on dry, rocky soil of flats and gullies. DISTRIBUTION: southern Baja California, Mexico. (Map 16, large dots.)

This little-collected species is endemic to Baja California. It can be easily distinguished from all other North American species of *Helianthemum* by its low, shrubby and much-branched habit, and by its spatulate leaves (0.5-1.5 mm. wide) whose margins bear on each side 1-3 simple hairs about 1.0-1.5 mm. long.

Grosser (Pflanzenreich 14 (IV. 193): 52. 1903.) supposed, judging only from the original description, that this species might be closely related to *H. scoparium*. The unique features possessed by this species would seem to indicate a relatively isolated position within the genus.

REPRESENTATIVE SPECIMENS: MEXICO: BAJA CALIFORNIA: Lower California, Plains of San Julian, 7 May 1889, *Brandegee* (A, F, NY, UC, US); 5 mi. n. of Mesquital Grande, 9 Feb. 1935, *Haines & Stewart* (A, ARIZ, DS, F, ILL, ND, RSA, TEX, UC); bushy gully in Cretaceous Sediments, 4 mi. e. of Santa Catarina Landing, *Dressler 610* (MO); locally common on bare flat area near Agua de Higuera, *Moran* 10232 (DUKE, SD).

12. Helianthemum patens Hemsl.

Helianthemum patens Hemsl., Diagn. Pl. Nov. Mex. et Centr. Amer. part 2: 20. 1879. Type: *Parry & Palmer 30* (K). Isotypes: (F, GH, MO, NY, US!). "Mexico: in regione San Luis Potosi, alt. 6000-8000 ped."

Halimium patens (Hemsl.) Gross., Pflanzenreich 14 (IV. 193): 46. 1903.

Perennial herb or somewhat suffruticose, (3)10-17(30) cm. tall with one to few stems arising from a woody caudex. STEMS ascending to erect, glabrous or densely stellate-pubescent, branching from near the base. LEAVES (on current season's growth) sessile or on petioles up to 1.0 mm. long; blade 2-8(15) mm. long, 0.6-4.0(6.0) mm. wide, ovate-elliptic or lanceolate, glabrous or sparsely to densely stellate-pubescent on both sides, midvein prominent and secondary veins obscure beneath; base of blade cuneate, apex acute or pointed and lustrous; margin entire or nearly so, non-revolute. Glabrous leaf-blades generally lanceolate and 5-times or more longer than wide; the sparsely to densely stellate-pubescent leaf-blades generally ovate-elliptic and 5-times longer than wide or less. FLOWERS isomorphic (chasmogamous) and with but few on each branch, borne in sympodial inflorescences but appearing solitary, axillary, or subterminal and either alternating or opposite the leaves.

CHASMOGAMOUS FLOWERS: pedicels 5-15 mm. long, (1)1.5-3 times longer than calyx, divergent to ascending, purple or greenish or even hoary in color, glabrous or stellate-pubescent, disarticulating near the base. CALYX either glabrous and lustrous and mostly purplish, or sparsely stellate-pubescent intermixed with simple villous hairs or densely and minutely stellate-pubescent. OUTER SEPALS (free portion) 1.0-2.4 mm. long, ¼-½ the length of the inner sepals, 0.2-0.4 mm. wide, linear; INNER SEPALS 2.6-4.0 mm. long, 1.6-2.5 mm. wide, ovate, acute. COROLLA pale yellow; petals 3-6 mm. long, 2.4-5.0 mm. wide, obovate. STAMENS 10-14(20). PISTIL 1.4-1.7 mm. long; ovary 0.8-1.2 mm. long, c. 0.8 mm. in diameter, ovoid, glabrous; style 0.2-0.5 mm. long; stigma 0.3-0.6 mm. wide, capitate. FRUITING CALYX 3-5 mm. long, 2.5-4.0 mm. in diameter, ovoid to subglobose. CAPSULE 3-4 mm. long, 2.4-3.2 mm. in diameter, ovoid to subglobose, 3-valved; each valve 2.4-3.2 mm. wide, ovate, acute, somewhat rounded at the back. SEEDS 10-13(20), inequilateral, light brown, with separable membrane when moistened and the embryo then visible.

FLOWERING: May-August. HABITAT: dry open rocky, grassland hills ond old lava among oak scrub. DISTRIBUTION: Mexico: from Zacatecas and San Luis Potosí to southeastern Puebla. (Map 16, small dots.)

Helianthemum patens can be readily distinguished from all central Mexican species by its relatively few petaliferous flowers borne on divergent to ascendent pedicels 1-3 times longer than its calyces in a sympodial, axillary or subterminal inflorescence.

Helianthemum nutans of Baja California has the same kind of inflorescence but is easily distinguished from *H. patens* by its shrubby and much-branched habit, by its fasciculate leaves that persist long after the principal leaves have fallen, and by the few simple hairs (1.0-1.5 mm. long) on the margin of the leaf.

Grosser (Pflanzenreich 14 (IV. 193) : 47. 1903.) treated this species as having dimorphic flowers, but no cleistogamous flowers were seen by us on any of the specimens examined. *Helianthemum patens* together with *H. nutans, H. scoparium,* and *H. Greenei* are the only North American species having only petaliferous flowers.

Vegetatively this is a rather variable species. Specimens examined may be arranged into three pubescence types. Plants collected from near the center of distribution of the species are light green, glabrous and lustrous throughout and have lanceolate leaves. Plants collected from the middle and southern portion of the species distribution are green, sparsely stellate-pubescent, somewhat lustrous and with ovate-elliptic leaves. The isotypes (and hence presumably the type) and the majority of the specimens examined belong to this form. Plants collected from the central and northern range of the species distributed are green or sometimes hoary, densely stellate-pubescent throughout, with ovate-elliptic leaves, and more woody than the other two. Specimens of all three types have however been collected in the same locality. More collections are necessary before any attempt to evaluate these conspicuous variants would appear warranted.

All North American species of *Helianthemum* are stellate-pubescent except for the few specimens of this species which were completely glabrous.

REPRESENTATIVE SPECIMENS: MEXICO: JALISCO: sw. of Ojuelos on road to Aquascalientes, *McVaugh 16799* (MICH), *McVaugh 16849* (MICH), *McVaugh 16850* (MICH); *McVaugh 16851* (MICH). PUEBLA: vicinity of San Luis Tultitanapa, near Oaxaca, *Purpus 3383* (F, GH, MO, UC); below Atzizintla (San Antonio), *Balls 5315* (A, UC); Esperanza, *Purpus 2486* (F, GH, MO, UC); Esperanza, *Balls 5401* (GH, UC); SAN LUIS POTOSI: San Rafael, *Schaffner 498* (F, ISC, MICH, MIN, PH, POM); chiefly in the region of San Luis Potosí, *Parry & Palmer 28½* (GH, PH), *Parry & Palmer 30* (F, GH, MO, NY, US); Mts. w. of San Luis Potosí, Sierra Madre Oriental, *Pennell 17630* (MICH, NY, PH, UC); Alvarez, *Palmer 602* (F, GH); ZACATECAS: 25 mi. nw. of Fresnillo, *Waterfall 15590 & 15591* (OKLA); Zacatecas, Aug. 1903, *Purpus* (UC).

13. Helianthemum corymbosum Michx.

Helianthemum corymbosum Michx., Fl. Bor.-Am. 1: 307. 1803. Type: Michaux (P). Photograph of type (GH!). "In maritimis Carolinae et Georgiae."

Cistus corymbosus (Michx.) Poir., Encyc. Suppl. 2: 272. 1811.

Heteromeris cymosa Spach, Ann. Sci. Nat. 2nd. ser. **6**: 370. 1836. nom. nud. & illegit. since *Helianthemum corymbosum* Michx. is cited as a synonym; *descr.* Spach, Hist. Nat. Vég. Phanér. 6: 103. 1838, but *Helianthemum corymbosum* Michx. is again cited as a synonym.

Halimium corymbosum (Michx.) Gross., Pflanzenreich 14 (IV. 193): 49. 1903.

Crocanthemum corymbosum (Michx.) Britt. in Britton & Brown, Ill. Fl. ed. 2. 2: 541. 1913.

Perennial herb or rarely suffruticose, (7)11-30(52) cm. tall with one to many stems arising from a caudex. STEMS erect or nearly so, covered with appressed stellate-pubescence but becoming glabrate. BRANCHES alternate, wiry, ascending, mostly restricted to the upper half of the stem. CAULINE LEAVES: petiole 1-5 mm. long; blades (9)18-35(47) mm. long, (1.5)4-10(13) mm. wide; obovate-elliptic, elliptic to elliptic-lanceolate near the apex, green and stellate-puberulent beneath, conspicuously discolorous; midvein and secondary veins prominent beneath; base of blade cuneate, apex obtuse or nearly so to acute; margin entire, upper leaves slightly revolute. INFLORESCENCE: a compound dichasium terminating the stem and sometimes the branches. FLOWERS dimorphic; the long-pedicellate chasmogamous flowers overtopping the very shortly pedicellate, smaller, more numerous and congested cleistogamous flowers. Bracts 1.6-7 mm. long, 0.2-1.2 mm. wide, spatulate-linear. Pedicel and calyx covered with short stellate pubescence and also with longer (0.5-1.5 mm. long), simple, often very abundant, villous trichomes.

CHASMOGAMOUS FLOWERS: pedicels 6-15(28) mm. long, 1-5 times longer than calyx. OUTER SEPALS (free portion) 2.4-4(5.2) mm. long, 0.7-1.2 mm. wide, spatulate-linear, apex obtuse or nearly so, often drying brownish; INNER SEPALS 3-6(8) mm. long, 2.5-3.6 mm. wide, ovate, acute to acuminate. PETALS 6-11 mm. long, 5-9.5 mm. wide, obovate. STAMENS 20-30. PISTIL 1-1.4 mm. long, ovary 0.7-1.1 mm. long, 0.6-1 mm. wide, ovoid, glabrous; style 0.2-0.5 mm. long; stigma 0.5-1 mm. wide, capitate. FRUITING CALYX 4-6.5(7.8) mm. long, 1.5-5 mm. in diameter. CAPSULE 3.6-5.4 mm. long, 3-4 mm. in diameter, ovoid and somewhat angled, apiculate, glabrous, 3-valved; each valve 2.4-3.3 mm. wide, ovate, acute, slightly concave; funiculi and placentae remaining attached to the receptacle after valves and seeds have fallen. SEEDS 15-30, ovoid to somewhat irregular, light to dark brown, smooth and with a thin, separable membrane.

CLEISTOGAMOUS FLOWERS: numerous, subsessile, sepal tips (especially the outer ones) brown. STAMENS 4-6. FRUITING PEDICELS 1-2.5 mm. long, shorter than calyx. FRUITING CALYX 2.2-4.8 mm. long, 1.8-3.5 mm. in diameter, ovoid. OUTER SEPALS (free portion) 1.8-3 mm. long, 0.3-0.9 mm. wide, spatulate-linear, apex obtuse or nearly so and brown; INNER SEPALS 2.2-4.8 mm. long, 1.2-3 mm. wide, ovate, acute. CAPSULE 1.6-3.8

mm. long, 1.4-3 mm. in diameter, ovoid-triquetrous, apiculate, 3-valved; each valve 1.4-2.4 mm. wide, ovate-elliptic, acute, slightly concave; funiculi and placentae remaining attached to the receptacle after valves and seeds have fallen. SEEDS 4-8(10), similar to those in the chasmogamous fruit.

FLOWERING: February-April. HABITAT: sand dunes and beaches, dry sandy pinelands, fields and openings in live-oak woodlands. DISTRIBUTION: along the Coastal Plain of North Carolina southward throughout peninsular Florida and west along the Gulf Coast into Mississippi. (Map 8.)

REPRESENTATIVE SPECIMENS: NORTH CAROLINA: Carteret Co., Lennox Point, Beaufort, *Godfrey 49843* (COLO, DS, DUKE, FSU, ILL, IA, IND, ISC, KANU, MIN, NCSC, NCU, NY, PENN, PH, SMU, TEX, UC, US, WIS, WVA); Dare Co., pineland at Frisco, *Radford, Haesloop & Miller 7790* (NCU). SOUTH CAROLINA: Beaufort Co., Hunting Island State Park, *Bell 2478* (FSU, NCU); Berkeley Co., 5 mi. w. of Pineville, *Godfrey & Tryon 1134* (GH, NY, US); Charleston Co., Isle of Palms, *Robinson 133* (GH); Georgetown Co., 3 mi. e. of Georgetown, *Godfrey & Tryon 1085* (CU, DUKE, GH, MICH, MO, MIN, NY, PENN, TENN, PH, UC, US). GEORGIA: Charlton Co., at Camp Cornelia, *Duncan 7428* (GA, NCSC, SMU); Chatham Co., Tybee Island, *Harper 2173* (GH, MO, NY, US). FLORIDA: Broward Co., Hollywood, *Moldenke 599* (DUKE, ILL, MO, NY, PENN); Citrus Co., s. of Inverness, *Cooley, Wood & Wilson 5936* (NCU, US, USF); Clay Co., Hibernia, March 1869, *Canby* (F, GH, MO, MICH, NY, US); Dade Co., Humbugus Prairie, *Small & Mosier 5602* (DUKE, FLAS, GH, NCU, NY, US); Dixie Co., 10 mi. n. of Suwannee, *Godfrey 56476* (DUKE, FSU, IA, USF, UC, VDB); Duval Co., near Jacksonville, *Curtiss 4601* (GH, ISC, MIN, MSC, NY, UC, US); *Curtiss 227* (CU, F, FLAS, GH, IA, KANU, MIN, MO, NY, PH, SMU, UC, US); Franklin Co., Alligator Point, *Godfrey 53201* (DUKE, FSU, GH, IA, NCSC, NCU, NY, USF, VDB); Lake Co., vicinity of Eustis, *Nash 137* (GH, MIN, MSC, NY, PH, UC, US); Lee Co., w. of Fort Myers, *Moldenke 926* (DUKE, ILL, MIN, MO, NY, PENN). MISSISSIPPI: Harrison Co., Cat Island, *Ray 2728* (USF).

14. Helianthemum concolor (Riley) Ortega

Halimium concolor Riley, Kew Bull. 1923: 107. 19 April 1923. Type: *Gonzalez 842* (K) not seen. "San Ignaciei Cerro del Buen Retiro, 1660 M." Sinaloa.

Halimium exaltatum Rose & Standl., Contr. U.S. Nat. Herb. **23** (3): 833. 18 July 1923; *ibid.*, **23**: 1675. 1926, Riley's epithet cited as follows: "Page 833. *Halimium exaltatum.* A synonym is *Halimium discolor* [*sic*] Riley, Kew Bull. *1923*: 107. 1923." Type: *Pringle 10409* (US!). Isotypes: (F, DUKE, GH, OKLA, MIN, MSC, SMU!). "dry hills above Uruapan, Michoacan, alt. 1,500 m."

Crocanthemum exaltatum (Rose & Standl.) Janchen, Nat. Pflanzenfam. ed. 2. 21: 305. 1925.

Helianthemum concolor (Riley) Ortega, Cat. Sist. Pl. Sinaloa 4. 1929.
Helianthemum exaltatum (Rose & Standl.) Ortega, Cat. Sist. Pl. Sinaloa 4. 1929.

Shrub up to 1 m. tall. STEMS erect, coarsely stellate-pubescent. CAULINE LEAVES: petiole 3-5 mm. long; blade 11-42 mm. long, 5-20 mm. wide; elliptic-obovate, green and sparsely stellate-pubescent on both sides, lower epidermis conspicuous and not masked by the pubescence; midvein and secondary veins conspicuous and mostly elevated beneath; base of blade attenuate, apex obtuse to acute, sometimes mucronate; margin entire, non-revolute. FLOWERS dimorphic (chasmogamous and cleistogamous) crowded at the end of the stem and branches. Chasmogamous flowers fewer and on pedicels subequaling to slightly longer than those of the cleistogamous flowers. Pedicel and calyx covered with short stellate-pubescence and with white and with much longer, coarse, stellate-pubescence, with the individual trichomes up to 2 mm. long. Bracts numerous, 2-6 mm. long, 0.2-0.5 mm. wide, linear to narrowly lanceolate.

CHASMOGAMOUS FLOWERS: pedicels 3.5-9.5 mm. long. OUTER SEPALS (free portion) 2.5-5.0 mm. long, 0.2-0.3 mm. wide, very narrowly linear; INNER SEPALS 4.5-7.0 mm. long, 2.8-3.6 mm. wide, ovate, acuminate, sometimes with veins prominent at the back. COROLLA yellow, petals 5-8 mm. long, 5-6 mm. wide, obovate. STAMENS 20-30. PISTIL 1.6-2.0 mm. long; ovary 1.2-1.6 mm. long, 0.5-0.8 mm. in diameter, ovoid, glabrous; style 0.4-0.7 mm. long; stigma 0.3-0.4 mm. wide, capitate. Chasmogamous flowers with mature fruit not seen.

CLEISTOGAMOUS FLOWERS: pedicels 2-3(up to 5 at fruiting) mm. long. Outer sepals (free portion) 2.0-3.6 mm. long, 0.1-0.3 mm. wide, narrowly linear; INNER SEPALS 3.5-5.0 mm. long, 1.6-2.0 mm. wide, ovate-lanceolate, acuminate. STAMENS 5-7. PISTIL 1.5-2.0 mm. long, ovary ovoid, glabrous. FRUITING CALYX 4.8-6.5 mm. long, 2.4-3.6 mm. in diameter, ovoid. CAPSULE 3.6-4.4 mm. long, about twice longer than wide, 1.7-2.5 mm. in diameter, ovoid-triquetrous, glabrous, 3-valved; each valve 1.7-2.4 mm. wide, ovate to ovate-lanceolate, acute. SEEDS 4-7, ovoid or depressed on both sides, with thin separable membrane and the embryo becoming visible when seed is moistened.

FLOWERING: October-February. HABITAT: Dry hillsides. DISTRIBUTION: Mexico: southern Sinaloa, northwestern Jalisco, central and northwestern Michoacán, and southwestern Mexico State. (Map 17, small dots).

This is the only Mexican species with a leaf-blade so sparsely stellate-pubescent that the epidermis is readily visible beneath.

SPECIMENS EXAMINED: MEXICO: JALISCO: San Sebastián, Segundo Arroyo, *Mexia 1542* (UC); trail from Real Alto to San Sabestián, *Mexia 1773* (F, UC). MEXICO: Dist. Temascaltepec, Pineda, *Hinton 3190* (ARIZ, GH, PH). MICHOACÁN: Uruapan, *Pringle 13447* (GH, MICH); dry hills above Uruapan, *Pringle 10409* (F, DUKE, GH, OKLA, MIN, MSC, SMU, US); Dist. Coalcomán, Coalcomán, *Hinton 12960* (ARIZ, GH). SINALOA: 3.7 mi. e. of Portrerillos; ca. 36 mi. e. of Concordia, *Breedlove 1679* (DUKE).

15. Helianthemum georgianum Chapm.

Helianthemum georgianum Chapm., Fl. S. U.S. ed. 3. 36. 1897. "Bainbridge, Georgia, Mobile (Mohr)." Lectotype: *Chapman* (MO!).

Halimium georgianum (Chapm.) Gross., Pflanzenreich 14 (IV. 193): 49. 1903.

Crocanthemum stipulatum Janchen, Öster. Bot. Zeit. **71**: 269. 1922. Type: *Tracy 8060*. (W, not seen.) Isotypes: (all seen F, GH, MIN, OS, TEX, UC). Weatherford, Texas.

Crocanthemum georgianum (Chapm.) Barnh. in Small, Man. SE. U.S. Fl. 879. 1933.

Perennial herb or very rarely suffruticose, (10)15-30(40) cm. tall with few to many stems arising from a caudex, spreading by slender, shallowly placed, horizontal roots. STEMS ascending to erect, stellate-tomentose, divergently branched. BASAL LEAVES often in a rosette or forming a mat at the base of the stem, but frequently lacking; petiole 1-2 mm. long; blade 10-28 mm. long, 4.5-11.0 mm. wide; spatulate-oblanceolate, stellate-tomentose on both surfaces; base of blade attenuate, apex obtuse to acute; margin entire, non-revolute. CAULINE LEAVES: estipulate (sometimes with smaller axillary fasciculate leaves at first resembling stipules); petiole 1-3 mm. long; blade (7)20-35(44) mm. long, (1.2)4.5-8.5(12) mm. wide; oblanceolate and becoming narrowly elliptic near the top of the stem, green and stellate-pubescent above, hoary and stellate-tomentose beneath; midvein and secondary veins prominent beneath; base of blade attenuate to cuneate, apex obtuse to acute; margin entire, the upper leaves somewhat revolute. FLOWERS dimorphic (chasmogamous and cleistogamous), 2-7 in racemose cyme at the end of the main stem and lateral branches. First chasmogamous flowers borne on longer pedicels. Bracts 1.2-5.0 mm. long, 0.3-1.0 mm. wide, lanceolate. Pedicel and calyx stellate-canescent.

CHASMOGAMOUS FLOWERS: pedicels 5-12(15) mm. long, 1-3 times longer than calyx. OUTER SEPALS (free portion) 1.5-3.5 mm. long, 5-10 times longer than wide, 0.3-0.5 mm. wide, linear; INNER SEPALS 3.6-6.6 mm. long, 3.0-4.5 mm. wide, ovate, acute. PETALS 6-10(12) mm. long, 4-8(11) mm. wide, obovate. STAMENS (15)20-36. PISTIL 1.2-2.5 mm. long; ovary 0.8-1.7 mm. long, 0.8-1.2 mm. in diameter, ovoid, glabrous; style 0.3-0.7 mm. long; stigma 0.6-1.0 mm. wide, capitate. FRUITING PEDICELS 6-13(16) mm. long. FRUITING CALYX 5.0-7.2 mm. long, 4.2-5.4 mm. in diameter, ovoid. CAPSULE 3.8-5.7 mm. long, 3.2-4.5 mm. in diameter, ovoid, apiculate, glabrous, 3-valved; each valve 3.0-4.2 mm. wide, ovate, acute, slightly concave. SEEDS 20-35, ovoid-depressed to inequilateral, smooth and when moistened, the membrane separable and the embryo visible.

CLEISTOGAMOUS FLOWERS: pedicels 0.6-3.0 mm. long. OUTER SEPALS (free portion) 1.4-2.2 mm. long, c. 0.3 mm. wide, linear; INNER SEPALS 3.0-4.2 mm. long, 2.6-3.8 mm. wide, ovate, acute. STAMENS (3)5(8), remaining attached to the base of the capsule. PISTIL 1.3-1.7 mm. long, ovary ovoid, glabrous. FRUITING PEDICELS 2-6 mm. long. FRUITING CALYX 4.0-5.4 mm. long, 3.2-4.8 mm. in diameter, ovoid. OUTER SEPALS (free portion) 1.9-3.0 mm. long, 5-10 times longer than wide, 0.3-0.5 mm. wide, linear; INNER SEPALS 4.0-5.4 mm. long, 3-4 mm. wide, ovate, acute. CAPSULE 3.0-4.2 mm. long, 2.4-3.3 mm. in diameter, ovoid, glabrous, with 3 valves; each valve 1.9-3.0 mm. wide, ovate, acute. SEEDS 12-20, similar to the seeds of the chasmogamous flowers.

FLOWERING: April-June. HABITAT: Dry, open, sandy woods and fields, turkey oak sand-ridges, and sand-dunes along the beach. DISTRIBUTION: along the coast from North Carolina to northern Florida, westward along the Gulf Coast to Louisiana, and through most of eastern and central Texas; also known from southern Oklahoma and southern Arkansas. (Map 2.)

The 2-7 dimorphic flowers in racemose cymes at the end of the principal branches, and the frequent presence of basal leaves are enough to distinguish this species from any other *Helianthemum* in the United States or Canada. The inflorescence of *H. georgianum* is approached by that of the Mexican and Central American *H. Pringlei.* However, the leaves of *H. georgianum* are long-petiolate and with prominent secondary veins beneath in contrast to the sessile or short-petiolate leaves with obscure secondary veins of *H. Pringlei.* In addition basal leaves are often present in *H. georgianum* while they are always lacking in *H. Pringlei.*

It was at first felt that an undescribed taxon rested undetected under the binomial of this species. Specimens obtained from the sandy maritime forests from the Carolinas and from the offshore islands in the Gulf of Mexico have a very different appearance from the majority of the specimens which resemble those collected in the eastern half of Texas. We were unable to find characters however to substantiate the different appearance that this extreme presents. They were noticeably different from the norm in their generally low habit and but few (2(3)), mostly cleistogamous flowers.

Janchen (Öster. Bot. Zeit. **71**: 269. 1922.) redescribed this species as *Crocanthemum stipulatum,* although all of the New World species of *Helianthemum* are estipulate. Janchen considered the small, fasciculate leaves found in the axil of the cauline leaves to be stipules and felt that this difference alone was of such importance that he had no hesitation to describe the new species on the basis of only this distinction.

REPRESENTATIVE SPECIMENS: NORTH CAROLINA: Brunswick Co., Southport, *Correll & Bloomquist 440* (PENN); Carteret Co., Lennox Point, e. of Beaufort, *Fox & Godfrey 2694* (GH, NCSC, NY, PH); Dare Co.: maritime forest at Buxton, *Radford, Haesloop & Miller 7580* (NCU). SOUTH CAROLINA: Horry Co.: Myrtle Beach, *Wilbur 6974* (DUKE). GEORGIA: Decatur Co., Bainbridge, *Chapman* (IA, MO); Dougherty Co., Albany, 21 May 1930, *Harper* (ARIZ, F, GH, MICH, MO, NY, PH, US); McIntosh Co., in southeast section of Sapelo Island, *Adams & Duncan 17887* (NCSC). FLORIDA: Gadsden Co., near River Junction, *Curtiss 6392* (DS, F, GH, ILL, ISC, MIN, MO. NY, SMU, UC, US); Okaloosa Co., 0.5 mi. w. of Mary Esther, *Godfrey 56671* (FSU, IA, MSC, NY, UC, USF); Wakulla Co., along the beach, Mashes Island, *Godfrey 53203* (DUKE, FSU, GH, IA, NCSC, NCU, NY, TENN, USF, VDB); Walton Co., 5 mi. w. of Portland, *Godfrey 56662* (FSU, IA, UC, VDB). ALABAMA: Mobile Co., Spring Hill, *Mackenzie 4032* (GH, IND, MIN, NY). MISSISSIPPI: Harrison Co., Deer Island, *Pollard 1184* (CU, F, GH, MO, NY, OS, US). LOUISIANA: Natchitoches Parish, Chopin, *Palmer 7985* (NY, US). ARKANSAS: Ouachita Co., near Chidester, *Moore 56-138* (NY). OKLAHOMA: Marshall Co., Lake Texoma, 20 June 1960, *Penfound* (OKL). TEXAS: Bastrop Co., West Point, *Barkley et al 7039* (BUS, COLO, DUKE, FLAS, GH, ILL, ISC, MIN, PENN, TEX); Denton Co., near Roanoke, *Lundell & Lundell 9539* (DS, GH, MICH, SMU); Llano Co., Enchanted Rock, *Tharp et al 47273* (BUS, COLO, DUKE, FLAS, GH, ISC, MIN, TEX); Mason Co., 7 mi. n. of Mason, *McVaugh 8318* (F, GH, MICH, SMU, TEX); Parker Co., Weatherford, *Tracy 8060* (F, GH, MIN, MSC, OS, TEX, UC); Taylor Co., 1 mi. n. of Abilene, *Tolstead 7499* (MO, NCSC, NY, SMU, TEX, UC); Travis Co., Austin, *Tharp 44105* (COLO, DS, DUKE, FSU, IA, ILL, IND, ISC, MO, NCU, NO, NY, OKL, OKLA, PH, SMU, UARK, UC, VDB, WVA).

16. Helianthemum Pringlei S. Wats.

Helianthemum Pringlei S. Wats., Proc. Am. Acad. **23**: 268. 1888. Type: *Pringle 1186*, September 1887 (GH!). Isotypes: (F, MIN, MSC, NY, UC, US!). "On pine plains at the base of the Sierra Madre, Chihuahua."

Halimium Pringlei (S. Wats.) Gross., Pflanzenreich 14 (IV. 193): 46. 1903.

Heteromeris Pringlei (S. Wats.) Ponzo, Nuovo Gior. Bot. Ital. n. s. 28: 169. 1921. (No basionym cited).

Crocanthemum Pringlei (S. Wats.) Janchen, Nat. Pflanzenfam. ed. 2. 21: 305. 1925.

Perennial herb or sometimes suffruticose, 10-42 cm. tall, with few stems arising from an upright caudex (or rarely from a horizontal, subterranean rootstock). STEMS branched, erect to ascending, stellate-pubescent, but also sometimes intermixed with simple, villous hairs on the lower half. CAULINE LEAVES: mostly appressed to the stem, sometimes with but few and small fasciculate leaves in their axils; sessile or with petiole up to 1 mm. long; blade 4.5-25 mm. long, 2.0-5(7.0) mm. wide, elliptic or oblance-elliptic, rarely the lowermost obovate, grayish and stellate-tomentose on both surfaces, or occasionally intermixed with simple villous hairs (especially those on the lower half of the stem); midrib conspicuous and elevated beneath, secondary veins obscure; base of blade cuneate, the apex subacute to acute; margin entire, nonrevolute. FLOWERS: dimorphic (chasmogamous and cleistogamous), 2-5 in racemose cymes terminating the stem and the branches. Pedicel and calyx stellate-tomentose (the outer sepals very rarely villous). Bracts 2-7 mm. long, 0.5-1.5 mm. wide, linear-lanceolate or narrowly elliptic.

CHASMOGAMOUS FLOWERS: pedicels 2-12 mm. long, shorter than to twice longer than calyx, articulate, sometimes purplish. OUTER SEPALS (free portion) 1.2-3.2 mm. long, 0.2-0.4 mm. wide, linear; INNER SEPALS 4-6 mm. long, 2-3 mm. wide, ovate, acute, sometimes purplish. PETALS 5-10 mm. long, 3.6-8.5 mm. wide, yellow or sometimes with purple spot at the middle of the upper edge. STAMENS 25-36. PISTIL 1.4-2.0 mm. long; ovary 1.0-1.4 mm. long, 0.8-1.0 mm. in diameter, ovoid, glabrous; style 0.4-0.6 mm. long; stigma 0.6-0.8 mm. wide, capitate. FRUITING PEDICELS 3-12 mm. long, shorter to twice longer than calyx, articulate. FRUITING CALYX 4.0-6.5 mm. long, 4-5 mm. in diameter, ovoid, sometimes with a distinct base. OUTER SEPALS (free portion) 2.2-3.2 mm. long, 0.2-0.4 mm. wide, linear; INNER SEPALS 4.0-6.5 mm. long, 2.8-3.2 mm. wide, ovate, acute, sometimes purplish. CAPSULE 3.5-6.0 mm. long, 3.0-4.5 mm. in diameter, ovoid-triquetrous, glabrous, 3-valved; each valve 3.0-4.5 mm. wide, ovate, acute. SEEDS 18-24, ovoid to laterally depressed or somewhat inequilateral, smooth and when moistened the membrane separable and the embryo visible.

CLEISTOGAMOUS FLOWERS: fruiting pedicels 1.0-4.2 mm. long, shorter to nearly as long as calyx, articulate. FRUITING CALYX 3.2-4.5 mm. long, 2.4-3.0 mm. in diameter, ovoid, sometimes with a distinct base. OUTER SEPALS (free portion) 1.2-3.0 mm. long, 0.2-0.4 wide, linear; INNER SEPALS 3.2-4.5 mm. long, 2.2-2.8 mm. wide, ovate, acute, sometimes purplish. STAMENS 4-5. CAPSULE 2.4-4.5 mm. long, 2.4-3.2 mm. in diameter, ovoid-triquetrous, glabrous, rarely exceeding the calyx in length, 3-valved; each valve 2.4-3.2 mm. wide, ovate, acute. SEEDS 4-8, similar to the seeds of the chasmogamous flowers.

FLOWERING: June-October. HABITAT: Dry hillsides, pine-oak forest, moist meadows, and mountain summits. DISTRIBUTION: eastern Sonora into Chihuahua and southward in scattered localities into Guanajuato; also occurring in Guatemala and Honduras. (Map 13.)

A few specimens examined during this study varied conspicuously from the typical plants which are herbaceous, erect and tall, and have numerous ascending branches. These few variants were dwarf plants possessing shorter internodes, smaller leaves, and whose crowded flowers are mostly borne on shorter pedicels than those of the typical plants. However, plants having intermediate characters between the two extremes have been encountered and were even mounted on the same herbarium sheet. A few other specimens (some from Mexico and all those collected from Guatemala and Honduras) were suffruticose but most had received stem injury.

REPRESENTATIVE SPECIMENS: MEXICO: CHIHUAHUA: Majalca, 18-20 Aug. 1935, *LeSueur* (ARIZ, F, GH, MO, SMU, TEX, UC); El Cima, *LeSueur 795* (F, TEX); pine plains, base of the Sierra Madre, *Pringle 1186* (F, GH, MIN, MSC, ND, NY, RSA, UC, US); Mesa, west of Hop Valley, Sierra Madre Mts., 17 Sept. 1903, *Jones* (DS, UC); Loreto, Rio Mayo, *Gentry 2578* (ARIZ, F, GH, MO, UC); Summit Sta. Clara Mts., *Shreve 7949* (ARIZ, F). DURANGO: 20 mi. w. of Durango, *Waterfall 12580* (OKLA); El Fuerte, on railroad west of Durango, *Pennell 18247* (F); Otinapa, *Palmer 442* (GH). GUANAJUATO: Dolores Hidalgo-Guanajuato Rd., *Kenoyer 2138* (GH). SONORA: region of the Rio de Bavispe, *White 3434* (GH, MICH, PH), *White 4406* (ARIZ, GH, MICH), *White 3513* (ARIZ, MICH), *White 4262* (MICH). ZACATECAS: road to Huejuquilla el Alto, Jal., *McVaugh 17745* (MICH). GUATEMALA: QUICHÉ: between Quiché & San Pedro Jacopilas, *Standley 62459* (F); HUEHUETENANGO: hills east of Aguacatán *Standley 62555* (F); Malacatán, *Smith 3286* (GH). HONDURAS: EL PARAÍSO: moist meadow, south of Guinope, *Standley 14863* (F); about 2 mi. nw. of Guinope, *Williams & Molina R. 11524* (F); Cumbre northwest of Guinope, *Standley et al 2023* (F), *Standley et al 2115* (F). MORAZÁN: Tanque, *Rodriquez 859* (F); Zamorano, *Rodriquez 2166* (F).

17. Helianthemum chihuahuense S. Wats.

Helianthemum chihuahuense S. Wats., Proc. Am. Acad. **23**: 268. 1888.

Type: *Pringle 1187*, October 1887. (GH!). Isotypes: (DS, F, MIN, NY, US!). "On pine plains at the base of the Sierra Madre, Chihuahua."

Halimium chihuahuense (S. Wats.) Gross., Pflanzenreich 14 (IV. 193): 45. 1903.

Heteromeris chihuahuensis (S. Wats.) Ponzo, Nuovo Gior. Bot. Ital. n.s. **28**: 169. 1921. (No basionym cited.)

Suffruticose perennial, 11-32(45) cm. tall with few to numerous stems arising from a woody caudex (or rarely from subterranean rootstock). STEMS sometimes decumbent, usually ascending to erect, covered with stellate pubescence intermixed with simple villous hairs (about 1.0-1.5 mm. long). CAULINE LEAVES sessile or with petioles up to 1 mm. long; blade 7-22 mm. long, 2.0-7.5 mm. wide, elliptic or sometimes elliptic-oblanceolate, densely covered on both surfaces with both short stellate pubescence and simple villous hairs 0.5-1.5 mm. long (the stellate tomentum decreases as the leaf ages and hence the lower leaves sometimes appear lustrous with only villous hairs on both sides), sometimes tinged with purplish color; midvein conspicuous and elevated beneath, secondary veins obscure beneath; (usually with small and numerous fasciculate leaves in the axil of the principal ones; those often persisting throughout the season). FLOWERS: dimorphic with the chasmogamous and cleistogamous usually borne upon different branches. Chasmogamous flowers few, glomerate or sometimes in a racemose cyme terminating the main stem and sometimes the major branches. Cleistogamous flowers 1-few, glomerate at the end of the branches (sometimes appearing in the axils of the leaves). Pedicel and calyx covered with minute stellate pubescence and intermixed with simple villous hairs 0.5-1.5 mm long. Bracts 1.5-5.4 mm. long, 0.2-0.6 mm. wide, linear.

CHASMOGAMOUS FLOWERS: pedicels 4-5 mm. long. OUTER SEPALS (free portion) 1.6-3.0 mm. long, 0.3-0.4 mm. wide, linear; INNER SEPALS 5.5-7.0 mm. long, 2.4-3.0 mm. wide, ovate, acute to acuminate. PETALS 7-10 mm. long, 5-6 mm. wide, obovate. STAMENS 24-30. PISTIL c. 1.8 mm. long, ovary c. 1.2 mm. long, c. 0.9 mm. in diameter, ovoid, glabrous; style 0.5-0.8 mm. long; stigma c. 0.6 mm. wide, capitate. FRUITING PEDICELS up to 10 mm. long, articulate. FRUITING CALYX 6-8 mm. long, 2.8-3.5 mm. in diameter, ovoid. OUTER SEPALS (free portion) c. 3 mm. long, c. 0.4 mm. wide, linear; INNER SEPALS 6-8 mm. long, 3-4 mm. wide, ovate, acute to acuminate. CAPSULE c. 6 mm. long, c. 4 mm. in diameter, ovoid-triquetrous, glabrous, 3-valved; each valve c. 4 mm. wide, ovate, acute. SEEDS: none seen.

CLEISTOGAMOUS FLOWERS: fruiting pedicels 1.6-5.0 mm. long, articulate. OUTER SEPALS (free portion) 1.2-3.6 mm. long, 0.2-0.4 mm. wide, linear; INNER SEPALS 3.6-5.6 mm. long, 2.4-3.2 mm. wide, ovate, acute to acuminate. STAMENS 5-6. CAPSULE 2-5 mm. long, 1.6-3.2 mm. in diameter, ovoid-triquetrous, glabrous, 3-valved; each valve 1.6-3.2 mm.

wide, ovate, acute. SEEDS (2)4-11, inequilateral, smooth, when seeds moistened the membrane separable and the embryo visible.

FLOWERING: June-October. HABITAT: pine-oak forest and wooded hillside. DISTRIBUTION: southwestern Chihuahua and southern Durango, and Hidalgo; also known from Guatemala, Honduras and Costa Rica. (Map 14.)

The simple, villous cauline hairs, the suffruticose habit, the obscure secondary veins on the lower surface of the cauline leaves, and the small fasciculate axillary leaves that persist on the plant long after the principal leaves have fallen are all features which in combination would readily distinguish this species from other American species of *Helianthemum.*

Helianthemum Pringlei is the only species included in this study whose leaves, when villous, strongly suggest those of *H. chihuahuense.* But although the flowers of both *H. Pringlei* and *H. chihuahuense* are dimorphic, they differ in arrangement. The chasmogamous flowers of *H. chihuahuense* are borne at the end of the main stem and sometimes the major branches, while its cleistogamous flowers are solitary or glomerate at the end of the branches; in *H. Pringlei* the dimorphic flowers are borne together at the end of the main stem and branches. The habit of *H. chihuahuense* is suffruticose while that of *H. Pringlei* is usually herbaceous. The cauline leaves of *H. chihuahuense* have small fasciculate leaves in their axil and this is rare indeed in *H. Pringlei.*

South of Mexico *H. chihuahuense* has been often mistakenly identified as *H. glomeratum,* but the latter species lacks the simple villous hairs and its chasmogamous flowers differ in being usually solitary at the end of the branches and branchlets and decidedly overtop the glomerate, cleistogamous ones.

REPRESENTATIVE SPECIMENS: MEXICO: CHIHUAHUA: Vicinity of Areponapuchic, slopes of Barranca de Urique, *Knoblock 1312* (MICH, MSC); Memelichi, Rio Mayo, *Standley 2791* (F); base of Sierra Madre, *Pringle 1187* (DS, F, GH, MIN, ND, NY, RSA, US). DURANGO: Coyotes, Sierra Madre Occidental, *Pennell 18269* (PH); 6 mi. southwest of El Salto, *Waterfall 15486* (OKLA, SMU). HIDALGO: Trinidad, *Pringle 11880* (GH). GUATEMALA: CHIMALTENANGO: near San Martin, Jilotepeque, *Standley 64392* (F); HUEHUETENANGO: Sierra de los

Cuchumatanes above Chiantla, *Standley 65609* (F); 10 km. e. of Huehuetenango, *Standley 82067, 82085,* & *82117* (F); nw. of Malacatancito, at km. 8 of the highway from Huehuetenango, *Standley 82220* (F, GH); along trail between San Juan Atitlán & San Sebastian, Sierra de Cuchumatanes, *Steyermark 52043* (F). JALAPA: Between Guisiltepeque & Potrero Carrillo, *Steyermark 33026* (F, GH); QUICHÉ: along road south of Chichicastenango, *Standley 62364* (F). SOLOLÁ: Volcan San Pedro, north facing slopes towards Lago de Atitlán, *Steyermark 47191* (F). TOTONICAPÁN: along road between San Francisco and El Alto Momostenango, *Standley 83983* (F). HONDURAS: MORAZÁN: slopes of Cerro de Uyuca, region of El Valle Encantado, *Standley et al 947* (F), *Standley & Williams 104* (F); Hoya Grande, along road between El Zamorano & Suyapa, *Standley & Williams 1432* (F); near Hoya Grande, drainage of the Rio Yeguare, *Williams & Molina R. 13278* (GH), *Williams & Molina R. 10993* (GH, MO, MICH); Zamorano, *Rodriguez 554* (F), *Rodriguez 618* (F). COSTA RICA: Los Friales, *Valerio 1371* (F).

18. Helianthemum glomeratum (Lag.) Lag. ex Dunal

Cistus glomeratus Lag., Gen. et Sp. Nov. 16. 1816. Type: not seen. "prope Acapulco et Cimapan in Nova Hispania."

Trichasterophyllum hyssopifolium Link, Jahr. Gewächskunde 3: 69. 1820. *nom. nud.*, cited in synonymy by Grosser.

Helianthemum glomeratum (Lag.) Lag. ex Dun., Prodr. 1: 269. 1824.

Helianthemum obcordatum Moç. & Sessé ex Dun., Prodr. 1: 284. 1824. Type: MA on loan to F! "In Mexico."

Heteromeris mexicana Spach, Ann. Sci. Nat. 2nd ser. 6: 370. 1836. *Helianthemum glomeratum* "Lag." cited as a questionable synonym; descr. Spach, Hist. Nat. Vég. Phanér. 6: 104. 1838. Type: not seen. "Cette plante croît au Mexique; nous l'avons décrite d'après des échantillons de l'herbier de M.P.B. Webb, les uns trouvés par M. Andrieux à Toluca, les autres envoyés par Pavon sous le nom de *Cistus mexicanus*, sans indication précise de localité."

Taeniostema micranthum Spach, Ann. Sci. Nat. 2nd ser. 6: 371. 1836. nom. nud.; descr. Spach, Hook. Comp. Bot. Mag. 2: 289. 1836 [1 May 1837]. Type: not seen. *Helianthemum glomeratum* cited as questionable synonym in Annales and as a synonym in the Histoire. "I have described it from dried specimens of plants cultivated in the Jardin des Plantes at Paris."

Cistus Mexicanus Sessé & Moç., Pl. Nov. Hisp. 180. 1894. Type: MA?, not seen. "ad Oppidum S. Rosae, prope Guanaxuatum."

Halimium glomeratum (Lag.) Gross., Pflanzenreich 14 (IV. 193): 47. 1903.

Heteromeris glomerata (Lag.) Ponzo, Nuovo Gior. Bot. Ital. n.s. **28**: 169. 1921. (No basionym cited.)

Crocanthemum glomeratum (Lag.) Janchen, Nat. Pflanzenfam. ed. 2. 21: 305. 1925.

Suffruticose perennial, 1.0-5.5(8.0) dm. tall with few to many stems arising from a woody, branched caudex and occasionally spreading by a horizontal, woody stem up to 1.5 dm. long. STEMS ascending to erect, stellate-tomentose, becoming glabrate and with numerous branches and ultimate branchlets. LEAVES on the current season's growth sessile to subsessile or with petiole up to 2 mm. long (if so, secondary veins prominent beneath); blade 1.0-2.5(3.5) cm. long, 2-6(14) mm. wide; oblanceolate or rarely elliptic to obovate, hoary and stellate-tomentose on both surfaces; midvein mostly prominent and secondary veins obscure or very slightly elevated or prominent beneath; base of blade attenuate, apex rarely obtuse, subacute to acute; margin entire, nonrevolute. FLOWERS: dimorphic (chasmogamous and cleistogamous) but rarely with only cleistogamous flowers and lacking the chasmogamous ones, or with chasmogamous and but very few cleistogamous ones. Chasmogamous flowers (mostly solitary) at the tip of the branches and branchlets, borne on filiform pedicel (1.5)2-3 times longer than calyx and overtopping the subsessile cleistogamous flowers. Cleistogamous flowers sub-sessile in axillary and terminal glomerules. Bracts 1.6-5.0 mm. long, 0.2-0.8 mm. wide, linear to oblanceolate, few to very numerous. Pedicel and calyx stellate-tomentulose.

CHASMOGAMOUS FLOWERS: pedicels (7)10-20 mm. long, (1.5)2-3 times longer than calyx. OUTER SEPALS (free portion) 0.6-4.0 mm. long, 1/5-2/3 the length of the inner sepals, 0.2-0.4 mm. wide, linear; INNER SEPALS 3-7 mm. long, 1.8-3.2 mm. wide, ovate or ovate-lanceolate, acute or acuminate, sometimes with somewhat elevated veins at the back. PETALS 4-9 mm. long, 3.5-6.0 mm. wide, obovate, "pale yellow with slight orange flush at base." [*Ball 4449* GH!] STAMENS 20-34. PISTIL 1.2-2.4 mm. long; ovary 0.6-1.6 mm. long, 0.5-0.9 mm. in diameter, ovoid, glabrous; style 0.5-1.0 mm. long; stigma 0.3-0.7 mm. wide, capitate. FRUITING CALYX 4.5-7.5 mm. long, 2.6-4.5 mm. in diameter, ovoid. CAPSULE 3.5-4.5 mm. long, 2-3 mm. in diameter, ovoid-triquetrous, glabrous, 3-valved; each valve 2-3 mm. wide, ovate, acute, slightly concave. SEEDS (6)10-20, ovoid, somewhat depressed on both sides to inequilateral, slightly pebbled, with thin separable membrane and the embryo becoming visible when seeds moistened.

CLEISTOGAMOUS FLOWERS: subsessile. FRUITING PEDICELS 0.3-3.6 mm. long, shorter than calyx. FRUITING CALYX 2.4-5.0 mm. long, 2-3(4) mm. in diameter, ovoid, sometimes with yellowish base. OUTER SEPALS (free portion) 0.6-3.0 mm. long, 0.2-0.4 mm. wide, linear; INNER SEPALS 2.4-5.0 mm. long, 1.2-3.6 mm. wide, ovate or ovate-lanceolate, acute or acuminate. STAMENS 3-6. CAPSULE 1.6-3.6 mm. long, 1.2-2.4(3.0) mm. in diameter, ovoid-triquetrous, glabrous, 3-valved; the valves 1.2-2.4(3.0) mm. wide, ovate, acute, slightly concave. SEEDS (1)2-7(11), similar to those of the chasmogamous flowers.

FLOWERING: throughout the year. HABITAT: grassland with scattered pine or oak or in open forests or on dry rocky hills. DISTRIBUTION: southwestern Texas, southern Baja California southward into Guatemala. (Map 15.)

Helianthemum glomeratum has a wide distribution and has been more extensively collected than any other species of the genus found in Mexico or Central America. This is the only species mainly restricted to Mexico and Guatemala which extends northward in the United States. It is found in the Chisos Mountains of Brewster Co., Texas.

The suffruticose habit and the densely glomerate, nearly sessile, cleistogamous flowers, often overtopped by the chasmogamous flowers possessing pedicels (1.5)2-3 times longer than its calyx, are characteristics which taken collectively readily distinguish this species from all American species of *Helianthemum.*

This species exhibits a remarkable variation in foliage, flowers, fruits and seeds. The foliage differs in blade size, length of petiole and extent of elevation of the secondary veins on the lower surface of the blade. The flowers differ in both kind and quantity; some specimens have both chasmogamous and cleistogamous ones, and still other plants have cleistogamous flowers only. The fruits, especially those derived from the cleistogamous flowers, differ greatly in size and number of seeds. This variation appears to be nearly continuous.

Following his two segregate genera, Spach listed two new species, *Heteromeris mexicana* and *Taeniostema micranthum.* For both of these species *Helianthemum glomeratum* was cited as a questionable synonym. *Heteromeris mexicana* was based upon specimens with both chasmogamous and cleistogamous flowers. Spach's (Hist. Nat. Vég. Phanér. 6: 104. 1838.) account of the latter species leaves no doubt that *Helianthemum glomeratum* was the plant being described. *Taeniostema micranthum* was based on specimens with cleistogamous flowers only. Spach (Hist. Nat. Vég. Phanér., 6: 104. 1838.), however, equated the latter species with *Helianthemum glomeratum.*

REPRESENTATIVE SPECIMENS: UNITED STATES: TEXAS: Brewster Co., top of Mt. Emory, Chisos Mts., *Warnock 20976* (TEX); Flat Top Mountain, Chisos Mountains, *Warnock 1116* (US). MEXICO: AGUASCALIENTES: road to Calvillo, 18 mi. west of Aguascalientes, *McVaugh & Koelz 114* (MICH). Sur Baja California: La Laguna, Sierra Laguna, *Gentry 4378* (ARIZ, DS, GH) CHIAPAS: Tstapa an sonnigen Hanger, *Seler 2086* (F, GH). CHIHUAHUA: Santa Eulalia Mts., *Pringle 300* (F, GH, MICH, PENN, RSA). DURANGO: Santiago Papasquiaro, *Palmer 56* (F, GH, UC). FEDERAL DISTRICT: lava fields near Eslaba, *Pringle 11371* (F, GH, SMU). GUANAJUATO: Puerto Nieto near San Miguel Allende, *Kenoyer 2049* (GH). GUERRERO: west of Chilpancingo, *Richands et al 3353* (SMU). HIDALGO: Trinidad, *Pringle 11881* (GH). JALISCO: hillside above Etzatlán, *Pringle 11372* (F, GH, MSC, SMU); hills near Guadalajara, *Pringle 2361* (ARIZ, F, GH, MSC, NY, PH, RSA, UC); San Sebastián, w. to Mascota, *Mexia 1414* (DS, F, GH, MICH, MIN, UC). MEXICO: Dist. Temascaltepec, *Hinton 3033* (F, UC), *Hinton 8401* (F, GH), *Hinton 8990* (DS, F, ILL, MICH, SMU, TEX), *Hinton et al 2720* (UC), *Hinton et al 8916* (ARIZ, F, GH, TEX). MEXICO-PUEBLA: Ixtaccihuatl, *Purpus 1815* (F, UC). MICHOACÁN: grassy hillslopes, Zitacuaro-Las Cañoas, Dist. Zitacuaro, *Hinton et al 13548* (F, ILL, MICH, UC); Tancitaro, Dist. Uruapan, *Hinton et al 15733* (ARIZ, GH, TEX). MORELOS: Cuernavaca, *Kenoyer A467*. NAYARIT: Tepic, *Palmer 2017* (GH). NUEVO LEON: about 15 mi. sw. of Galeana, *Mueller & Mueller 980* (F, GH, MICH, TEX). OAXACA: Sierra de San Felipe, *Smith 809* (F). PUEBLA: San Manuel de la Sierra, Sierra Negra, *Balls B4449* (GH, UC). QUERETARO: 15 mi. se. of San Juan del Rio, *Waterfall 13978* (OKLA, SMU). SAN LUIS POTOSI: Alvarez, *Palmer 56* (F, GH, UC); near San Luis Potosi, *Palmer 35* (GH, UC). SINALOA: Sierra Monterey, *Gentry 5891* (ARIZ, DS, GH, MICH). SONORA: Alamos, *Palmer 342* (GH). TLAXCALA: Sta. Ana Chiantauapan, *Arsene 1738* (MO). ZACATECAS: Zacatecas, *Purpus 502* (POM, UC). GUATEMALA: CHIMALTENANGO: *Johnston 1773* (F). HUEHUETENANGO: Sierra de Los Cuchumatanes, above Chiantla, *Standley 65620* (F), *65604* (F); Rio Pucal, *Standley 65826* (F, GH, MICH). JALAPA: hills between Guisiltepeque and Potrero Carrillo, *Steyermark 33024* (F). QUEZALTENANGO: Cerro La Pedrera, south of Quezaltenango, *Standley 66460* (F). QUICHÉ: without exact locality, *Aguilar 1444* (F). SAN MARCOS: Slopes of Volcán Tajumulco, *Steyermark 36917* (F). ZACAPA: Sierra de Las Minas, *Steyermark 42754* (F, UC).

19. Helianthemum rosmarinifolium Pursh

Helianthemum rosmarinifolium Pursh, Fl. Am. Sept. 2: 364. 1814. Type: "Enslen. July. v.s. in Herb. Enslen.", not seen; "In pine barrens, Georgia." not *Helianthemum rosmarinifolium* Presl, Symbolae Botanicae 1: 32. Tab. 21. 1832, which was from Palestine.

Heteromeris polifolia Spach, Hook. Comp. Bot. Mag. **2**: 291. 1836

[1 May 1837]. Type: ". . . in the Province of Texas by Mr. Drummond (third collection, No. 20!), as also by M. Berlandier.", not seen. Isolectotype: *Drummond,* 3rd collection No. 20 (GH, NY!) and *Berlandier* (US-1169410!) also seen.

Anthelis (*Horanthes*) *podanisia* Raf., New Fl. N. Am. 3: 30. 1836 [1838].

Horanthes podanisia (Raf.) Raf., Sylva Tell. 133. 1838.

Helianthemum polifolium (Spach) T. & G., Fl. N. Am. 1: 151. 1838; not *Helianthemum polifolium* DC., Lam. & DC. Fl. Fr. 4 (2): 823. 1815.

Helianthemum capitatum Nutt. ex Engelm. & Gray, Bost. Journ. Nat. Hist. 5: 212. 1847. A substitute for the preoccupied *Helianthemum polifolium* (Spach) T. & G.

Halimium rosmarinifolium (Pursh) Gross., Pflanzenreich 14 (IV. 193): 49. 1903.

Halimium domingense Urb., Symb. Ant. 7: 286. 1912. Type: *von Tuerckheim 3430*, not seen. Isotype: *von Tuerckheim 3430* (NY!). "in Sto. Domingo prope Constanza in Valle nuevo, 2200 m."

Halimium stenophyllum Urb., Symb. Ant. 7: 524. 1913. Type: *Fuertes 1919*, not seen. Isotypes: *Fuertes 1919* (NY, US!). "in Sto. Domingo prov. Azua ad Las Cañitas 1400 m. alt."

Crocanthemum domingense (Urb.) Janchen, Nat. Pflanzenfam. ed. 2. 21: 305. 1925.

Crocanthemum stenophyllum (Urb.) Janchen, Nat. Pflanzenfam. ed. 2. 21: 305. 1925.

Crocanthemum rosmarinifolium (Pursh) Janchen, Nat. Pflanzenfam. ed. 2. 21: 307. 1925.

Perennial herb (13)20-40(51) cm. tall with several stems arising from a woody caudex. STEMS ascending to erect, stellate-tomentose, with numerous ascending branches. BASAL LEAVES sometimes present, if so, 10-22 mm. long, 3-5 mm. wide, obovate. CAULINE LEAVES: petiole 1-4 mm. long; blade (4.5) 14-38(48) mm. long, 5-14 times as long as wide, (0.7)2.3-5.2(7.8) mm. wide, oblanceolate to elliptic to linear-lanceolate, green and stellate-pubescent above, hoary and stellate-tomentose beneath; midvein elevated and secondary veins but slightly elevated beneath; base of blade attenuate, apex subacute to acute; margin entire, somewhat revolute. FLOWERS: dimorphic (both chasmogamous and cleistogamous). Chasmogamous flowers solitary at the tip of the main branches borne on filiform pedicel (2-3 times longer than calyx) overtopping the subsessile, cleistogamous flowers. Cleistogamous flowers subsessile in axillary and terminal glomerules. Bracts up to 2 mm. long and c. 0.3 mm. wide, linear. Pedicel and calyx stellate-tomentose.

CHASMOGAMOUS FLOWERS: pedicels 10-22 mm. long, 2-4 times longer than calyx. OUTER SEPALS (free portion) 1.3-2.0(2.5) mm. long, 0.2-0.3 mm. wide, linear; INNER SEPALS 2.5-4.3 mm. long, 1.3-2.0 mm. wide, ovate, acute and slightly oblique. PETALS 4-5(6.4) mm. long, 3.6-4.8(5.4) mm. wide, yellow, obovate. STAMENS 15-24. PISTIL 0.8-1.5 mm. long; ovary 0.5-1.0 mm. long, 0.4-0.7 mm. in diameter, ovoid, glabrous; style 0.3-0.4 mm. long; stigma c. 0.3 mm. wide, capitate. FRUITING CALYX: 2.5-4.5 mm. long, 1.5-3.0 mm. in diameter, ovoid to nearly pyriform, with somewhat yellowish base. CAPSULE 2-3 mm. long, 1.4-1.8 mm. in diameter, ovoid, glabrous, 3-valved; each valve 1.0-1.4 mm. wide, ovate-elliptic, acute, separating to the middle at maturity. SEEDS 1-3(6), ovoid or somewhat appressed on both sides to inequilateral, smooth and when moistened with a thin separable membrane and then the embryo visible.

CLEISTOGAMOUS FLOWERS: subsessile. FRUITING PEDICELS 0.5-3.0 mm. long. FRUITING CALYX 1.5-1.8 mm. long, 1.2-1.5 mm. in diameter, somewhat obovoid with yellowish base. OUTER SEPALS (free portion) 0.5-1.0 mm. long, c. 0.2 mm. wide, linear; INNER SEPALS 1.5-1.8 mm. long, 1.0-1.5 mm. wide, ovate, acute. STAMENS 3-5. CAPSULE 1.3-1.7 mm. long, 1.0-1.3 mm. in diameter, somewhat obovoid, glabrous, 3-valved; each valve 0.8-1.0 mm. wide, somewhat obovate, subacute, separating to the middle at maturity. SEEDS 1(2), similar to those of the chasmogamous flowers.

FLOWERING: May-July. HABITAT: open sandy pinelands, sandhills, and fields. DISTRIBUTION: North Carolina southward into northern Florida and westward into the eastern half of Texas; also found in the West Indian Island of Santo Domingo. (Map 3.)

Helianthemum rosmarinifolium can be readily recognized by its solitary chasmogamous flowers borne at the top of the main branches on filiform pedicels 2-4 times longer than the calyx at anthesis, its cleistogamous capsules less than 1.5 mm. in diameter with the valves separating only to the middle, and the midcauline leaves 5-14 times as long as wide.

In spite of differences in habit and foliage, this taxon appears most closely related to *H. glomeratum*. Both of these taxa possess terminal, solitary, chasmogamous flowers on filiform pedicels 2-4 times longer than their calyces, overtopping the subsessile cleistogamous flowers which occur in axillary and terminal glomerules. The fruit and associated sepals derived from the cleistogamous flowers are quite variable in *H. glomeratum* and even one of its races approaches those of *H. rosmarinifolium* in shape and size of calyx, number of seeds, and seed characteristics.

Helianthemum argenteum is similar to *H. glomeratum* and *H. rosmarinifolium* in having solitary, terminal, chasmogamous flowers on filiform pedicel (1)1.5-2 times longer than the calyx. But it can be readily distinguished by its decumbent habit and its silvery pubescence. The axillary, sessile to subsessile, solitary (rarely two) cleistogamous flowers in the axil of the narrow (1.2 mm. wide or less) sessile leaves also serve to make it readily separable.

Although neither the type of the species nor a photograph of it has been available in this study, the original description seems sufficiently diagnostic to make it certain that this is the plant that Pursh described as *H. rosmarinifolium.*

This species has previously been considered endemic to the southeastern United States. However, Urban (Symb. Ant. 7: 286. 1912.) described a supposedly new species collected from the West Indies (Santo Domingo) naming it *Halimium domingense.* One year later, Urban (Symb. Ant. 7: 525. 1913.) proposed another species as new from the same general area, calling it *Halimium stenophyllum.*

The isotypes of both of Urban's species, *Halimium domingense* (NY!) and *Halimium stenophyllum* (NY! US!), were studied, and in spite of the geographical isolation, no difference could be found except that the Dominican specimens are not quite so erect as specimens collected in the United States. Therefore both of Urban's proposed species are here treated as synonyms of *H. rosmarinifolium.* This is the only species of *Helianthemum* known from the West Indies. The distribution of *Sabatia calycina* (Lam.) Heller is rather similar as both species range throughout the southern Coastal Plain and reappear in central Hispaniola. This *Helianthemum* is not known from peninsular Florida while the *Sabatia* ranges well into the peninsula and is known also from the Oriente Province of Cuba.

REPRESENTATIVE SPECIMENS: NORTH CAROLINA: Richmond Co., roadside, Hoffman, *Gupton 1610* (NCU). SOUTH CAROLINA: Berkeley Co., Gravel Hill Lake, ene. of Bonneau, *Ahles 30788* (DUKE, NCU); Edgefield Co., 3 mi. ene. of Trenton, *Radford 26416* (DUKE, NCU). GEORGIA: Baker Co., 10 mi. sw of Newton, *Thorne 4512* (GA, IA, CU); Candler Co., 10 mi. n. of Metter, 25 June 1950, *Sargent* (GH, KANU, MIN, NCSC, OKL, WIS, WVA); Decatur Co., near Bainbridge, *Curtiss 6477* (DS, F, GH, ILL, ISC, MIN, MO, NY, SMU, UC, US); McIntosh Co., along the Altamaha River near Darien, *Correll 5470* (DUKE, GA, NCSC, TENN); Screven Co., Oliver, *Curtiss 6838* (CU, GH, ILL, MIN, MO, NY). FLORIDA: Gadsden Co., without exact locality, *Boomhour 627* (DUKE). MISSISSIPPI: Clarke Co., De Soto, *Mohr* (NY, US); Lowndes Co.: Columbus, *Mohr* (MO, NY). ARKANSAS: Drew Co., Wilmar, *Demaree 24526* (SMU); Johnson Co., Piney, *Palmer 8162* (MO, PH, US). OKLAHOMA: Marshall Co., Lake Texoma, *Goodman 7044* (DUKE, OKL). TEXAS: Bastrop Co., about 5 mi. s. of Bastrop, *Lundell & Lundell 8975* (DS, GH, MICH, NY, SMU); Brazos Co., Bryan, *Palmer 7796* (MO, NY, US); Dallas Co., near Dallas, *Curtiss 228* (CU, F, GH, KANU, MICH, MIN, NY, OKL); Tarrant Co., without exact locality, *Ruth 496* (CU, F, GH, ILL, ISC, MICH, MSC, NY, PH, SMU, US, WIS); Waller Co., Hempstead, *Hall 30* (F, MO, NY, US). SANTO DOMINGO: Prope Constanza in Valle nuevo, 2200 m., *Tuerckheim 3430* (NY); prov. Azua ad Las Caffitas 1400 m. alt., *Fuertes 1919* (NY, US).

20. Helianthemum argenteum Hemsl.

Helianthemum argenteum Hemsl., Diagn. Pl. Nov. Mex. et Centr.-Amer. part 2: 20. 1879. Type: *Parry & Palmer 29.* (K) Isotypes: (GH, NY, US!) "Mexico: in regione San Luis Potosi, alt. 6000-8000 ped."

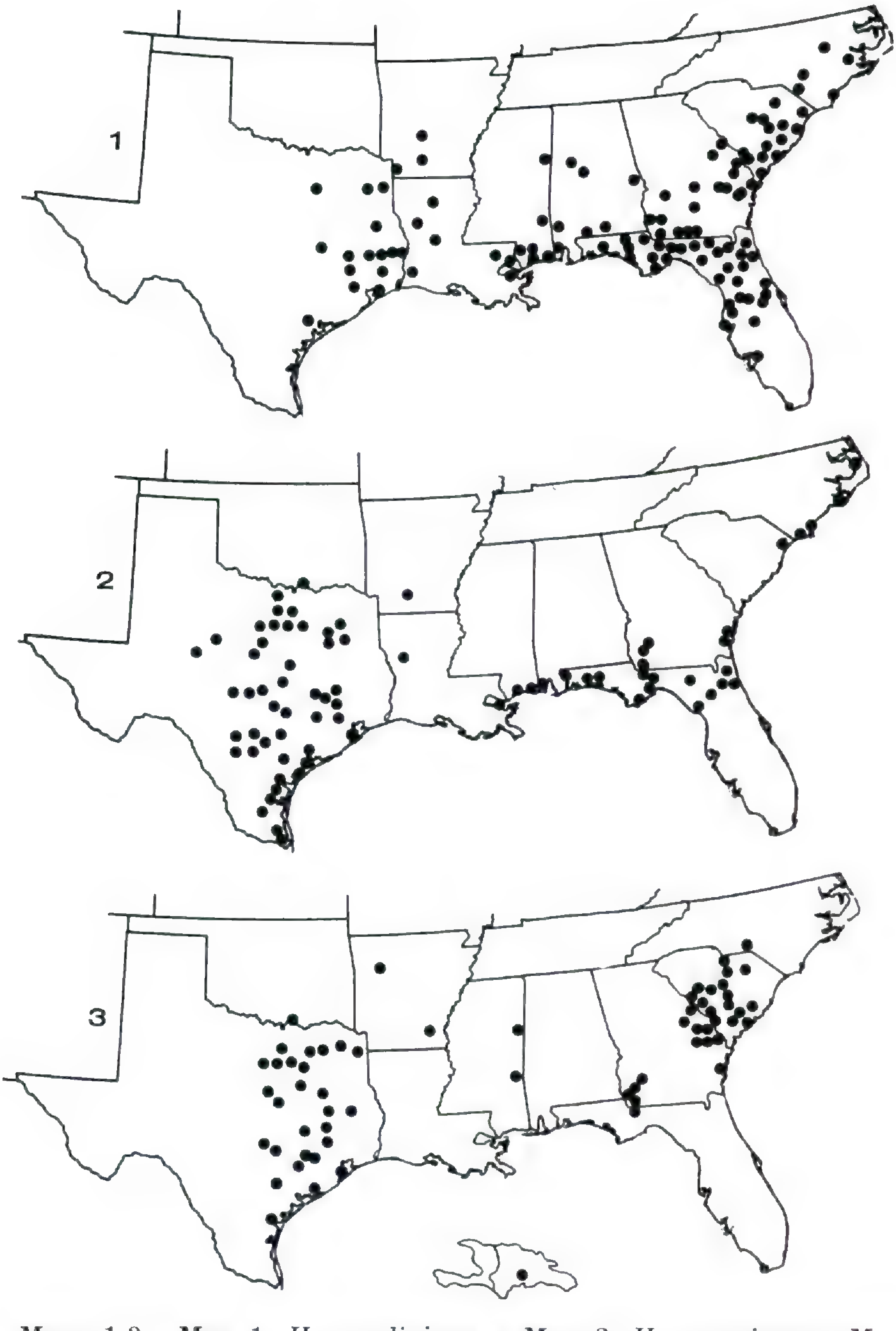
Halimium argenteum (Hemsl.) Gross., Pflanzenreich 14 (IV. 193): 47. 1903.

Heteromeris argentea (Hemsl.) Ponzo, Nuovo Gior. Bot. Ital. n.s. **28**: 170. 1921. (No basionym cited.)

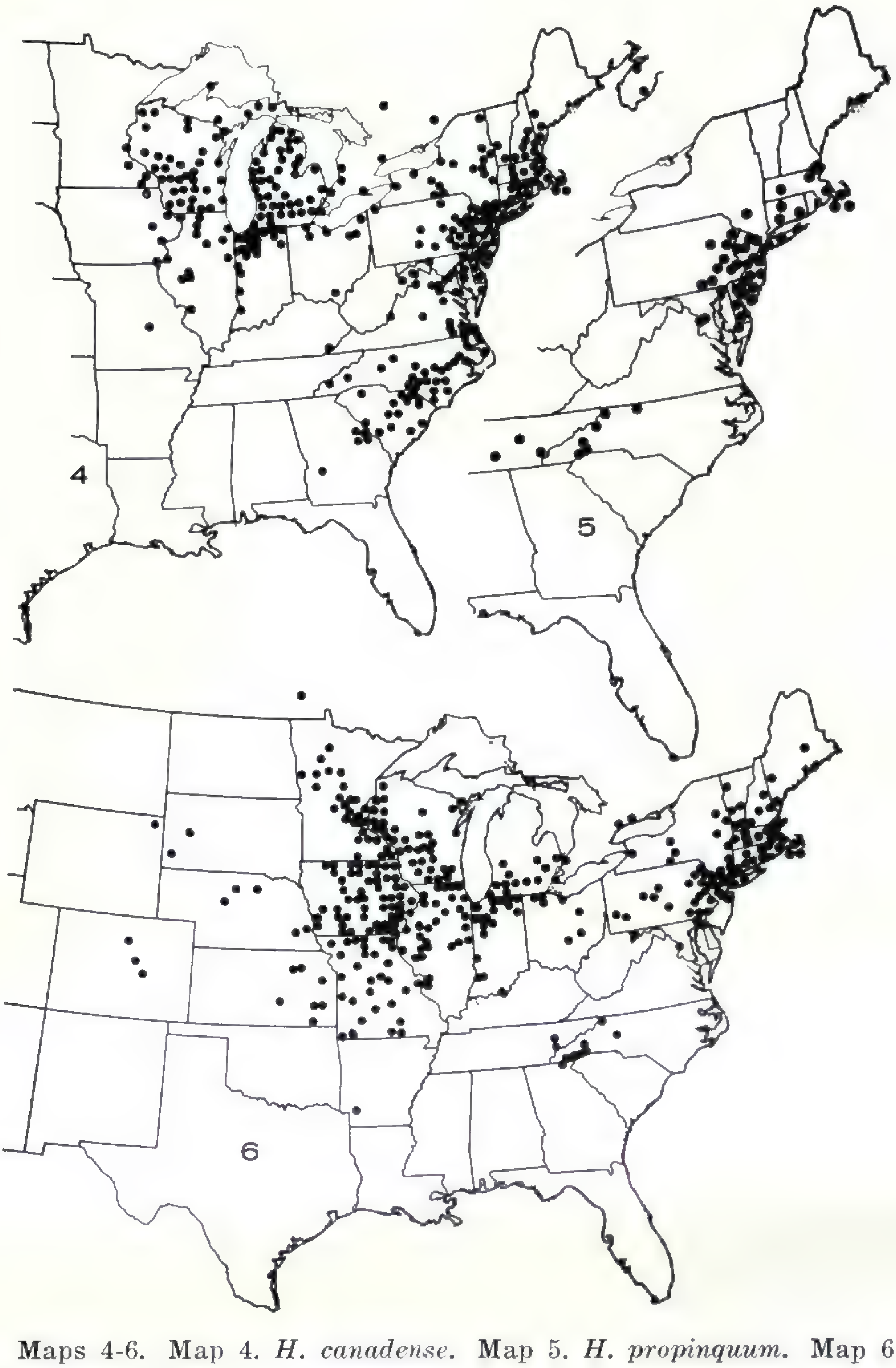
Crocanthemum argenteum (Hemsl.) Janchen, Nat. Pflanzenfam. ed. 2. 21: 305. 1925.

Suffruticose perennial, 5-15 cm. tall, arising from a thick woody root. STEMS short, erect, with numerous, decumbent to erect branches clothed with fine, silvery, appressed elongate tomentum. LEAVES (on the current season's growth) estipulate but with smaller leaves in their axil, sessile; blade 5-7 mm. long, 0.8-1.2 mm. wide; narrowly elliptic to linear, densely covered with fine, silvery, appressed elongate tomentum on both surfaces; midvein but slightly elevated and secondary veins obscure beneath; base of blade somewhat attenuate, apex acute to pointed and somewhat lustrous; margin entire, non-revolute. FLOWERS dimorphic (both chasmogamous and cleistogamous): the chasmogamous solitary at the end of the branches (mostly accompanied by two sessile cleistogamous flowers) borne on pedicel (1)1.5-2 times longer than calyx. Cleistogamous flowers solitary (sometimes two together), sessile in the leaf axil. Pedicel and calyx covered with fine, silvery, depressed elongate tomentum.

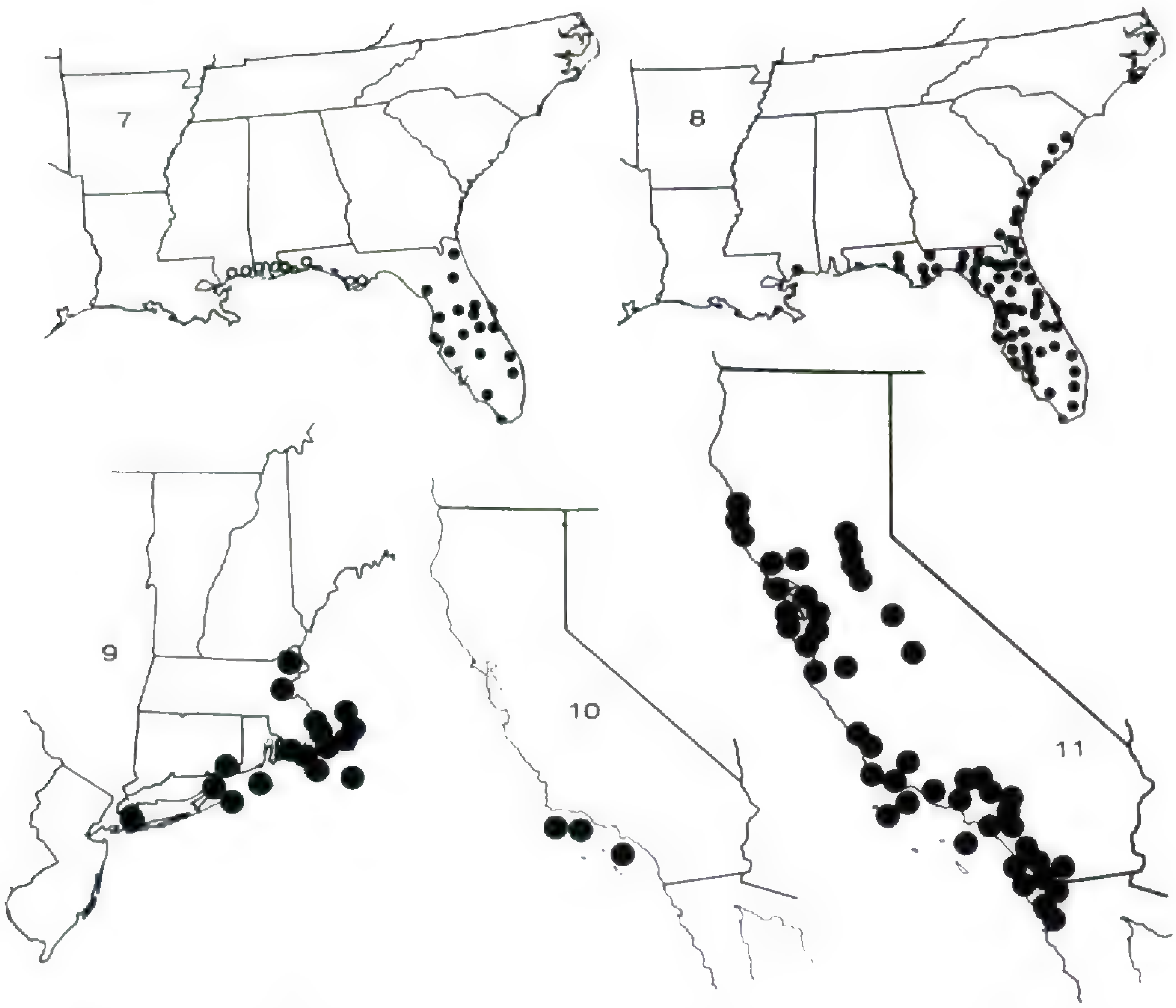
CHASMOGAMOUS FLOWERS: Pedicels 5-7 mm. long. OUTER SEPALS (free portion) 1.5-2.0 mm. long, about half the length of the inner sepals,



Maps 1-3. Map 1. *H. carolinianum*. Map 2. *H. georgianum*. Map 3. *H. rosmarinifolium* with inset of the island of Hispaniola.



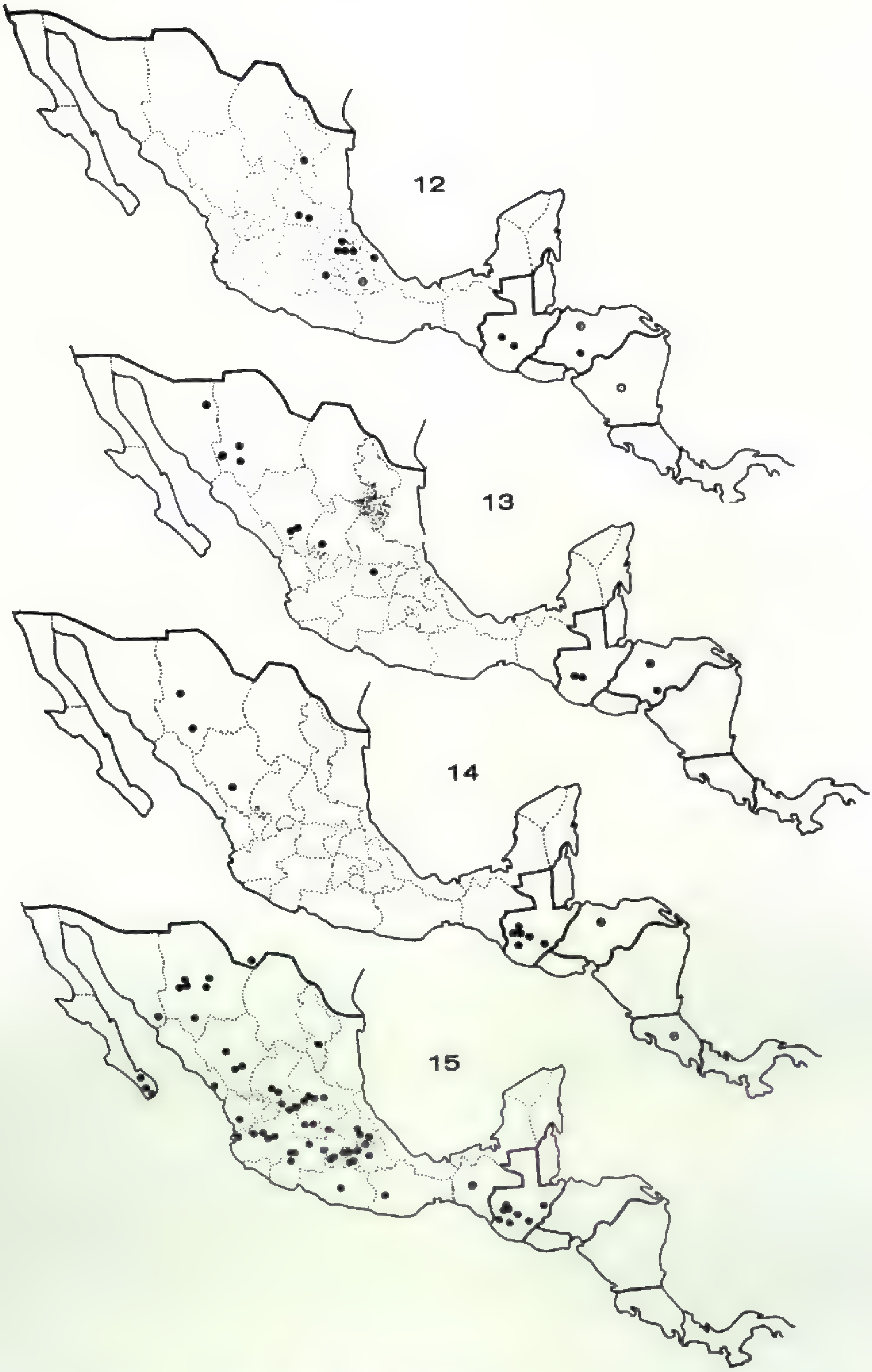
Maps 4-6. Map 4. *H. canadense.* Map 5. *H. propinquum.* Map 6. *H. Bicknellii.*



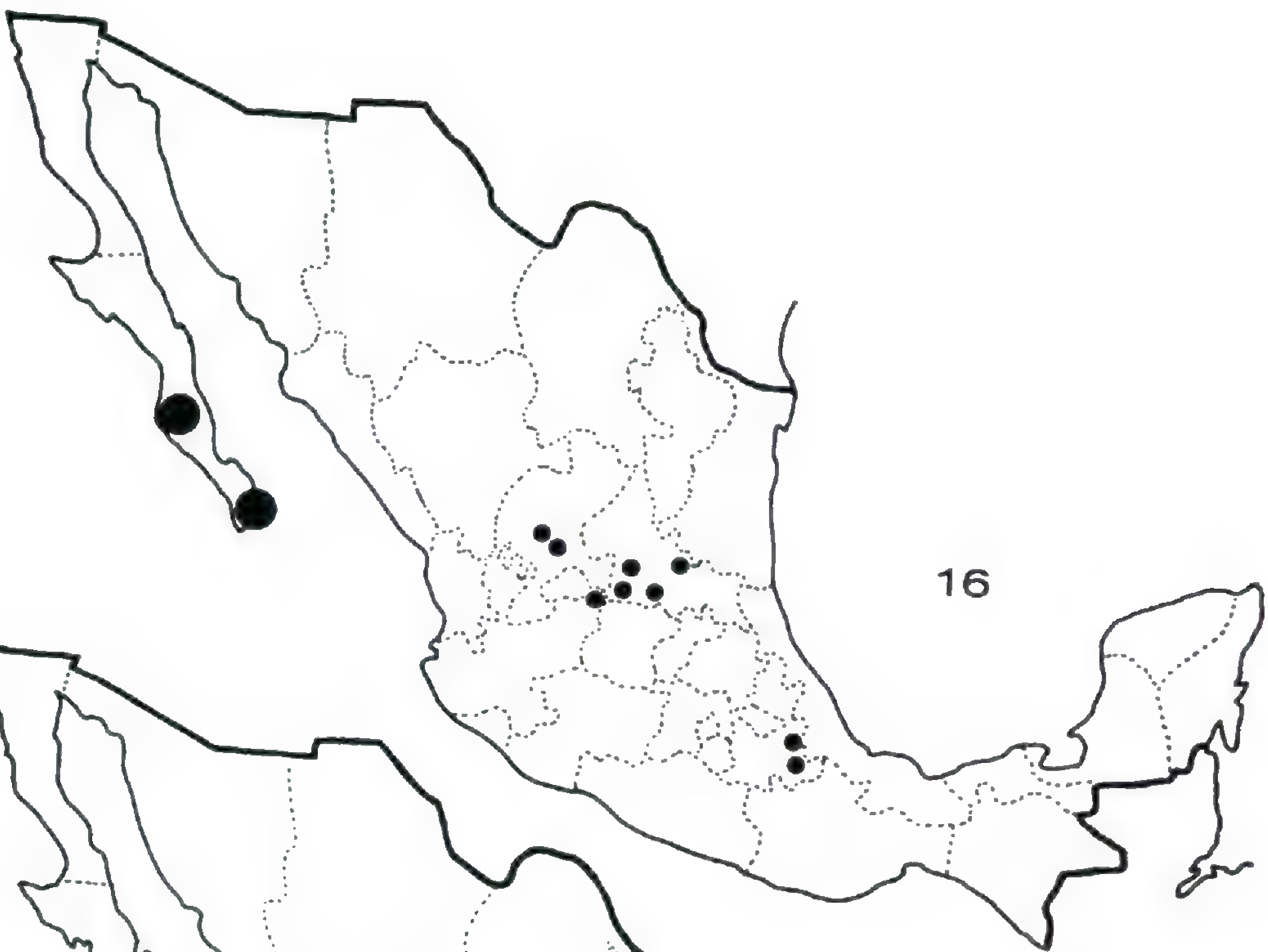
Maps 7-11. Map 7. *H. arenicola* (open circles) and *H. Nashii* (solid dots). Map 8. *H corymbosum*. Map 9. *H. dumosum*. Map 10. *H. Greenei*. Map. 11. *H. scoparium*.

0.3-0.4 mm. wide, linear; INNER SEPALS 3-4 mm. long, 1.2-1.6 mm. wide, ovate-lanceolate, acuminate. COROLLA yellow, petals 3-4.5 mm. long, 3.0-3.5 mm. wide, obovate. STAMENS 10-15. PISTIL 1.2-1.6 mm. long; ovary 0.8-1.2 mm. long, 0.4-0.5 mm. in diameter, narrowly ovoid; glabrous; style 0.1-0.2 mm. long; stigma about 0.2 mm. wide. FRUITING PEDICELS 7-10 mm. long. FRUITING CALYX narrowly ovoid. OUTER SEPALS (free portion) 1.5-2.5 mm. long, about half that of the inner, 0.3-0.4 mm. wide, linear; inner sepals 5.0-5.5 mm. long, 1.5-2.0 mm. wide, ovate-lanceolate, acuminate, about twice longer than wide. CAPSULE 3.6-4.0 mm. long, about twice as long as wide, 1.2-1.6 mm. in diameter, narrowly ovoid-triquetrous, glabrous, very thin-walled, 3-valved; each valve 1.2-1.6 mm. wide, ovate-lanceolate, acute, somewhat spreading at maturity. SEEDS 3, ovoid or nearly so, covered with white papillae borne on the thin separable membrane, the embryo visible when seed moistened.

CLEISTOGAMOUS FLOWERS: Sessile to subsessile. FRUITING PEDICELS up to 0.8 mm. long. FRUITING CALYX 2.8-3.6 mm. long, 1.4-1.7 mm. in



Maps 12-15. Map. 12. *H. Coulteri.* Map 13. *H. Pringlei.* Map 14. *H. chihuahuense.* Map 15. *H. glomeratum.* (Open circles on all maps indicate that the exact locality is unknown.)



Maps 16-17. Map 16. *H. nutans* (large dots) and *H. patens* (small dots). Map 17. *H. concolor* (small dots) and *H. argenteum* (large dot).

diameter, ovoid. OUTER SEPALS (free portion) 1.2-1.6 mm. long, about half the length of the inner sepals, 0.2-0.3 mm. wide, linear; INNER SEPALS 2.8-3.6 mm. long, about twice as long as wide, 1.0-1.4 mm. wide, ovate-lanceolate, acuminate. STAMENS 3. CAPSULE 1.2-1.4 mm. long, about twice longer than its diameter, 0.5-0.7 mm. in diameter, narrowly ovoid-triquetrous, very thin-walled, glabrous, 3-valved; each valve 0.5-0.7 mm. wide, ovate-lanceolate, acute. SEEDS 1-2, other characters similar to those of the chasmogamous seeds.

FLOWERING: June. HABITAT: rocky hillsides and summits. DISTRIBUTION: known only from the State of San Luis Potosi, Mexico. (Map 17, large dot).

Helianthemum argenteum is rare and has been little collected. Only three collections were seen by us. It is the only Mexican species of *Helianthemum* with the following combination of features: an elliptic-linear leaf blade, less than 1.5 mm. wide and 5-7 times longer than wide covered with depressed silvery pubescence and with solitary (or rarely two together) cleistogamous flowers which are sessile to subsessile in the leaf axil and whose chasmogamous flowers are solitary at the end of the branches.

SPECIMENS EXAMINED: MEXICO: SAN LUIS POTOSI: chiefly in the region of San Luis Potosi, *Parry & Palmer 29* (GH, NY, US); Cerro Tepetate, southwest of San Luis Potosi, *Pennell 17656* (PH), S. Miquelito Mts., *Schaffner 606* (PH).

DOUBTFUL AND EXCLUDED NAMES

Anthelis (*Horanthes*) *arenaria* Raf., New Fl. N. Am. 3: 31. 1836. [1838]; later *Horanthes arenaria* (Raf.) Raf., Sylva Tell. 133. 1838. The original description of Rafinesque's species is quoted here in full: "551 *Anthelis* (*Horanthes*) *arenaria* Raf. many procumbent stems nearly smooth. Leaves linear acute sometimes ciliate, pedicels axillary uniflore equal to leaves, 3 sepals membranaceous rufous smooth trinerve ovate acute, 2 linear subciliate — in sands of Pine barrens in South New Jersey and Florida, first discovered by Kin in 1801. Root large deep, many short diffuse stems, leaves small, flowers rather large."

There is not a single species of *Helianthemum* occurring in both "South New Jersey and Florida." However the following characteristics: ". . . leaves . . . sometimes ciliate . . . uniflore . . . in sands of Pine barrens in South New Jersey . . . flowers rather large" make it probable that Rafinesque was redescribing at least in part what was already known as *Helianthemum canadense* (L.) Michx.

Cistus Rosmarinifolius Moç. & Sessé, Fl. Mex. 130. 1894. Type: ? MA, not seen. "in oppido S. Andrés de el Valle haud procul Temascaltepec, ubi vulgo *Romerillo* audit."

Helianthemum astylum Moç. et Sessé ex Dunal, Prodr. 1: 284. 1824. Treated as a synonym of *Halimium glomeratum* (Lag.) Grosser (Pflanzenreich 14 (IV. 193): 47. 1903.) And previously Hemsley (Biol. Cent. Am. 1: 47. 1879) considered it a probable synonym of "one of the states of *H. glomeratum.*"

Helianthemum tripetalum Moç & Sessé ex Dun., Prodr. 1: 284. 1824.

= *Lechea tripetala* (Moç. & Sessé ex Dun.) Britt. Bull. Torrey Club 21: 252. 1894.

Horanthes tripetala attributed by Merrill (Ind. Raf. 169. 1949.) to Raf., New Fl. N. Am. 3: 30. 1836 [1838]. who under the genus *Anthelis* and subg. *Horanthes* merely indicates that "*H. tripetala* of Mexico is probably a Lechea!" The "H." doubtless stood for *Helianthemum* and referred to the publication of Dunal cited above.

DEPARTMENT OF BOTANY, DUKE UNIVERSITY
DURHAM, NORTH CAROLINA

THE EXTENDED DISTRIBUTION OF ERAGROSTIS TRACYI FROM SANIBEL ISLAND, FLORIDA[1]

A. S. Hitchcock in 1934 (1), based the description of *Eragrostis tracyi* on specimens of S. M. Tracy (no. 7168) collected on Sanibel Island, Florida, 1901. This endemic of narrow distribution was collected again from the type locality by George R. Cooley (no. 2608) (1954) (2). Since its discovery by Tracy in 1900, a period of 64 years, the species has been known only from Sanibel Island (3).

In 1964, the species was twice encountered in other localities. The 20th of April, collection no. 27403 was made on Mound Key, Estero Bay, Lee Co., only about 15 mi. southeast of Sanibel. Two pinkish plants 5 cm. tall, with basal branches and spreading panicles were growing in dry, compacted soil of the wooded trailside on the top of the Mound. They were the only ones available; pressure of time prevented wider search.

The 6th of October a population was found on Longboat Key, Sarasota Co., about 60 mi. north of Sanibel; collection no. 27566. It is established on a low terrace of the Gulf of Mexico on an extensive shell-beach with a remarkable association of *Sabal palmetto*, *Agave decipiens* and *Juniperus silicicola*. Frequency and size of the shrubs in the undergrowth give the appearance of a primary condition, or at

[1]Contribution 19, Botanical Laboratories, University of South Florida.

least absence of recent disturbance. Conspicuous elements are *Yucca aloifolia*, *Harrisia Aboriginum*, *Opuntia Dillenii*, *Rapanea guianensis*, *Randia aculeata*, and *Forestiera porulosa.*

In the strand vegetation *Eragrostis tracyi* was spotted by its panicles among *Sporobolus virginicus*, *Sesuvium portulacastrum*, *Flaveria floridana* and *Amaranthus australis.* This habitat presents a sharp contrast to that of the bare, disturbed soils of Sanibel Island. However, strand vegetation is subject to disturbance by various factors. The 10th of February the site was checked for signs of perennial growth for added information on the life duration of *Eragrostis tracyi.* The grasses were prostrate and matted. With scattered debris it appeared as if the area had been flooded. Many tufts of *Eragrostis* were dead, but in others tips of new green leaves were visible among the old dead ones. Two tufts were potted in the greenhouse. The growth of new leaves continues and, obviously, *Eragrostis tracyi* perennates from underground parts.

OLGA LAKELA,
UNIVERSITY OF SOUTH FLORIDA,
TAMPA

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1. HITCHCOCK, A. S. 1934. Eragrostis Tracyi. Am. Jour. Bot. **21**: 130. f.1.
2. COOLEY, GEORGE R. 1954. Vegetation of Sanibel Island. Rhodora **57**: 269-289.
3. HITCHCOCK, A. S. rev. AGNES CHASE. 1950. Manual of the Grasses of the United States. pp. 162-163.

Erratum for Rhodora Volume 67, Number 770
p. 183 Fig. 1 is Plate 1311

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Rhodora

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NOMENCLATURAL CHANGES AND ADDITIONS TO BRITTON AND WILSON'S "FLORA OF PORTO RICO AND THE VIRGIN ISLANDS"

BROTHER ALAIN LIOGIER, ([1])

Our knowledge of the flora of Puerto Rico and the Virgin Islands comes from its main and most recent source, the Flora published by N. L. Britton and P. Wilson between 1923 and 1930, as part of the Scientific Survey of Porto Rico and the Virgin Islands, sponsored by the New York Academy of Sciences. Already, as the last parts were being prepared, some plants not recorded in the previous parts had to be cited in an Appendix (1926) and a Supplement (1930). Many of the scientific names used by Britton and Wilson are now obsolete, either because the authors had a different concept of the generic lines, used a different Code of Nomenclature, or because new monographs having been published, some nomenclatural changes have proved necessary; also some species have been collected in the area for the first time, and have to be added to the flora; and a few species have been described as new from the Island of Puerto Rico. The species count in Britton and Wilson's Flora was 2464; our new count goes up to 2582, and the author is convinced that there are still some species to be collected in the area, that are not recorded so far.

In this paper, I shall cite all the changes in nomenclature,

[1]Honorary Curator of West Indian Botany, The New York Botanical Garden.

new records and new species, and also the reductions to synonymy made necessary since the publication of the Flora. Whenever possible, the bibliography will be given, for a family, a genus or a species. The pages refer to Britton & Wilson's Flora, as part of the Scientific Survey, Vols. V and VI. The first name cited is the correct name as here interpreted, and the name in parenthesis and in italics is the name applied by Britton & Wilson (except that the parenthetical authorities have been removed) in the Flora, or in a few occasions the name used in other Floras. For new records and new species, the locality is given, unless the plant is fairly common in the Island. For most cases, no attempt has been made by the author to make a critical study of each group; this kind of work would require several years of study and would amount to the preparation of a new Flora. Only occasionally has attention been given to the changes in nomenclature in the cultivated plants.

I am grateful to the New York Botanical Garden for the facilities given to me both in the Herbarium and in the Library, and also for financial support for some field work in Puerto Rico; my thanks also to the University of Puerto Rico, particularly the College of Agriculture and Mechanical Arts at Mayagüez, for the facilities in collecting and drying the plants, extended to me through the kindness of Dr. José A. Ramos.

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PULLE. A.A. et al.—Flora of Surinam.

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p. 38 Paspalum molle Poir. (*Paspalum portoricense* Nash)

p. 38 Paspalum saugetii Chase (*Paspalum poiretii* R. & S. as to the Puerto-Rican plant).

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p. 67 Chloris inflata Link (*Chloris paraguayensis* Steud.)
p. 68 Chloris petraea Sw. (*Eustachys petraea* Desv.)
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p. 71 Leptochloa panicea (Retz.) Ohwi (*Leptochloa filiformis* P. Beauv.)
p. 72 Leptochloa fascicularis (Lam.) A. Gray (*Diplachne fascicularis* Beauv.)
p. 72 Pappophorum pappiferum (Lam.) Kuntze (*Pappophorum alopecuroideum* Vahl)
p. 73 Phragmites communis Trin. (*Phragmites phragmites* Karst.)
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p. 77 Melinis minutiflora Beauv. To be added, as an escape. Las Mesas, Mayagüez.

CYPERACEAE

Ref.: KÜKENTHAL, G.—Bot. Jahrb. 1949-1950. (*Rhynchospora*)
SVENSON, H.—N. Amer. Flora 18, parts 8 and 9. 1947-1957.
KOYAMA, T.—Journ. Fac. Sci. Univ. Tokyo, Sect. III, Bot. VIII. 1961.
GONZALEZ MAS, ARTURO.—The Cyperaceae of Puerto Rico. 1964.

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p. 79 Cyperus peruvianus (Lam.) F. N. Williams (*Kyllinga peruviana* Lam.)
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p. 85 Cyperus imbricatus Retz. (*Cyperus radiatus* Vahl)
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p. 87 Cyperus mutisii (HBK.) Griseb. (*Cyperus incompletus* Link)
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p. 88 Cyperus unifolius Böckl. (*Cyperus filiformis* Sw.; *Cyperus calcicola* Britt., No. 23, p. 86).
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p. 92 Elocharis sintenisii Böckl. (*Eleocharis yunquensis* Britt.)

p. 92 Eleocharis minutiflora Böckl. (*Eleocharis microcarpa* Torr.)

p. 92 Eleocharis elegans (HBK.) R. & S. (*Eleocharis geniculata* R. & S. in part)

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Eleocharis radicans (Poir.) Kunth. Not collected by recent collectors. Based on a Ledru collection, before 1804.

p. 93 Fimbristylis vestita (Kunth) Hemsl. (*Stenophyllus vestitus* Britt.)

p. 93 Fimbristylis portoricensis (Britt.) Alain (*Stenophyllus portoricensis* Britt.; *Bulbostylis pauciflora* Clarke).

p. 93 Fimbristylis curassavica (Britt.) Alain (*Stenophyllus curassavicus* Britt.) To be added: Guanica.

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p. 97 Scirpus lacustris L. ssp validus (Vahl) T. Koyama (*Scirpus validus* Vahl)

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p. 101 Rhynchospora hispidula (Vahl) Böckl. (*Rhynchospora trichodes* Clarke in Urb.)

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p. 103 Rhynchospora podosperma Wr. ex Sauv. (*Rhynchospora filiformis* Vahl)

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Scleria ciliata Michx. Las Mesas, Mayagüez.

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DUNSTERVILLE, G. C. K.—Orquídeas de Venezuela. 1960.

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p. 190 Erythrodes hirtella (Sw.) Fawc. & Rendle (*Physurus hirtellus* Lindl.)

p. 191 Cranichis diphylla Sw. To be added: Maricao State Forest.

p. 194 Polystachya extinctoria Rchb. f. ex Walp. (*Polystachya minuta* Britt.) Cf. Taxon **IX**: 150. 1960.

p. 195 Polystachya cerea Lindl. (*Polystachya minor* Fawc. & Rendle)

p. 195 Scaphyglottis modesta (Rchb. f.) Schlecht. (*Tetragamestus modestus* Rchb. f.)

p. 196 Dilomilis montana (Sw.) Summerhayes (*Octadesmia montana* Benth.) Ref.: Taxon **X**: 253. 1961.

p. 196 Coelia triptera (Smith) G. Don (*Hormidium tripterum* Cogn.)

p. 197 Jacquiniella teretifolia (Sw.) Britt. & Wils. To be added: Cerro de Punta, Guilarte.

p. 197 Jacquiniella miserrima (Rchb. f.) Stehlé. To be added: Carite.

p. 197 Epidendrum fucatum Lindl. (*Encyclia fucata* Britt. & Millsp.)

p. 197 Epidendrum sintenisii Rchb. f. (*Encyclia sintenisii* Britt.)

p. 198 Epidendrum brittonianum A. D. Hawkes (*Encyclia papilionacea* Schlechtr.)

p. 198 Epidendrum cochleatum L. (*Anacheilium cochleatum Hoffmg.*)

p. 199 Epidendrum ottonis Rchb. f. (*Nidema ottonis* Britt. & Millsp.)

p. 199 Epidendrum ciliare L. (*Auliza ciliaris* Salisb.)

p. 200 Epidendrum difforme Jacq. (*Amphiglottis difformis* Britt.)

p. 200 Epidendrum moirianum A. D. Hawkes (*Amphiglottis corymbosa* Britt.)

p. 200 Epidendrum nocturnum Jacq. (*Amphiglottis nocturna* Britt.)

p. 200 Epidendrum anceps Jacq. (*Amphiglottis anceps* Britt.)

p. 201 Epidendrum secundum Jacq. (*Amphiglottis secunda* Britt.)

p. 201 Epidendrum lacerum Lindl. (*Amphiglottis lacera* Britt.)

p. 201 Epidendrum pallidiflorum Hook. (*Amphiglottis pallidiflora* Britt.)

p. 202 Epidendrum rigidum Jacq. (*Spathiger rigidus* Small)

p. 202 Epidendrum ramosum Jacq. (*Spathiger ramosus* Britt.)

p. 202 Epidendrum krugii Bello (*Encyclia krugii* Britt. & Wils. Sci. Surv. VI: 532) To be added: S.—W. of Puerto Rico; doubtfully different from *Epidendrum brittonianum* A. D. Hawkes; to be studied further).

To be added: Epidendrum vicentinum Lindl. Guilarte and Guavate.
Epidendrum belvederense Fawc. & Rendle; locality unknown.

p. 202 Domingoa haematochila (Rchb. f.) Carabia (*Domingoa hymenodes* Schlecht.) To be added: Mona Island Cf. Sci. Surv. VI: 340-341.

p. 203 Brassavola cucullata (L.) R. Br. (*Epidendrum cucullatum* L.)

p. 206 Pleurothallis foliata Griseb. (*Pleurothallis broadwayi* Ames) To be added: Cerro de Punta. Cf. Bull. Torrey Bot. Club **90**: 187. 1963.

p. 206 Pleurothallis appendiculata Cogn. To be added: Maricao.

p. 206 Pleurothallis longissima Lindl. To be added: Adjuntas.

p. 208 Eulophia alta (L.) Fawc. & Rendle (*Platypus altus* Small)
p. 209 Bulbophyllum pachyrrhachis (A. Rich.) Griseb. (*Bolbophyllaria pachyrrhachis* Rchb. f.)
p. 210 Maxillaria coccinea (Jacq.) L. O. Wms. (*Ornithidium coccineum* Salisb.)
p. 210 Maxillaria conferta (Griseb.) Schweinf. (*Ornithidium confertum* Griseb.)
p. 212 Oncidium lemonianum Lindl. (*Oncidium intermedium* Bert.)
p. 214 Cochleanthes flabelliformis (Sw.) R. E. Schultes & Garay (*Warszewiczella flabelliformis* Cogn.)
p. 216 Campylocentrum fasciola (Lindl.) Cogn. (*Campylocentrum sullivani* Fawc. & Rendle)

PIPERACEAE

Ref.: YUNCKER, T. G.—The Cuban Species of Peperomia. Rev. Soc. Cub. Bot. **VI.** 1949.
The Piperaceae of Northern South America. 1950.

p. 221 Piper hispidum Sw. (*Piper scabrum* Sw.)
p. 221 Piper wydlerianum (Miq.) DC. (*Piper citrifolium* Lam.)
p. 222 Piper glabrescens (Miq.) DC. (*Piper treleaseanum* Britt & Wils.)
p. 227 Peperomia sintenisii C. DC. (*Peperomia dendrophila* Schl.)
p. 228 Peperomia rhombea R. & P. (*Peperomia myrtillus* Miq.)
p. 228 Peperomia megapoda Trel. To be added: Cayey to Guayamas. Cf. Sci. Surv. VI: 533.
p. 228 Peperomia tenella A. Dietr. To be added: Cerro de Punta, Jayuya.
p. 229 Piper peltatum L. (*Pothomorphe peltata* Miq.)
p. 229 Piper umbellatum L. (*Pothomorphe umbellata* Miq., to be segregated from the preceding, same distribution).

MYRICACEAE

p. 232 Myrica holdridgeana Lundell. To be added: Sierra de Luquillo, El Toro. Cf. Contr. Univ. Michigan Herb. **7:** 5. 1942.

ULMACEAE

p. 234 Celtis iguanaea (Jacq.) Sarg. (*Momisia iguanaea* Rose & Standl.)

MORACEAE

p. 237 Ficus trigonata L. (*Ficus crassinervia* Desf.; *F. stahlii* Warb. in Urb.)
p. 237 Ficus citrifolia P. Mill. (*Ficus laevigata* Vahl)
p. 237 Ficus perforata L. (*Ficus sintenisii* Warb.)

p. 239 Ficus retusa L. (*Ficus nitida* Thunb.)
p. 241 Artocarpus heterophylla Lam. (*Artocarpus integrifolia* L.)

OLACACEAE

p. 254 Ximenia americana L. To be added: Guanica.

LORANTHACEAE

p. 255 Dendropemon bicolor Krug & Urb. (*Phthirusa bicolor* Engler)
p. 255 Dendropemon sintenisii Krug & Urb. (*Phthirusa sintenisii* Engler)
p. 255 Dendropemon purpureum (L.) Krug & Urb. (*Phthirusa purpurea* Engler)
p. 256 Dendropemon caribaeum Krug & Urb. (*Phthirusa caribaea* Engler)
p. 256 Eremolepis wrightii Griseb. (*Ixidium wrightii* Eichl.)
p. 259 Phoradendron berterianum (DC.) Griseb. (*Phoradendron dichotomum* Krug & Urb.)
p. 260 Dendrophthora flagelliformis (Lam.) Krug & Urb., include as a synonym: *Dendrophthora wrightii* Eichl. in Mart., No. 1, p. 259. Cf. Wentia **6**: 1-133. 1961.

ARISTOLOCHIACEAE

p. 262 Aristolochia bilabiata L. (*Aristolochia oblongata* Jacq.)
p. 263 Aristolochia grandiflora Vahl (*Aristolochia galeata* Mart. & Zucc.; *Aristolochia ringens* Vahl)
p. 263 Aristolochia cordiflora Mutis ex HBK. (*Aristolochia grandiflora* Sw.)
To be added: Aristolochia littoralis Parodi (*Aristolochia elegans* Masters). St. Kitts. Aristolochia odoratissima L. St. Jan, St. Thomas.

POLYGONACEAE

Ref.: Howard, R. A.—The species of Coccoloba from Puerto Rico and the Virgin Islands. Jour. Arn. Arb. **38**: 211-242. 1957.
p. 264 Polygonum punctatum Ell. (*Persicaria punctata* Small)
p. 265 Polygonum acuminatum HBK. (*Persicaria acuminata* Maza)
p. 265 Polygonum densiflorum Meisn. (*Persicaria portoricensis* Small)
p. 265 Polygonum segetum HBK. (*Persicaria segetum* Small)
p. 266 Antigonon guatemalense Meisn. (*Antigonon macrocarpum* Britt. & Small)
p. 266 Coccoloba (*Coccolobis*)
p. 267 Coccoloba swartzii Meisn. f. urbaniana (Lindl.) Howard (*Coccolobis borinquensis* Britt.)

p. 267 Coccoloba diversifolia Jacq., add synonym: *Coccolobis laurifolia* Jacq., no. 8.
p. 268 Coccoloba microstachya Willd. (*Coccolobis obtusifolia* Jacq.)
p. 269 Coccoloba pubescens L. (*Coccolobis grandifolia* Jacq.)
p. 270 Coccoloba costata Wr. ex Sauv. (*Coccolobis rupicola* Urb.)
p. 270 *Coccoloba swartzii* var. *portoricensis* Meisn. is synonym to C. swartzii f. urbaniana (Lindl.) Howard

CHENOPODIACEAE

p. 273 Suaeda fruticosa (L.) Forsk. (*Dondia fruticosa* Northrop)

AMARANTHACEAE

p. 277 Amaranthus viridis L. add synonym: *Amaranthus gracilis* Desf., No. 4.
p. 278 Achyranthes aspera L. (*Centrostachys aspera* Standl.; *C. indica* Standl.)
p. 279 Alternanthera peploides (H. & B.) Urb. (*Achyranthes peploides* Britt.)
p. 279 Alternanthera paronychoides St. Hil. (*Achyranthes polygonoides* Lam.)
p. 280 Alternanthera sessilis (L.) R. Br. ex DC. (*Achyranthes sessilis* Steud.)
p. 280 Alternanthera portoricensis Kuntze (*Achyranthes portoricensis* Standl.)
p. 280 Alternanthera ficoidea (L.) R. Br. ex R. & S. (*Achyranthes ficoidea* Lam.) This species is probably a synonym to Alternanthera polygonoides (L.) R. Br.
p. 280 Alternanthera ficoidea var. bettzickiana (Mich.) Baker *Achyranthes bettzickiana* Standl.)
p. 281 Alternanthera ramosissima (Moq.) Chod. (*Achyranthes ramosissima* Standl.)
p. 282 Gomphrena decumbens Jacq. (*Gomphrena dispersa* Standl.)
p. 283 Iresine diffusa H. & B. ex Willd. (*Iresine celosia* L.)

NYCTAGINACEAE

p. 285 Boerhaavia diffusa L. (*Boerhaavia coccinea* Mill.)
p. 286 The species of Torrubia are being studied and will probably be transferred to *Guapira*. Cf. Woodson, R. E. Ann. Mo. Bot. Gard. **XLVIII**: 61. 1961.

PHYTOLACCACEAE

p. 293 Stegnosperma cubense A. Rich. To be added: Aibonito.

AIZOACEAE

p. 296 Tetragonia tetragonioides (Pallas) O. Kuntze (*Tetragonia expansa* Murr.)

CARYOPHYLLACEAE (*Alsinaceae*)

p. 297 Stellaria antillana Urb. (*Alsine antillana* Britt. & Wils.)

PORTULACACEAE

Ref.: LEGRAND, DIEGO.—Las Especies americanas de Portulaca. Ann. Mus. Hist. Nat. Montevideo, 2 ser. **VII** (3): 1-147. 1962.

p. 300 Portulaca rubricaulis HBK. (*Portulaca phaeosperma* Urb.)

p. 300 Portulaca teretifolia HBK. (*Portulaca poliosperma* Urb.)

BASELLACEAE

p. 301 Anredera leptostachys (Moq.) Steen. (*Boussingaultia leptostachys* Moq.)

p. 301 Anredera baselloides (HBK.) Baill. (*Boussingaultia baselloides* HBK.)

p. 301 Basella alba L. (*Basella rubra* L.)

NYMPHAEACEAE (includes *Cabombaceae*)

p. 304 Nymphaea ampla (Salisb.) DC. (*Castalia ampla* Salisb.)

p. 304 Nymphaea pulchella DC. (*Castalia pulchella* Britt.)

p. 304 Nymphaea odorata Dryand (*Castalia odorata* Woodw. & Woodw.)

p. 305 Nymphaea amazonum Mart. & Zucc. (*Castalia amazonum* Britt. & Wils.)

p. 305 Nymphaea rudgeana G. F. W. Meyer (*Castalia rudgeana* Britt. & Wils.)

ANNONACEAE

Ref., FRIES, R. E.—Acta Horti Bergiani. 1931-1939.

p. 311 Guatteria blainii (Griseb.) Urb. (*Cananga blainii* Britt.)

p. 311 Guatteria caribaea Urb. (*Cananga caribaea* Britt.)

LAURACEAE (includes *Cassythaceae*)

Ref.: KOPP, LUCILLE.—Revision of Persea. Unpublished.
KOSTERMANS, A. J. G. H.—Reinwardtia **6**: 17-24. 1961.

p. 316 Beilschmiedia pendula (Sw.) Benth. & Hook. (*Hufelandia pendula* Nees)

p. 317 Licaria salicifolia (Sw.) Kosterm. (*Acrodiclidium salicifolium* Griseb.)

p. 317 Licaria triandra (Sw.) Kosterm. (*Misanteca triandra* Mez)

p. 317 Licaria brittoniana Allen & Gregory. To be added: Maricao & Susua. Brittonia **VII**: 267-269. 1951.

p. 318 Persea americana Mill. (*Persea persea* Cockerell)

p. 318 Persea urbaniana Mez (*Persea portoricensis* Britt. & Wils.) To be added: Luquillo & Cerro de Punta. Cf. Sci. Surv. VI: 346.

p. 318 Cinnamomum montanum (Sw.) Berchthold & Presl (*Phoebe montana* Griseb.)

p. 319 Cinnamomum elongatum (Vahl) Kosterm. (*Phoebe elongata* Nees)

p. 324 Cinnamomum zeylanicum Blume (correct author citation)

BRASSICACEAE

p. 327 Brassica rapa L. (*Brassica campestris* L.)

p. 328 Brassica kaber (DC.) L. C. Wheeler (*Sinapis arvensis* L.)

p. 328 Rorippa portoricensis (Spreng.) Stehlé (*Radicula portoricensis* Britt.)

p. 329 Rorippa palustris (L.) Bess. (*Radicula palustris* Moench.)

p. 329 Rorippa nasturtium-aquaticum (L.) Hayek. (*Sisymbrium nasturtium-aquaticum* L.)

To be added: Coronopus didymus (L.) Smith. Villalba.

CAPPARACEAE (*Capparidaceae*)

p. 332 Cleome rutidosperma DC. (*Cleome ciliata* Schum. & Thonn.)

p. 332 Cleome viscosa L. (*Cleome icosandra* L.)

MORINGACEAE

p. 337 Moringa oleifera Lam. (*Moringa moringa* Millsp.)

ROSACEAE (includes *Amygdalaceae*)

p. 342 Rubus probus Bailey, found in the central mountains of Puerto Rico; probably a good species, not a hybrid.

p. 344 Prunus myrtifolia (L.) Urb. (*Laurocerasus myrtifolia* Britt.)

p. 344 Prunus occidentalis Sw. (*Laurocerasus occidentalis* Roem.)

p. 345 Chrysobalanus icaco L., add to synonymy: *Chrysobalanus pellocarpus* G. F. W. Meyer.

LEGUMINOSAE-MIMOSOIDEAE

p. 347 Inga vera Willd. (*Inga inga* Britt.)

p. 347 Inga fagifolia (L.) Willd. (*Inga laurina* Willd.)

p. 348 Pithecellobium unguis-cati (L.) Benth. (correct author citation)

p. 350 Calliandra caracasana (Jacq.) Benth. (*Anneslia portoricensis* Britt.)

p. 350 Calliandra haematostoma (Bertero) Benth. (*Anneslia haematostoma* Britt.)

p. 350 Calliandra purpurea (L.) Benth. (*Anneslia purpurea* Britt.)

p. 351 Acacia farnesiana (L.) Willd. (*Vachellia farnesiana* Wight & Arn.)
p. 355 Leucaena leucocephala (Lam.) DeWit (*Leucaena glauca* Benth.)
p. 356 Desmanthus virgatus (L.) Willd. (*Acuan virgatum* Medic.; *Acuan depressum* Kuntze; *Acuan insulare* Britt. & Rose; cf. Sci. Surv. VI: 539).
p. 357 Schrankia portoricensis Urb. (*Morongia portoricensis* Britt.)
p. 358 Mimosa pigra L. To be added: Mayagüez.
p. 359 Prosopis limensis Benth. To be added: Vieques, St. Croix.
p. 360 Anadenanthera peregrina (L.) Speg. (*Piptadenia peregrina* Benth.)
p. 351 Albizia (correct spelling)

CAESALPINIOIDEAE

p. 366 Cassia diphylla L. (*Chamaecrista diphylla* Greene)
p. 366 Cassia glandulosa var. swartzii (Wickstr.) Macbride (*Chamaecrista swartzii* Britt.)
p. 366 Cassia mirabilis (Pollard) Urb. (*Chamaecrista mirabilis* Pollard)
p. 367 Cassia portoricensis Urb. (*Chamaecrista portoricensis* Cook & Collins)
p. 367 Cassia granulata (Urb.) Macbride (*Chamaecrista granulata* Britt.)
p. 367 Cassia grammica Spreng. (*Chamaecrista grammica* Pollard)
p. 367 Cassia diffusa DC. (*Chamaecrista chamaecrista* Britt.)
p. 368 Cassia aeschynomene DC. (*Chamaecrista aeschynomene* Greene)
p. 369 Cassia javanica L. (*Cassia nodosa* Hamilt.)
p. 369 Cassia antillana (Britt. & Rose) Alain (*Chamaecrista antillana* Britt. & Rose)
p. 370 Cassia fruticosa Mill. (*Chamaefistula bacillaris* G. Don)
p. 370 Cassia stahlii Urb. (*Adipera stahlii* Britt. & Rose)
p. 370 Cassia bicapsularis L. (*Adipera bicapsularis* Britt. & Rose)
p. 371 Cassia laevigata Willd. (*Adipera laevigata* Britt. & Rose)
p. 371 Cassia obtusifolia L. (*Emelista tora* Britt. & Rose)
p. 372 Cassia hirsuta L. (*Ditremexa hirsuta* Britt. & Rose). Collected again near Bayamón.
p. 372 Cassia occidentalis L. (*Ditremexa occidentalis* Britt. & Rose; *Ditremexa sophera* Britt. & Rose)
p. 373 Cassia polyphylla Jacq. (*Peiranisia polyphylla* Britt. & Rose)
p. 373 Cassia obovata Collad. (*Senna obovata* Batka)
p. 374 Cassia emarginata L. (*Isandrina emarginata* Britt. & Rose)
p. 374 Cassia alata L. (*Herpetica alata* Raf.)

To be added: Cassia patellaria DC. (*Chamaecrista patellaria* Greene)

See Sci. Surv. VI: 540. Abundant, Western and Southern Puerto Rico.
Cassia exunguis Urb. (*Chamaecrista exunguis* Britt.) See Sci. Surv. VI: 541. Between Aibonito and Coamo.
Cassia rotundifolia Pers. Cerro Gordo.

p. 376 Caesalpinia pulcherrima (L.) Sw. (*Poinciana pulcherrima* L.)
p. 378 Caesalpinia coriaria (Jacq.) Willd. (*Libidibia coriaria* Schl.)
p. 378 Caesalpinia crista L. (*Guilandina crista* Small)
p. 379 Caesalpinia bonduc (L.) Roxb. (*Guilandina bonduc* L.)
p. 379 Caesalpinia divergens Urb. (*Guilandina divergens* Britt.)
p. 379 Caesalpinia melanosperma (Eggers) Urb. (*Guilandina melanospermum* Eggers)
p. 380 Caesalpinia portoricensis (Britt. & Wils.) Alain (*Guilandina portoricensis* Britt. & Wils.)
p. 380 Caesalpinia culebrae (Britt. & Wils.) Alain (*Guilandina culebrae* Britt. & Wils.)
p. 380 Caesalpinia decapetala (Roth.) Alst in Trimen. (*Biancaea sepiaria* Todaro)
p. 381 Peltophorum inerme (Roxb.) Naves (*Peltophorum ferrugineum* Benth.)

PAPILIONOIDEAE

p. 386 Crotalaria saltiana Andr. (*Crotalaria striata* DC.)
p. 390 Dalea domingensis DC. (*Parosela domingensis* Millsp.)
p. 391 Tephrosia cinerea (L.) Pers. (*Cracca cinerea* Morong)
p. 391 Tephrosia senna HBK. (*Cracca cathartica* Britt. & Millsp.)
p. 391 Tephrosia candida DC. To be added: Ponce, Carolina, probably an escape.
p. 392 Gliricidia sepium (Jacq.) Kunth ex Walp. (correct author citation)
p. 394 Corynella paucifolia DC. (Correct spelling, not *C. pauciflora*)
p. 394 Cracca caribaea (Jacq.) Benth. (*Benthamantha caribaea* Kuntze)
p. 395 Sesbania sericea (Willd.) DC. (*Sesban sericea* Rydb.)
p. 395 Sesbania sesban (L.) Fawc. & Rendle (*Sesban sesban* Britt.)
p. 395 Sesbania emerus (Aubl.) Urb. (*Sesban emerus* Rydb.)
p. 395 Sesbania bispinosa (Jacq.) Steud. ex Fawc. & Rendle (*Sesbania spinosa* Spreng.) To be added: Guayanilla. See Sci. Surv. **VI:** 352.
p. 396 Sesbania grandiflora (L.) Pers. (*Agati grandiflora* Desv.)
p. 397 Aeschynomene gracilis Vogel (*Aeschynomene portoricensis* Urb.) See Contr. U. S. Nat. Herb. **32.** 1955.
p. 399 Zornia reticulata Sm. (*Zornia diphylla* Pers., as to the Puerto-Rican plant).

p. 399 Zornia gemella (Willd.) Vogel. To be added: Guanajibo, Mayagüez. See Webbia **XVI**. 1961.

p. 400 Desmodium barbatum (L.) Benth. & Oerst. (*Meibomia barbata* Kuntze) Ref: Contr. Gray Herb. **CXXIX**. 1940; CXXXV. 1941.

p. 401 Desmodium adscendens (Sw.) DC. (*Meibomia adscendens* Kuntze)

p. 401 Desmodium canum (J. F. Gmel.) Schinz & Thell. (*Meibomia supina* Britt.)

p. 401 Desmodium affine Schl. (*Meibomia affinis* Kuntze)

p. 402 Desmodium axillare (Sw.) DC. (*Meibomia axillaris* Kuntze)

p. 402 Desmodium axillare var. acutifolium (Kuntze) Urb. (*Meibomia umbrosa* Britt.)

p. 402 Desmodium axillare var. stoloniferum (Rich. ex Poir.) Schub. (*Meibomia sintenisii* Britt.)

p. 403 Desmodium wydlerianum Urb. (*Meibomia wydleriana* Britt.)

p. 403 Desmodium scorpiurus (Sw.) Desv. (*Meibomia scorpiurus* Kuntze)

p. 403 Desmodium glabrum (Mill.) DC. (*Meibomia mollis* Kuntze)

p. 403 Desmodium tortuosum (Sio.) DC. (*Meibomia purpurea* Vail. ex Small)

p. 404 Desmodium procumbens (Mill.) Hitchc. (*Meibomia procumbens* Britt.)

p. 404 Desmodium triflorum (L.) DC. (*Sagotia triflora* Duch. & Walp.)

To be added: Desmodium cubense Griseb. (*Meibomia cubensis* Schindl.) Coamo. See Sci. Surv. VI: 352.

Desmodium intortum (Mill.) Fawc. & Rendle. Maricao.

p. 405 Dalbergia monetaria L. f. (*Securidaca volubilis* L.)

p. 406 Dalbergia ecastaphyllum (L.) Taub. (*Ecastophyllum ecastophyllum* Britt.)

p. 406 Machaerium lunatum (L. f.) Ducke (*Drepanocarpus lunatus* G. F. W. Meyer)

p. 408 Lonchocarpus pentaphyllus (Poir.) DC. (*Lonchocarpus latifolius* HBK.) See Sargentia **VIII**: 154. 1949.

p. 409 Piscidia piscipula (L.) Sarg. (*Ichthyomethia piscipula* Hitchc.)

p. 410 Abrus precatorius L. (*Abrus abrus W. F.* Wight)

p. 411 Clitoria rubiginosa Juss. (*Martiusia rubiginosa* Britt.)

p. 412 Clitoria laurifolia Poir. in Lam. (*Martiusia laurifolia* Britt.)

p. 412 Centrosema plumieri (Turp.) Benth. (*Bradburya plumieri* Kuntze)

p. 413 Centrosema pubescens Benth. (*Bradburya pubescens* Kuntze)

p. 413 Centrosema virginianum Benth. (*Bradburya virginiana* Kuntze)

p. 414 Cajanus cajan (L.) Millsp. (*Cajan cajan* Millsp.)
p. 415 Rhynchosia phaseoloides (Sio.) DC. (*Dolicholus pyramidalis* Britt. & Rose)
p. 415 Rhynchosia reticulata (Sw.) DC. (*Dolicholus reticulatus* Millsp.)
p. 415 Rhynchosia minima (L.) DC. (*Dolicholus minimus* Medic.)
p. 416 Calopogonium mucunoides Desv. (*Calopogonium orthocarpum* Urb.)
p. 418 Canavalia (correct spelling, instead of *Canavali*). See Brittonia **16:** 106-181. 1964.
p. 419 Canavalia nitida (Cav.) Piper (*Canavali rusiosperma* Urb.)
p. 419 Canavalia ensiformis (Jacq.) DC. (correct author citation)
To be added: Canavalia gladiata (Jacq.) DC. Virgin Islands.
Canavalia brasiliensis Mart. ex Benth. Virgin Islands.
p. 420 Phaseolus schottii Benth. (*Phaseolus trichocarpus* Wr. ex Sauv., with doubt).
p. 421 Macroptilium lathyroides (L.) Urb. (*Phaseolus lathyroides* L.)
p. 421 Phaseolus coccineus L. (*Phaseolus multiflorus* Willd.)
p. 422 Vigna luteola (Jacq.) Benth. (*Vigna repens* Kuntze)
p. 423 Phaseolus peduncularis HBK. (*Vigna peduncularis* Fawc. & Rendle)
p. 424 Pachyrrhizus erosus (L.) Urb. (*Cacara erosa* Kuntze)
p. 424 Pueraria phaseoloides Benth. To be added: abundant, escaped from cultivation.
p. 426 Mucuna pruriens (L.) DC. (*Stizolobium pruritum* Piper)
p. 427 Erythrina eggersii Kruk. & Mold. (*Erythrina horrida* Eggers)

OXALIDACEAE

p. 431 Oxalis intermedia A. Rich. (*Ionoxalis intermedia* Small)
p. 431 Oxalis corymbosa Zucc. (*Ionoxalis martiana* Small)
p. 431 Oxalis corniculata L. (*Xanthoxalis corniculata* Small)
To be added: Oxalis barrelieri L. Eastern Puerto Rico.

ERYTHROXYLACEAE

p. 433 Erythroxylum rotundifolium Lunan (*Erythroxylum brevipes* DC.)
p. 434 Erythroxylum rufum Cav. To be added: Maricao. See Sci. Surv. VI: 354.

MALPIGHIACEAE

Ref.: Niedenzu, F.— Pflanzenreich IV[147]. 1928
p. 438 Tetrapteris citrifolia (Sw.) Pers. (*Tetrapteris inaequalis* Cav.)
p. 438 Banisteria lucida Rich. (*Banisteriopsis lucida* Small)
p. 438 Tetrapteris buxifolia Cav. (*Adenoporces buxifolia* Small).

To be added: St. Thomas. Cf. Sci. Surv. VI. 545.

p. 439 Heteropteris purpurea (L.) Kunth (*Banisteria purpurea* L.)

p. 439 Heteropteris wydleriana A. Juss. (*Banisteria wydleriana* C. B. Robins.)

p. 440 Heteropteris laurifolia (L.) Juss. (*Banisteria laurifolia* L.)

p. 440 Stigmaphyllon diversifolium A. Juss. (*Stigmaphyllon ledifolium* Small)

p. 441 Stigmaphyllon periplocifolium (Desf.) Juss. (*Stigmaphyllon lingulatum* Small)

p. 442 Galphimia gracilis Bartl. (*Thryallis glauca* Kuntze, as to the Puerto-Rican plant)

p. 444 Malpighia shaferi Britt. & Wils. Add locality: Maunabo, Puerto Rico. Cf. Sci. Surv. VI: 354.

p. 444 Malpighia angustifolia L. (*Malpighia linearis* Jacq.)

p. 446 Byrsonima lucida (Sw.) DC. (*Byrsonima cuneata* P. Wils.; *Byrsonima horneana* Britt. & Small, No. 2).

p. 447 Byrsonima spicata (Cav.) DC. (*Byrsonima ophiticola* Small, No. 3).

p. 448 Byrsonima wadsworthii Little. To be added: Luquillo Mts., and Cerro de Punta, Jayuya. Cf. Phytologia 4: 417. 1953

RUTACEAE

p. 445 Murraya exotica L. (*Chalcas exotica* Millsp.)

p. 455 Citrus limon (L.) Burm. f. (*Citrus limonum* Risso)

p. 457 Citrus maxima (J. Burm.) Merrill (*Citrus grandis* Osbeck)

SIMAROUBACEAE (*includes Surianaceae,* p. 457)

p. 459 Castela erecta Turp. (*Castelaria nicholsoni* Small)

p. 460 Picrasma antillana (Eggers) Urb. (*Aeschrion antillana* Small)

p. 460 Picrasma excelsa (Sw.) Planch. (*Aeschrion excelsa* Kuntze)

BURSERACEAE

p. 461 Bursera simaruba (L.) Sarg. (*Elaphrium simaruba* Rose)

POLYGALACEAE

Ref.: Blake, S. F.—N. Amer. Flora **25**: 305-379. 1924.

p. 469 Polygala cowellii (Britt.) Blake (*Phlebotaenia cowellii* Britt.)

p. 470 Polygala portoricensis (Britt.) Blake (*Badiera portoricensis* Britt.)

p. 470 Polygala penaea L. (*Badiera penaea* DC.)

p. 471 Securidaca virgata Sw. (*Elsota virgata* Kuntze)

p. 471 Securidaca diversifolia (L.) S.F. Blake (*Elsota diversifolia* Blake)

EUPHORBIACEAE

Ref.: WEBSTER, GRADY.—Journ. Arnold Arb. 1956-1959. (*Phyllanthus*)

p. 473 According to herbarium notes, *Andrachne cuneifolia* Britton must be placed into Securinega. Webster has not made the combination yet.

p. 474 Phyllanthus juglandifolius Willd. (*Asterandra grandifolia* Britt.)

p. 475 Flueggea virosa (Willd.) Baill. (*Conami portoricensis* Britt.)

p. 475 Phyllanthus acidus (L.) Skeels (*Cicca disticha* L.)

p. 476 Phyllanthus epiphyllanthus L. (*Xylophylla epiphyllanthus* Britt.)

p. 477 *Phyllanthus lathyroides* HBK. has not been collected in Puerto Rico. The specimens so named belong to Phyllanthus niruri L.

p. 477 Phyllanthus stipulatus (Raf.) Webster (*Phyllanthus diffusus* Klotzsch)

p. 477 Phyllanthus pentaphyllus Wr. ex Griseb. ssp. polycladus (Urb.) Webster (*Phyllanthus polycladus* Urb.)

p. 477 Phyllanthus pentaphyllus ssp. pentaphyllus. To be added: Susua State Forest.

To be added: Phyllanthus urinaria L. Abundant in the whole island of Puerto Rico.

p. 483 Croton trinitatis Millsp. To be added: St. Thomas. See Sci. Surv. VI: 547.

p. 484 Jatropha curcas L. (*Curcas curcas* Britt. & Millsp.)

p. 484 Jatropha hernandiaefolia Vent. (*Curcas hernandiaefolius* Britt.)

p. 485 Jatropha gossypifolia L. (*Adenoropium gossypifolium* Pohl)

p. 485 Jatropha multifida L. (*Adenoropium multifidum* Pohl)

p. 485 Jatropha integerrima Jacq. (*Adenoropium hastatum* Britt. & Wils.)

p. 486 Argythamnia fasciculata (Vahl) Muell. Arg. (*Ditaxis fasciculata* Vahl)

p. 487 Bernardia dichotoma (Willd.) Muell. Arg. (*Adelia bernardia* L.)

p. 488 Adelia ricinella L. (*Ricinella ricinella* Britt.)

p. 493 Manihot utilissima Pohl (*Manihot manihot* Cockerell)

p. 493 Sebastiania corniculata (Vahl) Pax. To be added: Hato Tejas, Cerro Gordo.

p. 496 Pedilanthus tithymaloides var. angustifolius (Poit.) Dressler (*Pedilanthus angustifolius* Poit.)

p. 496 Pedilanthus tithymaloides var. padifolius (L.) Dressler (*Pedilanthus padifolius* Poit.)

p. 497 Pedilanthus tithymaloides var. parasiticus (L.) Dressler (*Pedilanthus latifolius* Millsp.)
p. 499 Euphorbia oerstediana (Kl. & Garcke) Boiss. in DC. (*Dichylium oerstedianum* Britt.)
p. 500 Euphorbia petiolaris Sims (*Aklema petiolare* Millsp.)
The genus **Chamaesyce** has not been revised. Will report later.

BUXACEAE

p. 507 Buxus laevigata (Sw.) Spreng. (*Tricera citrifolia* Willd.)
p. 508 Buxus vahlii Baill. (*Tricera vahlii* Britt.)
p. 508 Buxus portoricensis Alain. To be added: Maricao, Moca.

ANACARDIACEAE

p. 510 Metopium linnaei Engl. (*Metopium toxiferum* Krug & Urb.)

AQUIFOLIACEAE (*Ilicaceae*)

p. 515 Ilex sideroxyloides var. occidentalis (Macfad.) Loes. To be added: Luquillo.
To be added: Ilex cookii Britt. & Wils. Cerro de Punta, Jayuya. Cf. Sci. Surv. VI: 357.

CELASTRACEAE

p. 517 Torralbasia cuneifolia (C. Wr.) Krug & Urb. To be added: Cerro de Punta and Luquillo Mts. Cf. Sci. Surv. VI: 358.
p. 517 Crossopetalum rhacoma Crantz (*Rhacoma crossopetalum* L.)
p. 519 Cassine xylocarpa Vent. (*Elaeodendron xylocarpum* DC.)

HIPPOCRATACEAE

Ref.: SMITH, A. C.—Brittonia **3:** 341-555. 1940.
p. 520 Pristimera caribaea (Urb.) A. C. Sm. (*Hippocratea caribaea* Urb.). Collected several times, mainly in the western part of Puerto Rico; also in Hispaniola.

SAPINDACEAE (includes *Dodonaeaceae*)

Ref.: RADLKOFER, L.— Sapindaceae, in Pflanzenreich 14. 165. 1931-1934.
p. 521 Dodonaea viscosa Jacq., add synonym: *Dodonaea ehrenbergii* Schl.) No. 1.
p. 525 Cardiospermum halicacabum var. microcarpum (HBK.) Blume (*Cardiospermum microcarpum* HBK.)
p. 525 Thouinia striata Radlk. (*Thyana striata* Britt.)
p. 526 Thouinia portoricensis Radlk. (*Thyana portoricensis* Britt.)
p. 528 Matayba apetala (Macf.) Radlk.. (*Matayba oppositifolia* Britt.)
p. 529 Melicoccus bijugatus Jacq. (*Melicocca bijuga* L.)

RHAMNACEAE

Ref.: Johnston, Marshall C.—Wrightia **3**: 91-96. 1963; Amer. Journ. Bot. **50**: 1021. 1963: **51**: 1113-1118. 1964.

p. 534 Ziziphus rignonii Delp. (*Sarcomphalus domingensis* Krug & Urb.)

p. 534 Ziziphus reticulata (Vahl) DC. (*Sarcomphalus reticulatus* Urb.)

p. 534 Ziziphus taylori (Britt.) M. C. Johnst. (*Sarcomphalus taylori* Britt.) To be added: Mona Island. See Sci. Surv. VI: 358.

p. 535 Ziziphus mauritiana Lam. (*Ziziphus jujuba* Lam.) Add to Puerto Rico: Guanica.

p. 536 Colubrina arborescens (Mill.) Sarg. (*Colubrina colubrina* Millsp.)

p. 537 Colubrina urbanii M. C. Johnst. (*Hybosperma spinosum* Urb.)

VITACEAE

p. 541 Cissus tuberculata Jacq. To be added: Limestone Mts., N. Puerto Rico.

ELAEOCARPACEAE

p. 542 Sloanea amygdalina Griseb. To be added: Maricao.

TILIACEAE

Ref.: Ko Ko Lay.—Ann. Mo. Bot. Gard. **37**: 315-395. 1950.

p. 544 Triumfetta bartramia L. (Add synonym: *Triumfetta excisa* Urb., No. 2)

p. 545 Triumfetta bogotensis DC. (*Triumfetta hispida* A. Rich.) To be added: St. Croix. See Sci. Surv. **VI**: 550.

MALVACEAE

p. 547 Abutilon americanum (L.) Sweet (*Abutilon abutiloides* Garcke)

p. 548 Wissadula contracta (Link) Fries, is cited from Puerto Rico in Flora of Trinidad and Tobago. I have seen no specimen of this species from the area of the Flora.

p. 550 Malvastrum americanum (L.) Torrey (*Malvastrum spicatum* A. Gray)

p. 551 Sida salviaevolia Presl (*Sida erecta* Macf.)

p. 552 Sida acuta Burm. f. (*Sida carpinifolia* L. f.)

p. 552 Sida alba L. To be added: Cabo Rojo. See Sci. Surv. VI: 550.

p. 560 Pavonia fruticosa (Mill.) Fawc. & Rendle (*Thyphalea fruticosa* Britt.)

p. 560 Pavonia scabra (Vogel) Stehlé & Quentin (*Malache scabra* B. Vogel)
p. 561 Pavonia paniculata Cav. (*Lebretonia paniculata* Britt.)
p. 564 Hibiscus tiliaceus L. (*Pariti tiliaceaum* St. Hil.)
p. 567 Gossypium arboreum L. var. nadam (Watt.) Prokh. (*Gossypium barbadense* L.)
p. 567 Malvaviscus arboreus Cav. (*Malvaviscus malvaviscus* Britt. & Wils.) To be added: St. Thomas.

BOMBACACEAE

Ref.: Bull. Jard. Bot. Bruxelles **XXXIII:** 1-315. 1963.
p. 570 Pachira insignis (Sw.) Sw. (*Pachira aquatica* Aubl.)

STERCULIACEAE

p. 571 Melochia tomentosa L. (*Moluchia tomentosa* Britt.)
p. 572 Melochia pyramidata L. (*Moluchia pyramidata* Britt.)
p. 572 Melochia villosa (Mill.) Fawc. & Rendle (*Riedlea hirsuta* DC.)
p. 573 Waltheria indica L. (*Waltheria americana* L.)
p. 574 Ayenia insularis Cristobal (*Ayenia pusilla* L., as to the plant). See Opera Lilloana IV: 1-230. 1960.
p. 575 Guazuma ulmifolia Lam. (*Guazuma guazuma* Cockerell)

OCHNACEAE

Ref.: Dwyer, J. D.—Lloydia **7:** 121-145. 1944.
p. 578 Ouratea striata (v. Tiegh.) Urb. To be added: Guavate.
p. 578 Ouratea ilicifolia (DC.) Baill. Virgin Islands.

THEACEAE

Ref.: Kobuski, Clarence E.—Journ. Arnold Arb. **XXII:** 395-416. 1941; **XXIV:** 60-76. 1943; **XXX:** 166-186. 1949.
p. 580 Ternstroemia peduncularis DC. (*Taonabo peduncularis* Britt.)
p. 580 Ternstroemia luquillensis Krug & Urb. (*Taonabo luquillensis* Britt.)
p. 581 Ternstroemia heptasepala Krug & Urb. (*Taonabo heptasepala* Britt.)
p. 581 Ternstroemia subsessilis (Britt.) Urb. (*Taonabo subsessilis* Britt.)
p. 581 Ternstroemia stahlii Krug & Urb. (*Taonabo stahlii* Britt.; *Taonabo pachyphylla* Britt.)
p. 582 Cleyera albopunctata (Griseb.) Krug & Urb. (*Eroteum albopunctatum* Britt.)
p. 582 Laplacea portoricensis (Krug & Urb.) Dwyer (*Haemocharis portoricensis* Krug & Urb.)

GUTTIFERAE (*Clusiaceae,* includes *Hypericaceae*)

p. 584 Calophyllum calaba L. (*Calophyllum antillanum* Britt.) See Howard, R. A.—Journ. Arnold Arb. **XLIII: 397-398. 1962.**

p. 584 Rheedia portoricensis Urb. [*Rheedia acuminata* (Spreng.) Tr. & Pl., not *Rheedia acuminata* (R. & P.) Tr. & Pl.]

p. 585 Clusia grisebachiana (Pl. & Triana) Alain (*Clusia krugiana* Urb.)

p. 587 Hypericum hypericoides (L.) Crantz (*Ascyrum hypericoides* L.)

COCHLOSPERMACEAE

p. 588 Cochlospermum vitifolium (Willd.) Spreng. (*Maximiliania vitifolia* Krug & Urb.)

FLACOURTIACEAE

p. 592 Homalium racemosum Jacq. (*Homalium pleiandrum* Blake; *Homalium leiogynum* Blake)

p. 592 Xylosma schwaneckeanum (Krug & Urb.) Urb. (*Myroxylon schwaneckeanum* Krug & Urb.)

p. 593 Xylosma pachyphyllum (Krug & Urb.) Urb. (*Myroxylon pachyphyllum* Krug & Urb.)

p. 593 Xylosma buxifolium A. Gray (*Myroxylon buxifolium* Krug & Urb.)

p. 593 Xylosma schaefferioides A. Gray. To be added: Maricao.

p. 596 Laetia procera (Poepp. & Endl.) Eichl. (*Casearia bicolor* Urb.)

p. 596 Lunania buchii Urb. To be added: Maricao.

VIOLACEAE

p. 597 Hybanthus linearifolius (Vahl) Urb. (*Ionidium linearifolium* Britt.)

p. 597 Hybanthus portoricensis Urb. (*Ionidium portoricense* Krug & Urb.)

PASSIFLORACEAE

Ref.: Killip, E. P.—Field Mus. Nat. Hist. Bot. Ser. **XIX.** 1938.

p. 602 Passiflora murucuja L. To be added: Quebradillas. See Sci. Surv. VI: 363.

p. 602 Passiflora anadenia Urb. To be added: Guanica.

p. 602 Passiflora suberosa L. (*Passiflora pallida* L.)

p. 604 Passiflora edulis Sims. To be added: Bayamón.

CACTACEAE

p. 608 Pereskia aculeata (L.) Mill. (*Pereskia pereskia* Karst.)

p. 612 Pilosocereus royeni (L.) Byles & Rowley (*Cephalocereus royeni* Britt. & Rose)

p. 617 Melocactus intortus (Mill.) Urb. (*Cactus intortus* Mill.)

p. 617 Mammillaria nivosa Link (*Neomammillaria* nivosa Britt. & Rose)

SCIENTIFIC SURVEY OF PUERTO RICO AND THE VIRGIN ISLANDS. VOLUME VI.

MELASTOMATACEAE

Ref.: WILLIAMS, LOUIS O.—Fieldiana, Bot. **29** 10: 545-586. 1963.

p. 2 Acisanthera quadrata Juss. (*Acisanthera acisanthera* Britt.)

p. 5 Miconia serrulata (DC.) Naud. (*Tamonea macrophylla* Krasser)

p. 6 Miconia mirabilis (Aubl.) L. O. Wms. (*Tamonea guianensis* Aubl.)

p. 7 Miconia microcarpa DC. (*Miconia affinis* DC.)

To be added: Graffenrieda ottoschulzii (Urb. & Ekm.) Urb. & Ekm. (*Miconia ottoschulzii* Urb. & Ekm): Isabón. Cf. Sci. Surv. VI: 555.

p. 15 Henriettea macfadyenii (Triana) Alain (*Henriettella macfadyenii* Triana)

p. 15 Henriettea membranifolia (Cogn.) Alain (*Henriettella membranifolia* Cogn.)

p. 16 Henriettea fascicularis (Sw.) G. Maza (*Henriettella fascicularis* Wr. ex Sauv.)

p. 16 Henriettea triflora (Vahl) Alain. To be added: Guavate.

LYTHRACEAE

p. 20 Cuphea parsonsia (L.) R. Br. (*Parsonsia parsonsia* Britt.)

p. 21 Cuphea micrantha HBK. (*Parsonsia micrantha* Jennings)

p. 21 Lagerstroemia speciosa (J. A. Murr.) Pers. (correct author citation)

COMBRETACEAE (*Terminaliaceae*, p. 22)

MYRTACEAE

Ref.: MCVAUGH, ROGERS.—Fieldiana, Bot. **29** (8): 395-532. 1963.

p. 26 Psidium amplexicaule Pers. Add locality: Utuado, Puerto Rico.

p. 26 Psidium cattleyanum Sabine. Add Locality: Utuado, Puerto Rico. An escape.

p. 27 Pimenta racemosa (Mill.) J. W. Moore (*Amomis caryophyllata* Krug & Urb.)

p. 28 Pimenta racemosa var. grisea (Kiaersk.) Fosberg (*Amomis grisea* Britt.)

p. 28 Aulomyrcia citrifolia (Aubl.) Amsh. (*Myrcia citrifolia* Urb.; *Eugenia saviaefolia* Alain).

p. 28 Aulomyrcia leptoclada (DC.) Berg (*Myrcia leptoclada* DC.)
p. 29 Myrcia fallax (Rich.) DC. (*Myrcia berberis* DC.)
p. 30 Siphoneugenia densiflora Berg (*Plinia dussii* Urb.)
p. 31 Calyptranthes pallens (Poir.) Griseb. To be added: Maricao, Guavate.

To be added: Calyptranthes triflorum Alain. Maricao. Bull. Torrey Bot. Club **90:** 189. 1963.
Calyptranthes peduncularis Alain. Maricao. Bull. Torrey Club **90:** 189. 1963.
Calyptranthes luquillensis Alain. Luquillo Mts. Bull. Torrey Club **90:** 189. 1963.
Calyptranthes dumetorum Alain. Susua.

p. 34 Eugenia domingensis Berg. (*Eugenia aeruginea* DC.)
p. 35 Eugenia maleolens Poir. (*Eugenia buxifolia* Willd.)

To be added: Eugenia farjardensis Krug & Urb. Fapardo, Dorado. Symb. Ant. **9:** 109. 1923.
Eugenia margarettae Alain. Doña Juana. Bull. Torrey Bot. Club **90:** 190. 1923.
Eugenia haematocarpa Alain. Luquillo Mts. Bull. Torrey Club **90:** 190. 1923.
Eugenia glabrata (Sw.) DC. Maricao.

p. 39 Myrciaria floribunda (West) Berg (*Eugenia floribunda* West)
p. 41 Jambosa jambos (L.) Millsp. (*Jambos jambos* Millsp.)
p. 42 Myrcianthes fragrans (Sw.) McVaugh (*Anamomis fragrans* Griseb.)
p. 42 Pseudanamomis umbellulifera (Britt.) Kassel (*Anamomis umbellulifera* Britt.) The presence of this plant in Puerto Rico has been confirmed.
p. 42 Pimenta dioica (L.) Merrill (*Pimenta pimenta* Cockerell). Escaped: Bayamón.

RHIZOPHORACEAE

p. 44 Cassipourea guianensis Aubl. (*Cassipourea alba* Griseb.)

ONAGRACEAE

Ref.: Hara, Hiroshi.—Journ. Jap. Bot. 28: 289-294.
Raven, Peter H.—Kew Bull. 15: 476. 1961.

p. 45 Ludwigia palustris (L.) Elliot (*Isnardia palustris* L.)
p. 45 Ludwigia peploides (HBK.) Raven (*Jussiaea repens* L.)
p. 45 Ludwigia leptocarpa (Nutt.) H. Hara (*Jussiaea leptocarpa* Nutt.)
p. 46 Ludwigia erecta (L.) H. Hara (*Jussiaea erecta* L.)
p. 46 Ludwigia peruviana (L.) H. Hara (*Jussiaea peruviana* L.)
p. 46 Ludwigia octovalvis (Jacq.) Raven (*Jussiaea angustifolia* Lam.)

ARALIACEAE

p. 48 Didymopanax gleasonii Britt. & Wils. Sci. Surv. VI: 365, 574. To be added: Cerro de Punta, Maricao.

UMBELLIFERAE (*Ammiaceae*)

p. 51 Hydrocotyle verticillata var. triradiata (A. Rich.) Fern. To be added.

p. 51 Hydrocotyle bonariensis Lam. To be added.

p. 51 Centella erecta (L. f.) Fern. (*Centella asiatica* Urb.)

p. 52 Apium leptophyllum (Pers.) F. Muell. (*Cyclospermum leptophyllum* Sprague)

p. 52 Petroselinum crispum (Mill.) Mansfeld (*Apium petroselinum* L.)

p. 52 Foeniculum vulgare Mill. (*Foeniculum foeniculum* Karst.)

p. 53 Anthriscus cerefolium (L.) Hoffm. (*Cerefolium cerefolium* Britt.)

ERICACEAE (includes *Vacciniaceae*)

p. 54 Lyonia rubiginosa (Pers.) G. Don (*Xolisma rubiginosa* Small)

p. 54 Lyonia stahlii Urb. (*Xolisma stahlii* Small)

p. 55 Hornemannia racemosa Vahl (*Thibaudia krugii* Urb. & Hoerold)

p. 56 Gonocalyx portoricensis (Urb.) A. C. Smith (*Ceratostoma portoricensis* Hoerold)

MYRSINACEAE

p. 57 Ardisia glauciflora Urb. (*Icacorea glauciflora* Britt.)

p. 57 Ardisia obovata Desv. (*Icacorea guadalupensis* Britt. & Wils.)

p. 58 Ardisia luquillensis (Britt.) Alain (*Icacorea luquillensis* Britt.)

p. 59 Wallenia yunquensis (Urb.) Mez (*Petesioides yunquense* Britt.)

p. 59 Wallenia pendula (Urb.) Mez (*Petesioides pendulum* Britt.)

THEOPHRASTACEAE

p. 62 Jacquinia stenophylla Urb. To be added: Guanica.

SAPOTACEAE

Ref.: Cronquist, Arthur.—Bull. Torrey Club **72**: 191-204. 1945; **72**: 550-562. 1945; **73**: 465-471. 1946; Lloydia **9**: 241-292. 1946; Journ. Arnold Arb. **XXVI**: 435-471. 1945.

p. 65 Manilkara zapota (L.) v. Royen (*Sapota achras* Mill.)

p. 65 *Micropholis curvata* Urb. is synonym to Micropholis chrysophylloides Pierre.

p. 66 Mastichodendron foetidissimum (Jacq.) Cron. (*Sideroxylon foetidissimum* Jacq.; *Sideroxylon portoricense* Urb., No. 2).
p. 67 Pouteria multiflora (A. DC.) Baehni (*Lucuma multiflora* A. DC.)
p. 67 Pouteria mammosa (L.) Cron. (*Achras zapota* L.)
p. 67 Pouteria dictyoneura (Griseb.) Radlk. ssp. fuertesii (Urb.) Cron. (*Paralabatia portoricensis* Britt. & Wils.) To be added: Limestone hills, N. Puerto Rico. See Sci. Surv. VI: 556.
p. 67 Pouteria hotteana (Urb. & Ekm.) Baehni. To be added: Maricao.
p. 68 Chrysophyllum bicolor Poir. (*Chrysophyllum eggersii* Pierre, No. 4. p. 69)
p. 70 Dipholis cubensis (Griseb.) Pierre (*Dipholis sintenisii* Pierre)
p. 71 Bumelia obovata var. krugii (Pierre) Cron. (*Bumelia krugii* Pierre)
p. 72 Manilkara balata (Aubl.) Dubard (*Manilkara nitida* Dubard; *Manilkara bidentata* Cher.)
p. 72 Manilkara pleeana (Pierre) Cron. (*Manilkara duplicata* Dubard)
p. 72 Manilkara jaimiqui (Wr. ex Griseb.) Dubard. To be added: Lajas to Parguera. See Sci. Surv. VI: 366. (*Manilkara emarginata* Britt. & Wils.)

EBENACEAE

p. 73 Diospyros sintenisii (Krug & Urb.) Standl. (*Maba sintenisii* Krug & Urb.)
p. 74 Diospyros digyna Jacq. (*Diospyros ebenaster* Retz.). See: Howard, Richard A.—Journ. Arnold Arb. **XLII**: 430. 1961; **XLIII**: 101. 1962.
p. 74 Diospyros philippensis (Desrousseaux) Guercke (*Diospyros discolor* Willd.)

OLEACEAE

p. 78 Haenianthus salicifolius var. obovatus (Krug & Urb.) Knobl. (*Haenianthus obovatus* Krug & Urb.)
p. 78 Linociera domingensis (Lam.) Knobl. (*Mayepea domingensis* Krug & Urb.)
p. 79 Linociera caribaea (Jacq.) Knobl. (*Mayepea caribaea* Kuntze)
p. 79 Linociera axilliflora Griseb. (*Mayepea axilliflora* Krug & Urb.)
p. 79 Linociera ligustrina Sw. To be added: El Jobo, San Antonio.
p. 79 Linociera holdridgii Camp & Monachino. To be added: Guanica. Lloydia **2**: 223. 1939.

p. 85 *Menyanthaceae* in **GENTIANACEAE.**

APOCYNACEAE

Ref.: Woodson, Robert E.—N. Amer. Flora **29** (2). 1938.

p. 88 Plumeria obtusa L. (*Plumeria portoricensis* Urb.; *Plumeria krugii* Urb.)

p. 89 Tabernaemontana divaricata (L.) R. Br. (*Tabernaemontana coronaria* Willd.)

p. 90 Rauvolfia nitida Jacq. (*Rauvolfia tetraphylla* L.)

p. 91 Rauvolfia viridis R. & S. (*Rauvolfia lamarckii* A. DC.)

p. 91 Thevetia peruviana (Pers.) K. Schum. (*Cerbera thevetia* L.)

p. 92 Prestonia agglutinata (Jacq.) Woods. (*Echites agglutinata* Jacq.)

p. 94 Forsteronia portoricensis Woods. To be added: common in the mountains.

p. 94 Forsteronia corymbosa G. F. W. Meyer is represented by a doubtful specimen.

p. 94 Carissa macrocarpa (Ecklon) A. DC. (*Arduina grandiflora* E. Meyer)

ASCLEPIADACEAE

p. 96 Cynanchum ephedroides (Griseb.) Alain (*Metastelma ephedroides* Schltr.)

p. 97 Cynanchum monense (Britt.) Alain (*Metastelma monense* Britt.)

p. 97 Cynanchum lineare (Bello) Alain (*Metastelma lineare* Bello)

p. 97 Cynanchum anegadense (Britt.) Alain (*Metastelma anegadense* Britt.)

p. 97 Cynanchum parviflorum Sw. (*Metastelma parviflorum* R. Br.)

p. 97 Cynanchum cheesmanii Woods. (*Metastelma decipiens* Schltr.)

p. 98 **Cynanchum grisebachianum** (Schltr.) Alain, comb. nov. (*Metastelma grisebachianam* Schltr. in Urb. Symb. Ant. 5: 469. 1908; *Metastelma decaisneanum* Schltr. in Urb. Symb. Ant. 1: 250. 1899, not *Cynanchum decaisneanum* R. Holm, 1953; *Cynanchum decaisneanum* Alain, Mem. Soc. Cub. Hist. Nat. **22**: 119. 1955.)

p. 99 Matelea maritima (Jacq.) Woods. (*Ibatia maritima* Dcne.)

p. 99 Sarcostemma clausum (Jacq.) R. & S. (*Funastrum clausum* Schltr.)

p. 100 Gonolobus stephanotrichus Griseb. (*Vincetoxicum stephanotrichum* Britt.)

p. 100 Matelea variifolia (Schltr.) Woods. (*Vincetoxicum variifolium* Britt.)

p. 100 Matelea sintenisii (Schltr.) Woods. (*Vincetoxicum sintenisii* Britt.)

CONVOLVULACEAE (includes *Cuscutaceae*)

Ref.: Ooststrom, S. J. van.—A Monograph of the genus Evolvulus. Meded. Mus. Herb. Univ. Utrecht **14**: 1-267. 1934.

O'Donell, C. A.—Revisión de las especies americanas de Merremia. Lilloa **VI**: 467-554. 1941.

p. 104 Evolvulus alsinoides L. var. linifolius (L.) Baker (*Evolvulus linifolius* L.) St. Thomas, St. Croix.

p. 105 Evolvulus tenuis Mart. var. longifolius (Choisy) v. Ooststr. (*Evolvulus bocasanus* Britt.)

p. 106 Jacquemontia obcordata (Millsp.) House (*Jacquemontia subsalina* Britt.)

p. 107 Jacquemontia tamnifolia (L.) Griseb. (*Thyella tamnifolia* Raf.)

p. 107 Jacquemontia canescens (HBK.) Benth. To be added: Guanica.

p. 107 Ipomoea alba L. (*Calonyction aculeatum* House)

p. 108 Ipomoea tuba (Schltr.) G. Don (*Calonyction tuba* Colla)

p. 108 Ipomoea quamoclit L. (*Quamoclit quamoclit* Britt.)

p. 108 Ipomoea hederifolia L. (*Quamoclit coccinea* Moench)

p. 109 Ipomoea solanifolia L. (*Exogonium solanifolium* Britt.)

p. 109 Ipomoea repanda Jacq. (*Exogonium repandum* Choisy)

p. 110 Ipomoea steudelii Millsp. (*Exogonium arenarium* Choisy)

p. 111 Merremia umbellata (L.) Hall. f. (*Ipomoea polyanthes* R. & S.)

p. 111 Merremia dissecta (Jacq.) Hall. f. (*Ipomoea dissecta* Pursh)

p. 111 Merremia aegyptia (L.) Urb. (*Ipomoea aegyptia* L.)

p. 112 Ipomoea setifera Poir. (*Ipomoea rubra* Millsp.) Add synonym: *Ipomoea palustris* Urb. Cf. Sci Surv. VI: 368

p. 112 Ipomoea acuminata (Vahl) R. & S. (*Ipomoea cathartica* Poir. in Lam.)

p. 113 Ipomoea purpurea A. W. Roth; correct author citation.

p. 113 Ipomoea pes-caprae var. brasiliensis (L.) v. Oostr. To be added: St. Thomas.

p. 114 Merremia quinquefolia (L.) Hall. f. (*Ipomoea quinquefolia* L.)

p. 114 Ipomoea spirillus House (*Ipomoea heptaphylla* Voigt)

p. 115 Merremia tridentata (L.) Hall. f. ssp. angustifolia (Jacq.) v. Oostr. (*Ipomoea angustifolia* Jacq.)

p. 116 Ipomoea batatas (L.) L.; correct author citation.

p. 117 Ipomoea violacea L. (*Ipomoea tricolor* Cav.) Cf. Blumea III: 541. 1940.

p. 117 Ipomoea ochroleuca Spanoghe (*Ipomoea kentrocarpa* Hochst.)

To be added: San Germán.

p. 118 Merremia tuberosa (L.) Rendle (*Operculina tuberosa* Meissn. in Mart.)

p. 119 Stictocardia tiliaefolia (Desr.) Hall f. (*Rivea campanulata* House)

p. 121 Cuscuta obtusiflora HBK. var. glandulosa Engelm. (*Cuscuta glandulosa* Small)

p. 121 Cuscuta campestris Yuncker (*Cuscuta pentagonia* Engelm.)

p. 121 Cuscuta globulosa Benth. To be added: quite abundant, in Puerto Rico and the Virgin Islands.

HYDROPHYLLACEAE

p. 122 Nama jamaicensis L. (*Marilaunidium jamaicense* Kuntze)

BORAGINACEAE (includes *Ehretiaceae*)

p. 123 Cordia alliodora (R. & P.) Oken (*Cerdana alliodora* R. & P.)

p. 123 Cordia alba (Jacq.) R. & S. (*Calyptracordia alba* Britt.)

p. 123 Cordia gerascanthus L. To be added: Yauco

p. 124 Cordia sebestena L. (*Sebesten sebestena* Britt. & Small)

p. 124 Cordia rickseckeri Millsp. (*Sebesten rickseckeri* Britt.)

p. 125 Cordia collococca L. (*Cordia glabra* L.)

p. 126 Cordia stenophylla Alain (*Varronia angustifolia* West)

p. 127 Cordia polycephala (Lam.) Johnst. (*Varronia corymbosa* Desv., pro parte)

p. 127 Cordia globosa (Jacq.) HBK. (*Varronia globosa* Jacq.)

p. 127 Cordia bahamensis Urb. (*Varronia bahamensis* Millsp.)

p. 127 Cordia lima (Desv.) R. & S. (*Varronia lima* Desv.)

p. 128 Cordia rupicola Urb. (*Varronia rupicola* Britt.)

p. 128 Cordia bellonis Urb. (*Varronia bellonis* Britt.)

p. 129 Bourreria succulenta var. revoluta (HBK.) O. E. Schult. (*Bourreria revoluta* HBK.)

p. 131 Tournefortia gnaphalodes (L.) R. Br. (*Mallotonia gnaphalodes* Britt.)

p. 133 Tournefortia maculata Jacq. (*Tournefortia peruviana* Poir.; *Tournefortia laurifolia* Vent.)

p. 133 Tournefortia volubilis L. Add synonym: *Tournefortia microphylla* Bert. ex Spreng. No. 7.

p. 134 Heliotropium indicum L. (*Tiaridium indicum* Lehm.)

p. 134 Heliotropium angiospermum Murray (*Schobera angiosperma* Britt.)

p. 135 Heliotropium procumbens Mill. (*Heliotropium inundatum* Sw.)

p. 136 Heliotropium microphyllum Sw. (*Heliotropium crispiflorum* Urb.)

p. 137 Heliotropium arborescens L. (*Heliotropium peruvianum* L.)
p. 137 Heliotropium amplexicaule Vahl (*Cochranea anchusaefolia* Gürcke; *Heliophytum amplexicaule* Britt. & Wils.)
To be added: Cynoglossum furcatum Wall. in Roxb. Maricao.

VERBENACEAE

Ref.: Moldenke, Harold, N.—The known geographic distribution of the Verbenaceae, etc. New York, 1949. Suppl. 1-13.

p. 138 Verbena tenuisecta Briq. To be added, cited by Moldenke, perhaps only cultivated.
p. 138 Verbena bonariensis L. To be added: Guavate.
p. 139 Ghinia boxiana Mold. (*Ghinia spinosa* Britt. & Wils., as to the Puerto Rican plant)
p. 139 Lantana camara var. aculeata (L.) Mold. (*Lantana aculeata* L.)
p. 139 Lantana camara var. mista (L.) L. H. Bailey. To be added: Bayamón, Mayagüez, St. Thomas.
p. 139 Lantana camara var. mutabilis (Hook.) L. H. Bailey. To be added: Trujillo.
p. 139 Lantana camara var. sanguinea L. H. Bailey. To be added, cited by Moldenke.
p. 139 Lantana camara f. parvifolia Mold. To be added: Bayamón.
p. 139 Lantana strigosa (Griseb.) Urb. To be added: S. Puerto Rico.
p. 139 Lantana fucata var. antillana Mold. To be added: San Juan.
p. 139 Lantana reticulata Pers. To be added: S. Puerto Rico.
p. 139 Lantana arida Britt. To be added: abundant in P. Rico; St. Croix.
p. 139 Lantana insularis Mold. To be added: St. Croix.
p. 139 Lantana involucrata var. odorata (L.) Mold. To be added: P. Rico, St. Croix, St. Thomas.
p. 139 Lantana montevidensis (Spreng.) Briq. To be added: P. Rico; St. Thomas.
p. 141 Lippia micromera Schau var. helleri (Britt.) Mold. (*Lippia helleri* Britt.)
p. 142 Phyla nodiflora (L.) Greene (*Lippia nodiflora* Michx.)
p. 142 Phyla nodiflora var. reptans (HBK.) Mold. (*Lippia reptans* HBK.)
p. 142 Phyla stoechadifolia (L.) Small (*Lippia stoechadifolia* HBK.)
p. 142 Phyla scaberrima (A. L. Juss.) Mold. To be added, cited by Moldenke
p. 142 Phyla strigulosa f. parvifolia (Mold.) Mold. To be added: S. P. Rico, St. Croix.
p. 143 Bouchea prismatica var. longirostra Grenz. To be added: Ponce.

p. 143 Bouchea prismatica var. brevirostra Grenz. To be added: St. Thomas.

p. 143 Stachytarpheta cayennensis (L. C. Rich.) Vahl (*Valerianoides cayennense* Kuntze)

p. 144 Stachytarpheta cayennensis var. albiflora Mold. To be added: Pueblo Viejo.

p. 144 Stachytarpheta X hybrida Mold. To be added: S. P. Rico, Culebrita.

p. 144 Stachytarpheta urticaefolia (Salisb.) Sims. To be added: Mayagüez.

p. 144 Stachytarpheta jamaicensis (L.) Vahl (*Valeranoides jamaicense* Kuntze)

p. 144 Stachytarpheta strigosa Vahl (*Valerianoides strigosum* Britt.)

p. 145 Citharexylum fruticosum var. subvillosum Mold. To be added: St. Thomas, Culebra.

p. 145 Citharexylum fruticosum var. villosum (Jacq.) O. E. Schulz. To be added: Puerto Rico, Virgin Gorda, Tortola.

p. 146 Citharexylum pentandrum Vent. To be added: in Herb. Ventenat.

p. 146 Citharexylum X perkinsii Mold. To be added: Cerro de Punta.

p. 146 Citharexylum tristachyum Turcz. To be added: St. Thomas.

p. 147 Aegiphila elata Sw. To be added, cited by Moldenke.

p. 149 Vitex parviflora A. L. Juss. To be added: Mayagüez to Maricao.

p. 149 Vitex negundo var. intermedia (P'ei) Mold. To be added: St. Croix.

p. 150 Clerodendrum aculeatum (L.) Schlecht. (*Volkameria aculeata* L.)

p. 150 Clerodendrum bungei Steud. To be added: Vega Baja, probably an escape.

p. 151 Clerodendrum indicum (L.) Kuntze (*Siphonanthus indicus* L.)

p. 151 Clerodendrum inerme (L.) Gaertn. To be added: St. Croix.

p. 151 Avicennia germinans (L.) L. (*Avicennia nitida* Jacq.)

p. 152 Congea tomentosa Roxb. To be added: Trujillo, Cultivated.

p. 152 Petrea kohautiana Presl. To be added: Mayagüez, St. Thomas. Cultivated.

p. 152 Tektona grandis L. (*Tectona grandis* incorrect spelling).

LABIATAE (*Lamiaceae*)

p. 156 Salvia misella Kunth. To be added: *Wydler* (1826).

p. 156 Salvia micrantha Vahl. To be added: St. Croix, Mona Island.

p. 157 Hyptis spicigera Lam. (*Hyptis americana* Urb.)

p. 159 Hyptis escobilla Urb. To be added: Bayamón.

p. 159 Hyptis scoparia Poit. To be added: Guilarte.

SOLANACEAE

p. 163 Lycium tweedianum Griseb. var. chrysocarpum (Urb. & Ekm.) L. C. Hitchc. (*Lycium americanum* Jacq.)

p. 166 Solanum caribaeum Dunal. To be added: Comerio.

p. 167 Solanum erianthum D. Don (*Solanum verbascifolium* L.)

p. 169 Solanum campechiense L. (*Solanum guanicense* Urb.)

p. 170 Solanum ficifolium Ort. (*Solanum torvum* Sw.)

p. 171 Solanum elaegnifolium Cav. To be added: Ensenada.

p. 171 Solanum antillarum O. E. Schulz. To be added: Guilarte.

p. 171 Solanum ciliatum Lam. To be added: Maricao.

p. 171 Solanum pterocaulon Dunal. To be added.

p. 172 Lycopersicon lycopersicum (L.) Karst. (*Lycopersicon lycopersicon* Karst.)

p. 172 Saracha antillana Krug & Urb. To be added: Cerro de Punta.

p. 173 Solandra grandiflora Sw. (*Swartzia grandiflora* Gmel.)

p. 173 Datura suaveolens H. & B. (*Brugmansia suaveolens* Bercht. & Presl)

p. 174 Datura candida (Pers.) Safford (*Brugmansia arborea* Steud.)

p. 174 Datura inoxia Mill. (*Datura metel* L. of Britt. & Wils.)

p. 175 Datura metel L. (*Datura fastuosa* L. of Britton & Wilson)

p. 176 Cestrum salicifolium Dunal. To be added: Bayamón. Cf. Candollea **6**: 360. 1935.

p. 176 Cestrum daphnoides Griseb. To be added: St. Thomas.

SCROPHULARIACEAE

p. 181 Mecardonia dianthera (Sw.) Pennell (*Mecardonia procumbens* Small), as to the plants from Hispaniola southward in the Lesser Antilles.

p. 182 Bacopa repens (Sw.) Wettst. (*Macuillamia repens* Pennell)

p. 182 Bacopa monnieri (L.) Pennell (*Bramia monnieri* Drake)

p. 183 Bacopa stricta (Schrad.) Robins. (*Caconapea stricta* Britt.)

p. 183 Bacopa innominata (Maza) Alain (*Herpestis rotundifolia* Gaertn. f.)

p. 185 Lindernia diffusa (L.) Wettst. (*Vandellia diffusa* L.)

p. 185 Lindernia dubia (L.) Wettst. (*Ilysanthes dubia* Barnhart)

p. 185 Lindernia crustacea (L.) F. Muell. To be added: common in waste grounds.

p. 185 Micranthemum umbrosum (Walt.) Blake (*Globifera umbrosa* J. F. Gmel.)

LENTIBULARIACEAE

p. 191 Utricularia subulata L. (*Setiscapella subulata* Barnh.)

p. 191 Utricularia pusilla Vahl (*Setiscapella pusilla* Barnh.)
p. 191 Utricularia juncea Vahl (*Stomoisia juncea* Barnh.)

BIGNONIACEAE

p. 194 Doxantha unguis-cati (L.) Rehder (*Batocydia unguis* Mart.)
p. 196 Tabebuia pallida Miers (*Tabebuia heterophylla* Britt., No. 4).
p. 199 Schlegelia brachyantha Griseb. (*Schlegelia portoricensis* Britt.)
p. 199 **Tynnanthus caryophylleus** (Bello) Alain, comb. nov. (*Bignonia caryophyllea* Bello, Anal. Soc. Esp. Hist. Nat. **10**: 293. 1881; *Tynnanthus myrianthus* Bur. & K. Schum in Mart. Fl. Bras. 8 (2): 197. 1896).
p. 199 Catalpa longissima (Jacq.) Dum.-Cours. To be added: St. Thomas.

PEDALIACEAE

p. 202 Sesamum indicum L. (*Sesamum orientale* L.)

GESNERIACEAE

p. 204 Alloplectus ambiguus Urb. (*Crantzia ambigua* Britt.) Cf. Contr. U. S. Herb. **29**: 16. 1944.
p. 206 Gesneria sintenisii Urb. (*Duchartrea sintenisii* Britt.)
p. 206 Gesneria albiflora (Dcne.) Kuntze (*Pentarhaphia albiflora* Dcne.)

ACANTHACEAE

p.210 Blechum pyramidatum (Lam.) Urb. (*Blechum blechum* Millsp.)
p. 211 Ruellia tweediana Griseb. To be added: common in western Puerto Rico.
p. 213 Teliostachya alopecuroidea (Vahl) Nees (*Lepidagathis alopecuroidea* R. Br.)
p. 214 Stenandrium tuberosum (L.) Urb. (*Gerardia tuberosa* L.; *Gerardia portoricensis* Britt. & Wils., No. 2.)
p. 215 Dicliptera assurgens (L.) Juss. (*Diapedium assurgens* Kuntze)
p. 215 Dicliptera krugii Urb. (*Diapedium krugii* Britt.)
p. 218 Justicia pectoralis Jacq. (*Stethoma pectoralis* Raf.)
p. 218 Justicia verticillaris (Nees) Urb. (*Stethoma verticillaris* Britt.)
p. 218 Justicia comata (L.) Lam. (*Stethoma comata* Britt.)
To be added: Asystasia gangetica (L.) T. Anders. Escaped and common.

RUBIACEAE

p. 224 Oldenlandia corymbosa L. To be added to Puerto Rico: San

Juan, Bayamón. Cf. Sci. Surv. VI: 563.

p. 224 Oldenlandia lancifolia (K. Schum.) DC. (*Oldenlandia herbacea* DC.)

p. 224 Oldenlandia callitrichoides Griseb. To be added: Bayamón.

p. 225 Lucya tetrandra (L.) K. Schum. (*Clavenna tetrandra* Standl.)

p. 226 Phialanthus myrtilloides Griseb. To be added: Maricao, Susua.

p. 226 Phialanthus grandifolius Alain. To be added: Maricao.

p. 228 Exostema ellipticum Griseb. To be added: Maricao, Villalba. Cf. Sci. Surv. VI: 371.

p. 228 Schradera vahlii Steyerm. (*Urceolaria exotica* Gmelin, pro parte). Cf. Mem. N. Y. Bot. Gard. **10**: 277. 1963.

p. 229 Gonzalagunia spicata (Lam.) Maza (*Duggena hirsuta* Britt.)

p. 230 Coccocypselum herbaceum Aubl. (*Tontanea herbacea* Standl.)

p. 231 Randia aculeata L. (*Randia mitis* L.)

p. 233 Hamelia patens Jacq. (*Hamelia erecta* Jacq.)

p. 235 Guettarda valenzuelana A. Rich. (*Guettarda laevis* Urb.)

p. 237 Antirhea obtusifolia Urb. (*Stenostomum obtusifolium* Britt. & Wils.)

p. 237 Antirhea coriacea (Vahl) Urb. (*Stenostomum coriaceum* Griseb.)

p. 237 Antirhea lucida (Sw.) Benth. & Hook. (*Stenostomum lucidum* Gaertn. f.)

p. 237 Antirhea portoricensis (Britt. & Wils.) Standl. (*Stenostomum portoricense* Britt. & Wils. Sci. Surv. VI: 564. 1930). To be added: Limestone hills, N. Puerto Rico.

p. 238 Antirhea sintenisii Urb. (*Stenostomum sintenisii* Britt. & Wils.)

p. 238 Antirhea acutata (DC.) Urb. (*Stenostomum acutatum* DC.)

p. 238 Terebraria resinosa (Vahl) Sprague (*Laugeria resinosa* Vahl)

p. 241 Chione seminervis Urb. & Ekm. To be added: Cerro de Punta, Jayuya.

p. 241 Scolosanthus multiflorus (Sw.) Krug & Urb. (*Scolosanthus grandifolius* Krug & Urb.)

p. 241 Scolosanthus versicolor Vahl (*Scosanthus versicolor*, incorrect spelling)

p. 242 Scolosanthus densiflorus Urb. To be added: Mariaco.

p. 245 Psychotria microdon (DC.) Urb. (*Psychotria pinularis* Sessé & Moc.)

p. 250 Palicourea crocea (Sw.) R. & S. Add synonym: (*Palicourea brevithyrsa* Britt. & Standl.)

p. 251 Lasianthus lanceolatus (Griseb.) Urb. (*Lasianthus moralesii* Wr. ex Sauv.)

p. 251 Geophila repens (L.) I. M. Johnst. (*Geophila herbacea* Schum.)

p. 253 Richardia brasiliensis Gomez. To be added: Cerro Gordo.

p. 254 Diodia serrulata (P. Beauv.) G. Tayl. (*Diodia maritima* Thonn.)

p. 254 Hemidiodia ocymifolia (Willd. ex R. & S.) K. Schum. Correct spelling and author citation.

p. 255 Borreria brachysepala Urb. (*Borreria laevis* var. *sintenisii* Urb.). To be added

p. 256 Spermacoce confusa Rendle (*Spermacoce tenuior* L., sensu Britt. & Wils.)

p. 256 Spermacoce tenuior L. (*Spermacoce riparia* C. & S.)

p. 258 Mitracarpus villosus (Sw.) DC. (*Mitracarpus hirtus* DC.)

CUCURBITACEAE

p. 262 Lagenaria siceraria (Molina) Standl. (*Cucurbita lagenaria* L.)

p. 264 Citrullus lanatus (Thunb.) Mansfeld (*Citrullus citrullus* Karst.)

p. 265 Cucurbita moschata (Duch.) Duchesne & Poir. (*Pepo moschata* Britt.)

CAMPANULACEAE (includes *Lobeliaceae* as a sub-family)

p. 272 Lobelia rotundifolia Juss. ex A. DC. To be added: Cerro de Punta.

p. 272 Lobelia assurgens var. portoricensis (A. DC.) Urb. (*Tupa robusta* A. DC.)

p. 272 Lobelia portoricensis (Vatke) Urb. (*Tupa portoricensis* Vatke)

p. 273 Laurentia longiflora (L.) Peterm. (*Isotoma longiflora* Presl.)

COMPOSITAE (includes: *Cichorieae, Ambrosiaceae, Carduaceae*Q

p. 276 Lactuca intybacea Jacq. (*Brachyramphus intybaceus* DC.)

p. 277 Xanthium strumarium L. (*Xanthium chinense* Mill.)

p. 279 Ambrosia confertiflora DC. To be added: Lajas.

p. 284 Piptocoma antillana Urb. (*Piptocoma rufescens* Cass., as to the Puerto-Rican plant)

p. 284 Elephantopus scaber L. (*Elephantopus mollis* HBK.)

p. 285 Pseudo-elephantopus spicatus (Aubl.) Gleas. Correct author citation.

p. 287 Eupatorium macrophyllum L. (*Hebeclinium macrophyllum* DC.)

p. 287 Eupatorium odoratum L. (*Osmia odorata* Sch.-Bip.)

p. 288 Eupatorium corymbosum Aubl. (*Osmia corymbosa* Britt. & Wils.)

p. 288 Eupatorium geraniifolium Urb. (*Osmia geraniifolia* Britt. & Wils.)

p. 288 Eupatorium sinuatum Lam. (*Osmia sinuata* Britt. & Wils.)

p. 288 Eupatorium ivaefolium L. (*Osmia ivaefolia* Sch.-Bip.)

p. 288 Eupatorium borinquense (Britt.) Robins. (*Osmia borinquensis* Britt.)

p. 291 Eupatorium portoricense Urb. (*Critonia portoricensis* Britt. & Wils.)

To be added: Eupatorium iresinoides Kunth. Villalba.
Eupatorium oteroi Monachino. Mona Island. Phytologia **2**: 406. 1948.

p. 293 Mikania micrantha var. congesta (DC.) Robins. (*Mikania congesta* DC.)

p. 296 Conyza canadensis (L.) Cron. var. pusilla (Nutt.) Cron. (*Leptilon pusillum* Britt.)

p. 297 Conyza bonariensis (L.) Cron. (*Leptilon bonariense* Small)

p. 297 Conyza floribunda HBK. (*Leptilon linifolium* Small)

p. 297 Conyza apurensis HBK. (*Leptilon chinense* Britt.)

p. 298 Pluchea carolinensis (Jacq.) D. Don (*Pluchea odorata* Cass.)

p. 299 Gnaphalium americanum Mill. (*Gnaphalium spicatum* Lam.)

p. 300 Lagascea mollis Cav. (*Nocca mollis* Jacq.)

p. 302 Zinnia peruviana (L.) L. (*Crassina elegans* Kuntze; *Crassina multiflora* L.)

p. 302 Helichrysum bracteatum (Vent.) Willd. To be added: Toro Negro. Cf. p. 323.

p. 309 Melanthera nivea (L.) Small. Add to synonymy: *Melanthera calcicola* Britt.; *Melanthera canescens* O. E. Schulz; *Melanthera montana* O. E. Schulz; *Melanthera confusa* Britt.

p. 311 Verbesina alata L. (*Tepion alatum* Britt.)

p. 312 Verbesina encelioides (Cav.) Benth. & Hook. (*Ximenesia encelioides* Cav.)

p. 313 Bidens cynapiifolia var. tenuis O. E. Schulz. To be added.

p. 313 Bidens cynapiifolia var. portoricensis (Spreng.) O. E. Schulz. To be added.

p. 314 Bidens reptans var. urbanii (Greenm.) O. E. Schulz (*Bidens urbanii* Greenm.)

p. 316 Flaveria trinervia (Spreng.) C. Mohr To be added: Guanica.

p. 317 Porophyllum ruderale (Jacq.) Cass. (*Porophyllum porophyllum* Kuntze)

p. 319 Pectis floribunda A. Rich. To be added: Pueblo Viejo. Cf. Sci. Surv. VI: 365.

p. 320 Erechtites valerianaefolia (Wolf) DC. To be added: Guavate, Maricao.

p. 324 Chrysanthemum indicum L. (*Chrysanthemum morifolium* Ram.)

TAXACEAE

p. 326 Podocarpus coriaceus L. C. Rich. (*Nageia coriacea* Kuntze)

OPHIOGLOSSACEAE

p. 375 Ophioglossum palmatum L. (*Cheiroglossa palmata* Presl)

SCHIZAEACEAE

p. 380 Schizaea pennula Sw. (*Actinostachys pennula* Hook.)
p. 381 Schizaea poeppigiana Sturm. in Mart. (*Lophidium poeppigianum* Underw.)

GLEICHENIACEAE

Gleichenia
p. 383 ~~Gleichena~~ flexuosa (Schad.) Mett. (*Dicranopteris flexuosa* Underw.)
p. 383 Gleichenia pectinata (Willd.) Presl (*Dicranopteris pectinata* Underw.)
p. 384 Gleichenia bifida (Willd.) Spreng. (*Dicranopteris bifida* Maxon)

CYATHEACEAE

p. 388 Cyathea horrida (L.) J. E. Sm. (*Hemitelia horrida* R. Br.)
p. 388 Cyathea wilsoni (Hook. in Hook. & Baker) Domin (*Hemitelia wilsoni* Hook.)
p. 388 Cyathea escuquensis (Karst.) Domin (*Hemitelia escuquensis* Karst.)
p. 389 Cyathea borinquena (Maxon) Domin (*Alsophila borinquena* Maxon)
p. 390 Cyathea aquilina (Christ) Domin (*Alsophila aquilina* Christ)
p. 390 Lophosoria quadripinnata (Gmel.) C. Chr. (*Alsophila quadripinnata* C. Chr.)

POLYPODIACEAE

p. 394 Elaphoglossum pumilum (Mett.) C. Chr. (*Elaphoglossum piloselloides* Moore)
p. 396 Elaphoglossum rigidum (Aubl.) Urb. (*Elaphoglossum flaccidum* Moore)
p. 397 Elaphoglossum martinicense (Desv.) Moore (*Elaphoglossum underwoodianum* Maxon)
p. 398 Add: Elaphoglossum longifolium (Jacq.) J. Sm. (*Elaphoglossum rigidum* Urb., sensu Maxon in Flora of Puerto Rico).
p. 399 Elaphoglossum maxonii Underw. & Maxon (*Elaphoglossum pteropus* C. Chr., as to the Puerto-Rican plant).

p. 400 Elaphoglossum serpens Maxon. To be added: Cerro de Punta, Jayuya.
p. 401 Elaphoglossum crinitum (L.) Christ (*Hymenodium crinitum* Fée)
p. 401 Peltapteris peltata (Sw.) Morton (*Rhipidopteris peltata* Schott)
p. 403 Vittaria graminifolia Kaulf. (*Vittaria filifolia* Fée)
p. 406 Polytaenium cajenense (Desv.) Benedict (*Antrophytum cayennense* Kaulf.). Determination confirmed; the plant belongs to the Flora of Puerto Rico.
p. 409 Grammitis hessii (Maxon) Alain (*Polypodium hessii* Maxon)
p. 409 Grammitis serrulata (Sw.) Sw. (*Polypodium duale* Maxon)
p. 409 Grammitis myosuroides (Sw.) Sw. (*Polypodium myosuroides* Sw.)
p. 410 Grammitis trifurcata (L.) Copel. (*Polypodium trifurcatum* L.)
p. 410 Grammitis taenifolia (Jenm.) Proctor (*Polypodium taenifolium* Jenm.)
p. 410 Grammitis asplenifolia (L.) Proctor (*Polypodium asplenifolium* L.)
p. 411 Grammitis jubaeformis (Kaulf.) Proctor (*Polypodium jubaeforme* Kaulf.)
p. 411 Grammitis mollissima (Fée) Proctor (*Polypodium mollissimum* Fée).
p. 412 Grammitis taxifolia (L.) Proctor (*Polypodium taxifolium* L.)
p. 412 To be added: Grammitis suspensa (L.) Proctor. Luquillo Mts. Grammitis hartii (Jenm.) Proctor. Cerro de Punta, Jayuya.
p. 417 Polypodium phyllitidis var. latum (Moore) Proctor (*Polypodium latum* Sodiro)
p. 427 Cheilanthes trichomanoides (L.) Mett. (*Notholaena trichomanoides* R. Br.)
p. 429 Cheilanthes paupercula (Kuntze) Mett. (*Adiantopsis paupercula* Fée)
p. 429 Lonchitis hirsuta L. (*Anisosorus hirsutus* Underw. & Maxon)
p. 430 Pteridium aquilinum var. caudatum (L.) Urb. (*Pteridium caudatum* Maxon)
p. 430 Pteridium aquilinum var. arachnoideum (Kaulf.) Brade (*Pteridium arachnoideum* Maxon)
p. 436 Pityrogramme trifoliata (L.) Tryon (*Trismeria trifoliata* Diels)
p. 442 Diplazium cristatum (Desv.) Alston (*Diplazium arboreum* Presl)
p. 454 Blechnum polypodioides (Sw.) Kuhn (*Struthiopteris polypodioides* Trev.)

p. 454 Blechnum divergens (Kunze) Mett. (*Struthiopteris exaltata* Broadh.)
p. 454 Blechnum underwoodianum (Broadh.) C. Chr. (*Struthiopteris underwoodiana* Broadh.)
p. 455 Blechnum lineatum (Sw.) C. Chr. (*Struthiopteris lineata* Broadh.)
p. 457 Lomariopsis amydrophlebia (Slosson ex Maxon) Holttum (*Stenochlaena amydrophlebia* Slosson ex Maxon)
p. 457 Lomariopsis kunzeana (Underw.) Holttum (*Stenochlaena kunzeana* Underw.)
p. 458 Lomariopsis sorbifolia (L.) Fée (*Stenochlaena sorbifolia* J. Smith)
p. 459 Bolbitis nicotianaefolia (Sw.) Alst. (*Leptochilus nicotianaefolius* C. Chr.)
p. 460 Bolbitis pergamentacea (Maxon) Ching (*Leptochilus pergamentaceus* Maxon)
p. 460 Bolbitis cladorrhizans (Spreng.) Ching (*Leptochilus cladorrhizans* Maxon)
p. 460 Bolbitis aliena (Sw.) Alst. (*Leptochilus alienus* C. Chr.)
p. 461 Lomogramma guianensis (Aubl.) Ching (*Leptochilus guianensis* C. Chr.)
p. 463 Polystichum echinatum (Gmel.) C. Chr. (*Polystichum triangulum* Fée, as to the Puerto-Rican plant).
p. 464 Rumohra adiantiformis (Forst.) Ching (*Polystichum adiantiforme* J. Smith)
p. 466 Thelypteris opposita (Vahl) Ching (*Dryopteris opposita* Urb.)
p. 467 Thelypteris sancta (L.) Proctor (*Dryopteris sancta* Kuntze)
p. 467 Thelypteris sancta var. portoricensis (Kuhn) Morton. To be added.
p. 467 Thelypteris piedrensis (C. Chr.) Morton (*Dryopteris piedrensis* C. Chr.)
p. 468 Thelypteris diplazioides (Moritz ex Mett.) Ching (*Dryopteris linkiana* Maxon)
p. 468 Thelypteris germaniana (Fée) Proctor (*Dryopteris germaniana* C. Chr.)
p. 468 Thelypteris balbisii (Spreng.) Ching (*Dryopteris sprengelii* Kuntze)
p. 469 Thelypteris decussata (L.) Proctor (*Dryopteris decussata* Urb.)
p. 469 Thelypteris deltoidea (Sw.) Proctor (*Dryopteris deltoidea* Kuntze)
p. 470 Thelypteris gongylodes (Schkuhr) Small (*Dryopteris gongylodes* Kuntze)

p. 470 Thelypteris dentata (Forsk.) E. St. John (*Dryopteris dentata* C. Chr.)
p. 471 Thelypteris patens (Sw.) Small (*Dryopteris patens* Kuntze)
p. 471 Thelypteris normalis (C. Chr.) Small (*Dryopteris normalis* C. Chr.)
p. 472 Thelypteris serra (Sw.) R. St. John (*Dryopteris serra* Kuntze)
p. 472 Thelypteris oligophylla (Maxon) Proctor (*Dryopteris oligophylla* Maxon)
p. 472 Thelypteris poiteana (Bory) Proctor (*Dryopteris poiteana* Urb.)
p. 473 Thelypteris tetragona (Sw.) Small (*Dryopteris subtetragona* Maxon)
p. 473 Thelypteris megalodus (Schkuhr) Proctor (*Dryopteris megalodus* Urb.)
p. 474 Thelypteris guadalupensis (Wikstr.) Proctor (*Dryopteris domingensis* Maxon)
p. 474 Thelypteris sclerophylla (Kuntze) Morton (*Dryopteris sclerophylla* C. Chr.)
p. 475 Thelypteris reptans (J. F. Gmel.) Morton (*Dryopteris reptans* C. Chr.)
p. 475 Thelypteris brittonae (Slosson) Alain (*Dryopteris brittonae* Slosson)
p. 475 Thelypteris nephrodioides (Klotzsch) Proctor (*Dryopteris guadalupensis* Kuntze)
p. 476 Thelypteris hastata (Fée) Proctor (*Dryopteris hastata* Urb.)
p. 476 Thelypteris leptocladia (Fée) Proctor (*Dryopteris leptocladia* Maxon)
p. 477 Thelypteris angustifolia (Willd.) Proctor (*Dryopteris angustifolia* Urb.)
p. 477 Thelypteris serrata (Cav.) Alst. (*Dryopteris serrata* C. Chr.)
p. 477 Thelypteris reticulata (L.) Proctor (*Dryopteris reticulata* Urb.)
p. 478 Ctenitis hirta (Sw.) Copel. (*Dryopteris hirta* Kuntze)
p. 478 Ctenitis nemorosa (Willd.) Copel. (*Dryopteris nemorosa* Urb.)
p. 478 Ctenitis subincisa (Willd.) Copel. (*Dryopteris subincisa* Urb.)
p. 479 Polystichopsis chaerophylloides (Poir.) Morton (*Dryopteris chaerophylloides* C. Chr.)
p. 479 Ctenitis effusa (Sw.) Copel. (*Dryopteris effusa* Urb.)
p. 482 Tectaria incisa Cav. (*Tectaria martinicensis* Copel.)
p. 490 Orthiopteris domingensis (Spreng.) Copel. (*Saccoloma domingense* Prantl.)

p. 490 Orthiopteris inaequale (Kunze) Copel. (*Saccoloma inaequale* Mett.)

p. 492 Dennstaedtia obtusifolia (Willd.) Moore (*Dennstaedtia ordinata* Moore)

p. 492 Dennstaedtia bipinnata (Cav.) Maxon (*Dennstaedtia adiantoides* Moore)

p. 493 Dennstaedtia cicutaria (Sw.) Moore (=*Dennstaedtia rubiginosa* Moore)

HYMENOPHYLLACEAE

Ref.: J. G. Wessels Boer.—Acta Bot. Neerl. **11**: 277-330. 1962.
Morton, C. V.—Contr. U. S. Nat. Herb. **29** (3). 1947.

p. 496 Trichomanes punctatum ssp. sphenoides (Kunze) W. Boer (*Trichomanes sphenoides* Kunze)

To be added: Trichomanes robustum Fourn. Cerro de Punta, Jayuya.

p. 497 Trichomanes angustifrons (Fée) W. Boer in Kramer (cited by Maxon as *Trichomanes pusillum* Sw.). Cidra, Puerto Rico.

p. 497 Trichomanes pusillum Sw. To be added: Las Cruces; Andubo, Puerto Rico.

To be added: Trichomanes ovale (Fourn.) W. Boer.
Trichomanes kapplerianum Sturm.

p. 506 Hymenophyllum hirsutum (L.) Sw. (*Hymenophyllum ciliatum* Sw.)

To be added: Hymenophyllum axillare Sw. Toro Negro.
Hymenophyllum elegantulum var. petiolulatum Morton Cerro de Punta.
Hymenophyllum undulatum (Sw.) Sw. Cerro de Punta, Jayuya.
Hymenophyllum lanatum Fée. Fide Maxon.
Hymenophyllum sieberi (Presl) v.d. Bosch El Yunque, Luquillo Mts.

LYCOPODIACEAE

p. 516 Lycopodium sintenisii (Herter) Maxon (*Urostachys sintenisii* Herter) Determination and record confirmed for Puerto Rico.

SELAGINELLACEAE

p. 518 Selaginella armata Baker (*Selaginella plagiochila* Baker)

p. 518 Selaginella plumosa (L.) C. Presl (*Selaginella stolonifera* Spring)

p. 519 Selaginella substipitata Spring (*Selaginella portoricensis* A. Braun)

p. 520 Selaginella tenella (Beauv.) Spring (*Selaginella albonitens* Spring)

p. 520 Selaginella subcaulescens Bak. (*Selaginella sintenisii* Hieron.)
To be added: Selaginella flabellata (L.) Spring.
Selaginella stipitata Spring. Toro Negro.

THE NEW YORK BOTANICAL GARDEN
BRONX, NEW YORK

THE STATUS OF CAREX INCOMPERTA BICKN.

F. J. HERMANN

In 1908 Eugene P. Bicknell, equally well-known as a student of the New England flora and of its avifauna, described a sedge from Nantucket Island, Massachusetts, as *Carex incomperta.* It had been generally passing as *C. sterilis* Willd., and it is still a problematical plant, showing affinities, as pointed out by Mackenzie (North American Flora 18(2):107.1931), with such diverse allies as *C. cephalantha, C. angustior, C. howei, C. muricata, C. interior, C. mohrii, C. atlantica, C. ruthii, C. ormantha, C. wiegandii* and *C. phyllomanica.* By Mackenzie and most current authors it has been rightly treated as most nearly related to *C. atlantica* Bailey (1893). From this it has been held to differ chiefly in characteristics of the pistillate scales. These are detailed in the following key which is a composite of those of Mackenzie (*op. cit.*), Fernald (Gray's New Manual of Botany, 8th ed., 1952) and Gleason (New Britton and Brown Illustrated Flora, 1952).

Pistillate scales sharply keeled, acutish to short-cuspidate, two-thirds to fully as long as the perigynium-body, the raised, prominent midrib extending to the tip; culms slender, sharply triangular, 1.5-2.5 mm. thick at the base; leaf-blades 1.5-2.5 mm. wide .... *C. incomperta.*

Pistillate scales flat or very obscurely keeled, obtuse, half to two-thirds as long as the perigynium-body, the midrib not raised, obsolete or nearly so at the tip; culms stiff, obtusely triangular below, 2-3.5 mm. thick at the base; leaf-blades 1.5-4 mm. wide .... *C. atlantica.*

Both plants occur in swamps and bogs, particularly in peaty soils, and have a broad range in eastern North America, from Nova Scotia to Florida westward to Texas, but *C. atlantica* is found chiefly on the coastal plain, whereas *C. incomperta* extends inland to Michigan and Indiana.

In their extreme forms these two taxa are fairly distinct, but it is not often that a specimen will be found to be consistent in all of its purported diagnostic characteristics, and throughout most of their over-lapping geographic ranges (particularly in southern New England, I am informed by Mr. Richard J. Eaton) the proportion of intermediates is bewildering. Since correlation of the distinctions is so frequently impossible, it would appear that varietal status would better represent the relationship of *Carex incomperta* to *C. atlantica,* as well as facilitating identification of the plants, so it is here proposed as *Carex atlantica* Bailey var. **incomperta** (Bickn.) F. J. Herm., comb. nov. (*C. incomperta* Bickn., Bull. Torrey Bot. Club 35: 494. 1908).

FOREST SERVICE HERBARIUM
RANGE AND WILDLIFE HABITAT RESEARCH
U. S. DEPARTMENT OF AGRICULTURE, WASHINGTON, D. C.

THE DISTRIBUTION PATTERNS OF NORTHERN AND SOUTHERN ELEMENTS IN THE FLORA OF NEWFOUNDLAND[1]

by

A. W. H. Damman

Introduction

The flora of the Island of Newfoundland has attracted much attention, mainly as a result of the explorations of Fernald (1911, 1918a, 1918b, 1924, 1925) in the beginning of this century. The vivid descriptions of his field trips, and especially his explanation of the origin of the Newfoundland flora, have focused the attention of plant geographers on the island and the general region of the Gulf of St. Lawrence. His theories have had a great impact on plant geographical thinking in America as well as Northern Europe.

The most conspicuous features of the flora of Newfoundland Rouleau, 1956; Arsène, 1927) are the occurrence of many species with arctic affinities, the absence of many temperate-boreal species present on Cape Breton Island, and the common occurrence of the so-called Coastal Plain species, very often in close association with the arctic species. In addition, the flora contains a number of species which have their main distribution area in western North America. This Cordilleran element is mainly restricted to the mountains and unstable soils of western Newfoundland.

Most of the data on species distribution in Newfoundland, used in this paper, were obtained by personal observation and collection. However, I am grateful to Dr. E. Rouleau of the University of Montreal for showing me many of his unpublished distribution maps of Newfoundland vascular plants. These maps were particularly helpful in checking

[1]Department of Forestry, Canada, Forest Research Branch Contribution No . . .

my observations on the absence of a species from certain parts of the island. Some published accounts of botanical expeditions, in particular those of Fernald (1926, 1933), provided useful additional information on the distribution of a few rare speces.

Thanks are also due to Dr. T. Ahti, University of Helsinki, Dr. W. S. Benninghoff, University of Michigan, Dr. T. C. Brayshaw and Dr. J. S. Rowe, Department of Forestry of Canada, and Dr. W. S. Maass, National Research Council, for helpful suggestions and valuable criticism on a draft of the manuscript, and to Dr. M. E. Hale, Smithsonian Institution for identification of some of the lichens.

In this paper an attempt will be made to analyse the southern and northern elements in the flora of Newfoundland. Before doing this, it will be necessary to describe briefly the geography of the island.

Geographic Setting

The Island of Newfoundland is located off the east coast of the American continent between 46°30′ and 51°30′ N. Lat. and between 59°30′ and 52°45′ W. Long. It covers an area of a little over 42,000 square miles. It is separated in the southwest from Cape Breton Island by the Cabot Strait, and in the northwest from Labrador by the Strait of Belle Isle, 70 and 11 miles wide at their narrowest points respectively (Figure 1).

The island consists essentially of a tilted plateau of moderate to slight relief. It rises gradually to the west, where elevations of over 2,500 feet can be found.

Calcareous soils and limestone outcrops and cliffs prevail along the west coast from St. George's Bay to the northernmost tip of the Great Northern Peninsula. Acidic bedrock, and glacial till derived from it, cover most of the remainder of the island. Serpentine mountains occur along the west coast, between St. George's Bay and Bonne Bay, and also in the northern part of the Great Northern Peninsula.

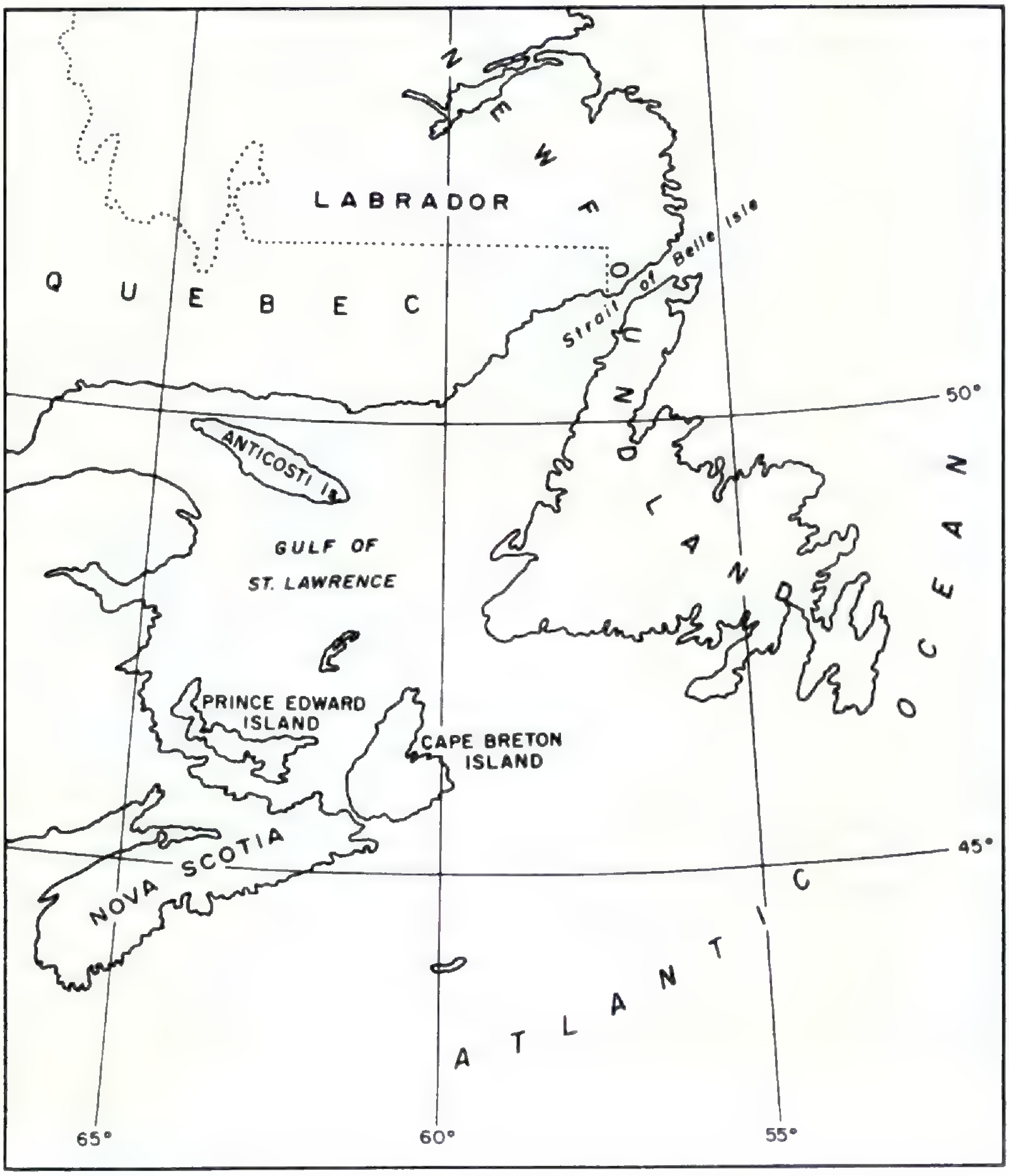

Figure 1. Location of the Island of Newfoundland in relation to the American continent.

In spite of its location, the island does not have a hyper-oceanic climate. Southwestern and western winds prevail throughout the year. Consequently, the climate is greatly influenced by the American continent. This is clearly emphasized by the occurrence near the coast of many species considered continental or sub-continental in Europe, e.g., *Chamaedaphne calyculata, Rhododendron lapponicum,* and many others. Therefore, the climate of the coastal areas should be considered sub-oceanic at most.

The cold Labrador Current flows along the shores of Newfoundland; this current brings ice floes along the shores in winter and spring, and icebergs during spring and summer. The coastal ice fields greatly retard the arrival of spring (Figure 2). The vegetative period starts from 30 to 50 days later in Newfoundland than in Montreal (Hare, 1952).

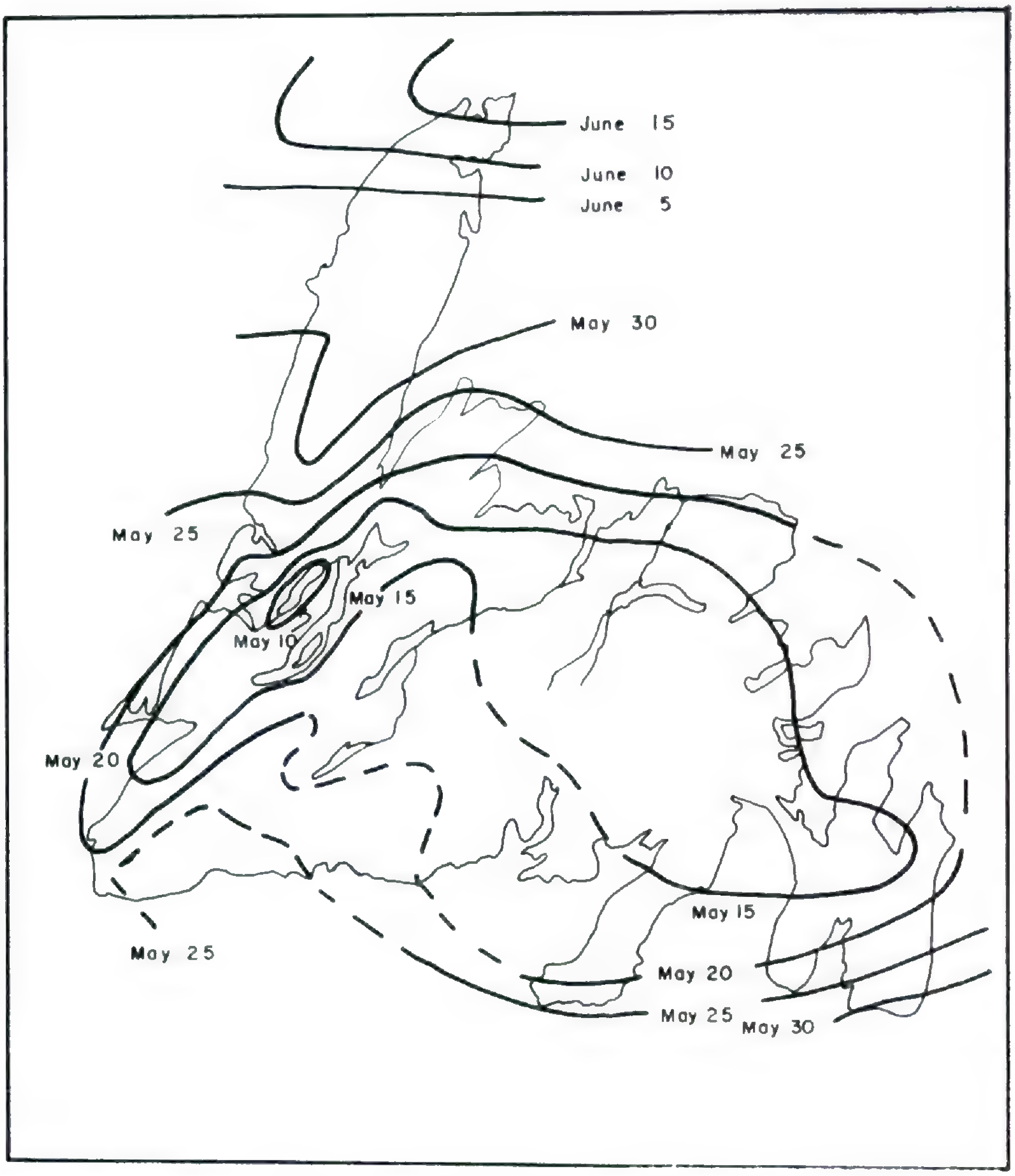

Figure 2. Start of vegetative season based on threshold temperature of 43°F. (After Hare 1952)

Very low summer temperatures prevail along the coast owing to the frequent occurrence of fog and the cooling effect of the sea; this phenomenon is particularly pronounced in the southern and southeastern parts of the island (Figure 3).

In winter, the sea has a moderating effect on the temperatures; the winters of Newfoundland are considerably milder than those of the adjacent continent. This is es-

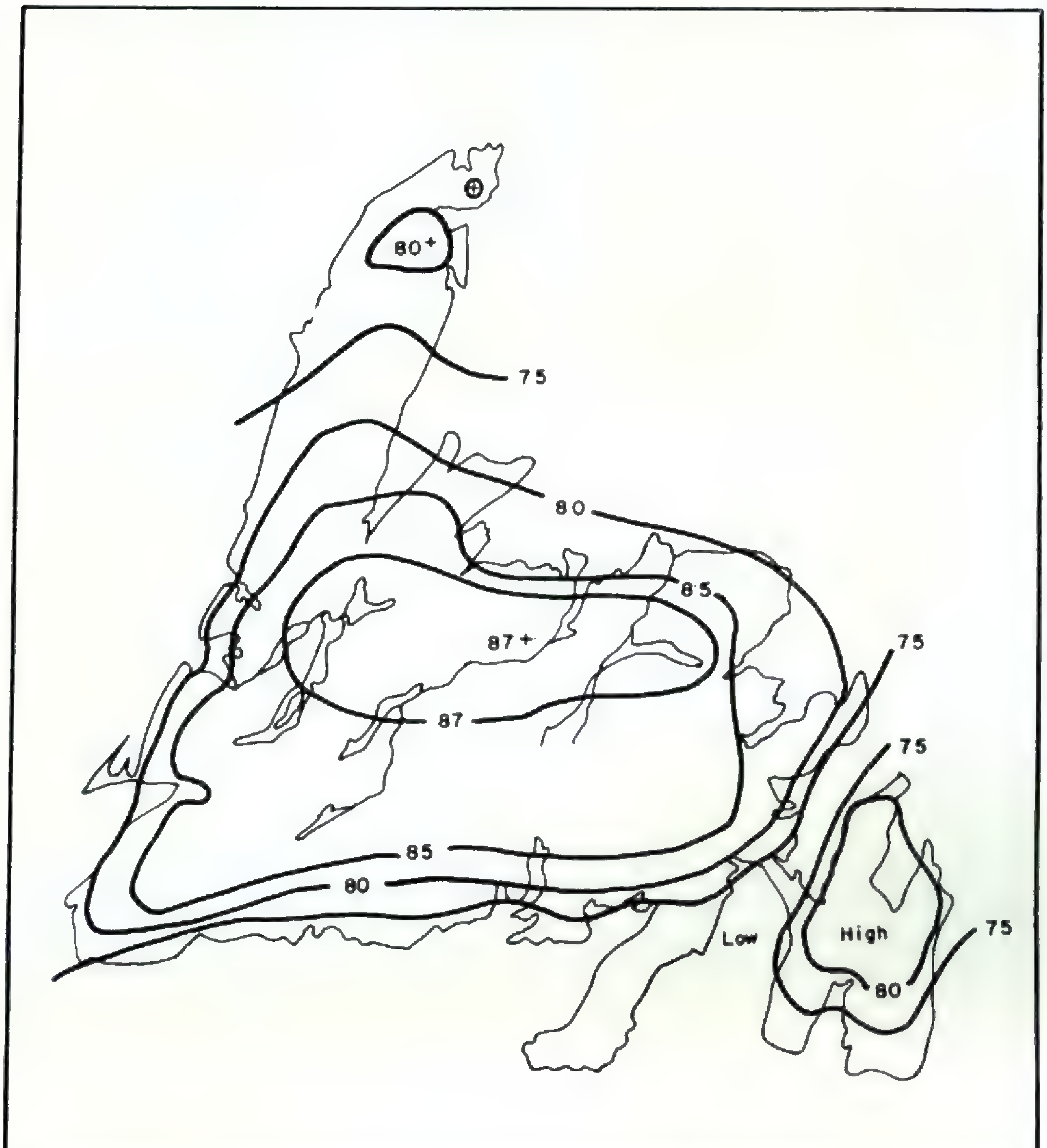

Figure 3. Mean annual maximum temperature in °F. The isotherms have been drawn on the basis of sea level temperatures, and thus show the temperature irrespective of elevation.

pecially true for the areas along the ice-free south coast and the Avalon Peninsula which is not usually surrounded by ice until March (Figures 4 and 5).

The precipitation is well distributed throughout the year in all parts of the island. It ranges from over 55 inches in the southern and southwestern parts to less than 35 inches in the northern areas. The driest area, with a precipitation of 30 inches, is found in the northwestern tip of the Great Northern Peninsula.

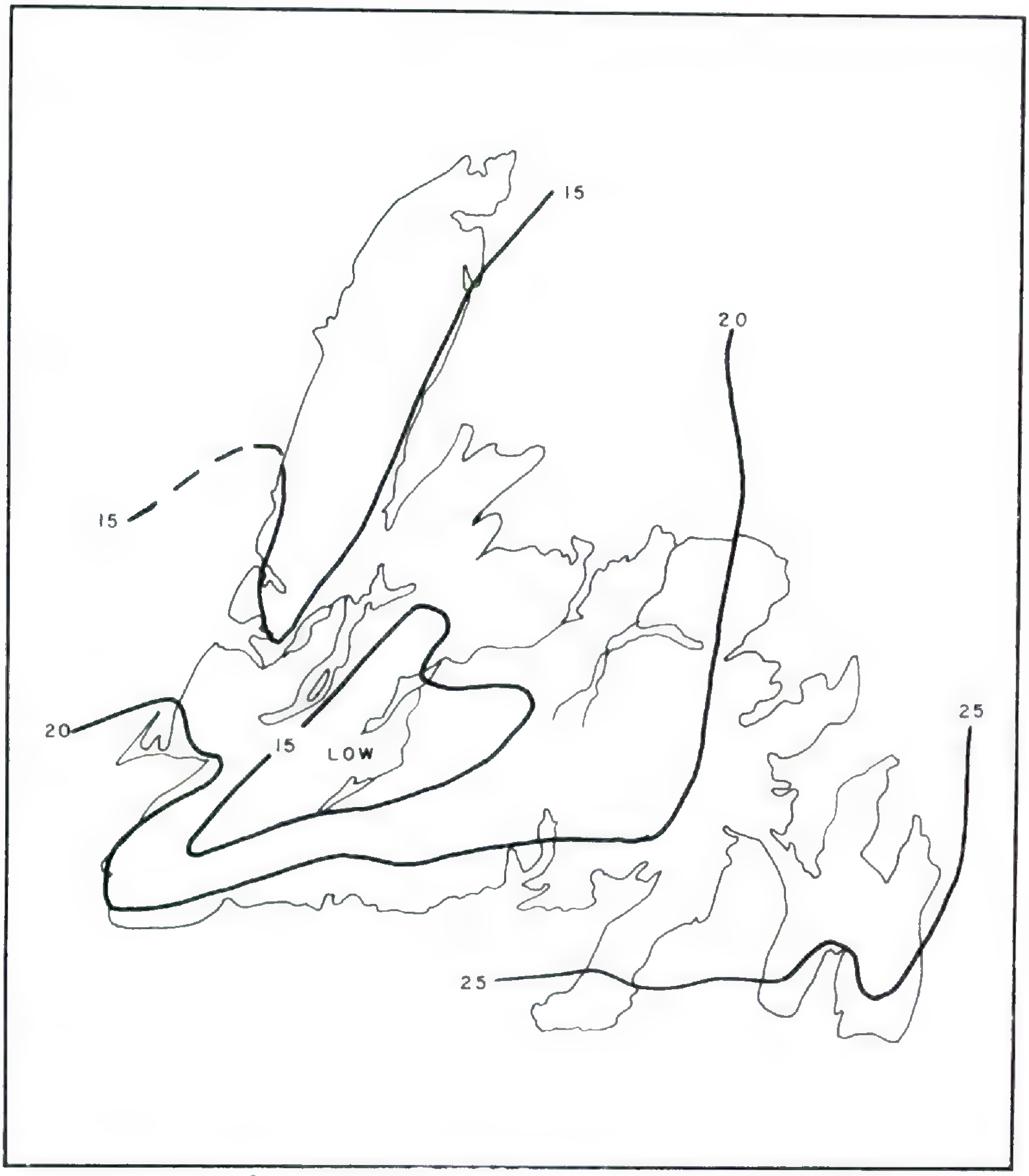

Figure 4. Mean ~~monthly minimum~~ temperature for January in °F. ~~(After~~ Hare 1952) after

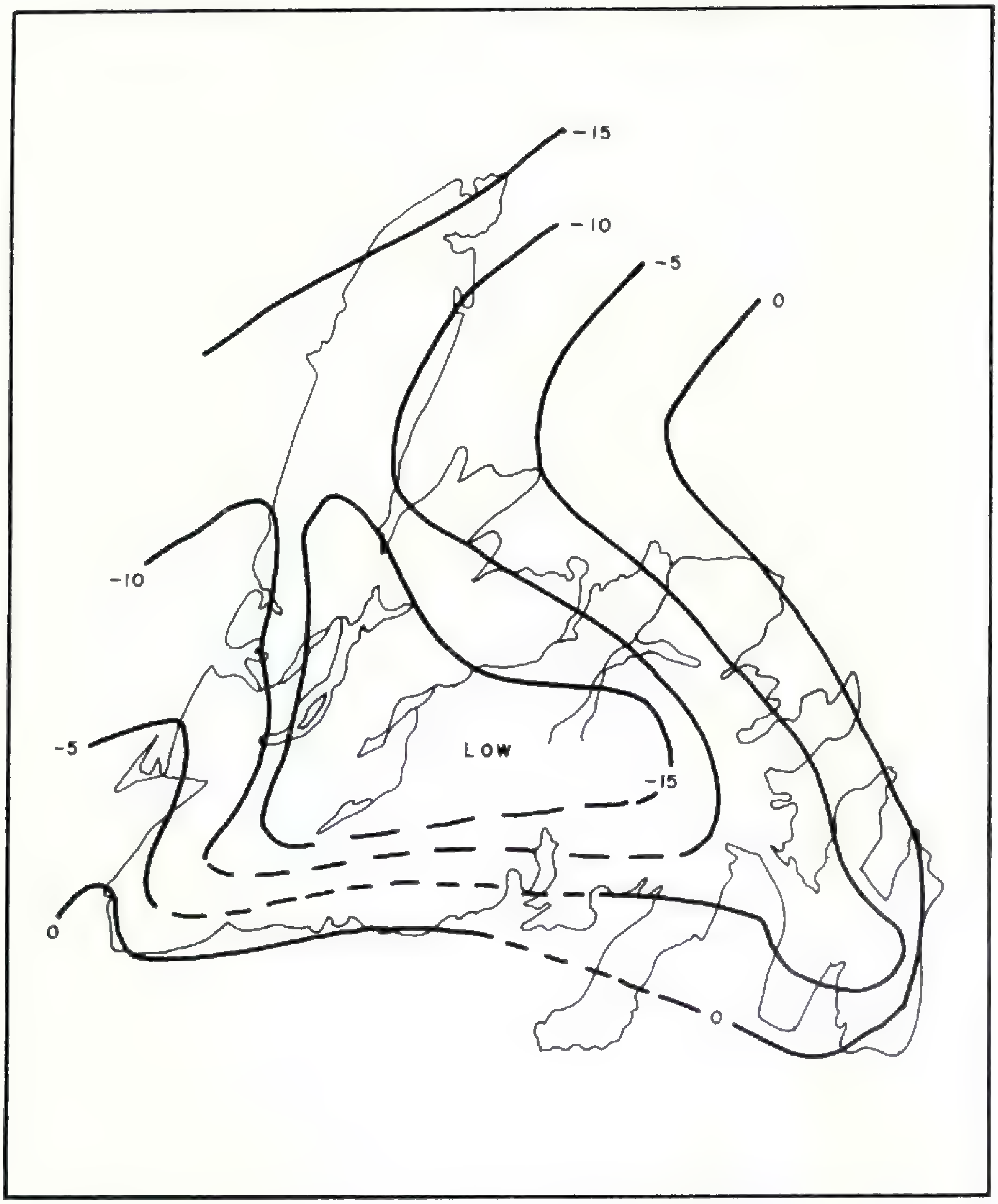

Figure 5. Mean monthly minimum temperature for January in °F. (After Hare 1952)

The island is situated within the Boreal forest region (Rowe, 1959). The central and western parts are heavily forested with treeless barrens restricted to the higher elevations. Most of the southern and eastern parts are covered by dwarf shrub heath and bogs (Ahti, 1959).

Plants with Southern Affinities

This group includes the so-called Coastal Plain element, a group of species restricted to oligotrophic bogs and dry sandy soils, and occurring southward along the Atlantic coast to the pine barrens of New Jersey. Although it is the most talked-about element, it is by no means the only southern element in the flora of Newfoundland; temperate-boreal species of both Canadian and Alleghanian range also occur.

The southern element is defined here to include those species occurring in Newfoundland but having their main range south and west of the island, and whose continuous range on the Canadian mainland does not reach as far north as southern Labrador. Thus defined, the southern element includes those species which, under the present climatic conditions, can reach Newfoundland only across the Cabot Strait; a point of interest in Fernald's theories on the origin of the Newfoundland flora, and in the discussion in the final part of this paper. A few species belonging to the southern element, as defined above, but occurring rather commonly up to the northern tip of the Great Northern Peninsula have been left out of consideration in the following discussion.

What are the ecological factors controlling the distribution of southern species in Newfoundland? Both climatic and edaphic factors are important in this respect; they will be briefly discussed below before describing the types of distribution to be found on the island.

CONTROLLING FACTORS

1. SUMMER TEMPERATURES AND LENGTH OF VEGETATIVE SEASON. Most of the southern plants have the main part of their range in areas with considerably warmer summers and a longer vegetative season than that found in Newfoundland. Therefore, this is the most obvious factor controlling their distribution. Species thus controlled will either show a clear northern boundary in Newfoundland, or they are restricted to some of the warmer valleys and sites.

It is worth mentioning that the areas with the longest and generally warmest vegetative season do not coincide with those with the highest annual maximum temperatures. The former occur in the valleys of the southern part of the west coast, whereas the latter are found in the northern central parts of the island. The annual maximum temperatures do not appear to be a relevant factor in determining the distribution of southern plants; at least, no species were found whose distribution was closely related to it.

2. WINTER TEMPERATURES. Most of the southern species reaching Newfoundland have a range extending far into areas with a much more continental climate. Therefore, they are adapted to winters much colder than those of Newfoundland, and it is obvious that low winter temperatures will not prevent any of these species from occurring on the island.

On the other hand, many species sensitive to low winter temperatures will be able to grow in Newfoundland because of the relatively mild winters of the coastal areas. These species concentrate especially on the southeastern peninsulas and along the south coast.

3. SPRING TEMPERATURES. One of the typical features of a continental climate is the rapid change from winter to summer, and the absence of a long period with alternating cold and warm spells so frequently encountered in northern oceanic climates. The occurrence of a cold spell following a mild period can be very detrimental to species which start their growing season as soon as the first mild days occur. This factor probably limits the distribution of a large number of continental species.

The phenomenon of a spring with alternating cold and mild spells is most common in the typically oceanic parts of the Island, e.g., the south coast and the eastern peninsulas, but it is also of great importance in central Newfoundland and along the northern shore. The west coast is the area most favorable for species sensitive to this factor.

4. SOIL CONDITIONS. Edaphic factors play an important role in determining the distribution of plants. The distribution of calcareous soils causes the greatest regional differences in the flora of Newfoundland, and many southern plants are restricted to western Newfoundland for this reason only.

Nutrient-rich soils are also more abundant in the western parts, but, although this limits the frequency of occurrence, it will rarely eliminate a species completely from the infertile eastern parts.

Dry, sandy soils also are warm soils, and a few southern species with low nutrient and moisture requirements can be found exclusively on these sites. A few other southern species occur only on unstable talus or terrace slopes and other sites with limited competition.

5. BIOTIC FACTORS. Some species are so dependent on the habitat condition created by the plant community in which they grow that the absence of one or more of their dominant associates can be the factor limiting their distribution. This factor is indirectly controlled by the climate. An extreme example of this kind of dependence is given by a number of liverworts, such as *Mylia anomala* and *Odontoschisma sphagni*, which occur almost exclusively in clumps of *Sphagnum fuscum* and *S. rubellum*. In analogy with this, it is quite possible that the occurrence of many species of northern hardwood forests, such as *Erythronium americanum*, *Medeola virginiana*, *Uvularia* * *sessili~~flora~~*folia, and *Sanguinaria canadensis*, are dependent on the occurrence of this type of forest. Sugar maple-yellow birch forests occur locally on rich soils in Cape Breton Island but they are lacking on Newfoundland, and with them many species characteristic of this forest type.

TYPES OF DISTRIBUTION

It will be obvious, that the distribution of the southern species is rarely limited by any single factor but as a rule

* SESSILIFOLIA

the result of the simultaneous action of several of them. The following distribution types can be recognized:

A. COMMON OR FREQUENT THROUGHOUT BUT ABSENT ON THE GREAT NORTHERN PENINSULA AND AT HIGHER ELEVATIONS.

This group is clearly limited by the length and warmth of the vegetative season. A large number of species belong to this group only a few of them are mentioned below.

Osmunda regalis
Trillium cernuum
Dulichium arundinaceum
Carex intumescens
Carex debilis
Carex gracillima
Carex crinita
Carex castanea
Corylus cornuta
Nemopanthus mucronatus[2]
Viburnum cassinoides[2]
Diervilla lonicera
Nymphaea odorata[2]
Aster umbellatus
Sambucus pubens
Alnus rugosa
Prunus virginiana
Vaccinium macrocarp~~*a*~~on,
Senecio aureus
Solidago rugosa
Acer rubrum
Pogonia ophioglossoides
Arethusa bulbosa
Rhododendron canadense[2]
Cypripedium acaule

B. RESTRICTED TO THE WEST COAST SOUTH OF DEER LAKE, THE DEEPER INLETS OF THE SOUTH COAST, NOTABLY BAY D'ESPOIR, AND SHELTERED PARTS OF THE SOUTHERN AVALON PENINSULA.

This group is also clearly limited by the length and warmth of the vegetative season, but its species demand somewhat higher summer temperatures than those of group A.

Betula lutea
Scutellaria lateriflora
Agrimonia striata

C. RARE OR LOCALLY OCCURRING SPECIES WHOSE DISTRIBUTION IS CLEARLY LIMITED BY LENGTH AND WARMTH OF THE VEGETATIVE SEASON.

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[2]Species extremely rare on the Great Northern Peninsula.

a. Restricted to Warm, Favorable Locations on the West Coast.
(Extreme examples of groups A and B.)
Claytonia caroliniana
Geranium robertianum
Fraxinus nigra (always as a small tree or shrub)
Cornus alternifolia

b. Limited to a Few Dry, Sandy Areas in Central Newfoundland. Most likely these are relic species for it is difficult to understand how they could otherwise have reached their present locations. This applies particularly to *Pinus resinosa.*
Carex houghtonii
Pinus resinosa
Gaultheria procumbens

c. Halophytes Restricted to Southwestern Newfoundland. The water of the Gulf of St. Lawrence is considerably warmer than that of the other coasts. It could well be that this rather than the air temperature determines the distribution of these species.
Scirpus validus
Spartina pectinata
Scirpus maritimus[3]

d. Very Scattered, but Clearly Limited by the Length of the Vegetative Season.

Typha latifolia — This species is restricted to a relatively warm belt extending from Port-aux-Basques along the west coast to Bonne Bay, and then to the northern part of Central Newfoundland; it occurs also in the central parts of the Avalon Peninsula.

D. RESTRICTED TO WESTERN NEWFOUNDLAND, SOUTH OF BONNE BAY.

[3]New addition to the Newfoundland flora discovered by the author in a salt marsh near Boswarlos, Port au Port Bay, during the field season of 1961.

This type of distribution appears to be caused by two sets of conditions:

a. The Occurrence of Calcareous or Highly Basic Soils.

Cypripedium reginae	*Dryopteris robertiana*
Scirpus acutus	*Salix glaucophylloides*

b. Rather Continental Course of Spring Temperatures.

Epigaea repens is the most conspicuous example of this. The species occurs very commonly in western Newfoundland south of Bonne Bay, and even reaches rather high elevations at the east side of the Lewis Hills and in the mountains east of Grand Lake. It is very rare in the forested interior around Red Indian Lake and Victoria Lake. At high elevations the species is restricted to sites well covered with snow in winter and early spring. Consequently, it starts its vegetative period very late, and at a time that severe cold spells are unlikely to occur.

An example of a similar protection against early sprouting is seen in *Smilacina racemosa*[1]. It occurs in an *Alnus crispa* thicket on the southwest slope of the Lewis Hills at about 1000 feet elevation. It is not a particularly warm site, but it is usually covered with snow until the middle of June. Moreover, the conditions on the forest floor show an interesting resemblance to those of a hardwood forest.

E. CONCENTRATED IN SOUTHEASTERN NEWFOUNDLAND, THE SOUTH COAST, AND THE BOGS OF THE CARBONIFERIOUS SANDSTONE AREA OF ST. GEORGE'S BAY, BUT ALSO PRESENT IN BOGS ON THE WEST COAST MOUNTAINS AND OF THE INTERIOR BARRENS.

This group includes the Coastal Plain species. They are moderately oceanic species, apparently sensitive to low winter temperatures, adapted to cool summers, and possibly requiring a high air humidity. Only some of the bog and

[1]Recent addition to the Newfoundland flora; discovered by the author in 1961. In 1963, Dr. E. Rouleau (oral communication) found this species in an *Alnus rugosa* swamp along Mollichicnic Brook, Western Newfoundland.

pond species of this group occur, rather sparingly, at the higher elevations. In these areas, as in the coastal areas, snow drifting is severe in winter time, and thick snow layers cover the valleys and depressions. The occurrence of these species at higher altitudes could well be dependent on this protective snow cover.

The species with a very conspicuous concentration in the oceanic parts of the island, i.e., on the Avalon Peninsula, the Carboniferous sandstone area of St. George's Bay, and to a lesser degree along the south coast, are listed under b.

a. *Schizaea pusilla*
Myriophyllum tenellum
Nymphoides lacunosa
Utricularia geminiscapa
Sphagnum molle[5]
Sphagnum strictum[5]
Potamogeton oakesianus
Xyris montana
Bartonia paniculata
Aronia floribunda
Juncus militaris
Juncus pelocarpus
Scirpus subterminalis

In contrast to the other species of this group, both *Sphagnum molle* and *Sphagnum strictum* have never been found on the West Coast north of Port-aux-Basques.

b. *Gaylussacia dumosa*
Calopogon pulchellus
Habenaria blephariglottis

Four species with a much less oceanic distribution farther south have a very similar range in Newfoundland as the species of group Eb, viz. *Gaylussacia baccata, Carex folliculata, Habenaria orbiculata,* and *Dryopteris noveboracensis.*

Species which also have an oceanic distribution in America, *Lycopodium inundatum* and *Sphagnum pylaesii,* go much farther north along the Atlantic coast. The latter, especially, is often peculiarly abundant in bog pools on very cold peaks.

[5]Until recently, *Sphagnum molle* was known from only two localities north of New Jersey, both on Newfoundland. Dr. W. S. G. Maass of the Atlantic Regional Laboratory, National Research Council, discovered the species on a number of localities in recent years, most of them on the Avalon and Burin Peninsulas.

F. RESTRICTED TO AVALON AND BURIN PENINSULAS.

Apparently an extreme form of group Eb.

Sphagnum macrophyllum[6]

This type of distribution is also found in many species which do not reach their northern limit in Newfoundland. Most conspicuous among them are some European species such as *Nardus stricta, Pedicularis sylvatica, Juncus bulbosus,* and *Sieglingia decumbens.* For some of them southeastern Newfoundland is their only foothold in North America.

G. SPECIES KNOWN FROM ONLY ONE OR TWO LOCALITIES.

Their occurrence is either due to accident or to historical factors. Obviously, they are not very well adapted to the climatic conditions and the competition relationships existing on the island.

Aster acuminatus	
Smilacina racemosa	
Mitchella repens	
Carex lacustris[7]	West Coast
Dryopteris marginalis[8]	
Scirpus maritimus	
Dennstaedtia punctilobula	
	South Coast
Myrica pensylvanica	
Oxalis montana	

PLANTS WITH ARCTIC OR SUB-ARCTIC AFFINITIES

The flora of Newfoundland contains a very considerable arctic element. Many of these species reach their southern limit at sea level in Newfoundland, and occur farther south

[6]In 1962 Dr. W. S. G. Maass collected *Sphagnum macrophyllum,* thus far not known north of Nova Scotia, from five localities on the island, four of them on the Avalon Peninsula.

[7]Collected by Dr. R. Tuomikoski along the Harry's River in 1949.

[8]Occurs on a forested but unstable talus slope east of Barachois Pond. This station was discovered by the author in 1964.

only in alpine habitats, whereas others occur nowhere south of the island.

Their distribution in Newfoundland can largely be explained by a combination of climatic and edaphic factors, but lack of competition is an important factor for some species. In the following the factors thought to be controlling their distribution will be briefly discussed, followed by the description of a few typical distribution types.

CONTROLLING FACTORS

1. COMPETITION. It seems strange that more optimal physiological conditions, such as higher temperatures, should eliminate species in more southern latitudes. Therefore, the restriction of arctic species to northern latitudes is often believed to be a result of competition. The northern species, being species with a large temperature amplitude but unable to compete successfully with the more vigorous southern species, are expelled to areas with less severe competition.

2. HIGH SUMMER TEMPERATURES. Dahl (1951) lists a number of species which grow very poorly in botanical gardens at lower altitudes. He made the interesting observation that these species generally grow well in the autumn, and develop fine buds in spring. However, during the summer they become yellowish or brownish along the margins of the leaves, and after a few years they die. Dahl considers high summer temperatures detrimental to these species, and found a very good correlation between the isotherms of the annual maximum temperature and the southern limit of these species.

This intolerance for high temperatures also explains the occurrence of many arctic-alpine species in closed plant communities along the outer coast line far south of their inland range.

3. LIGHT REQUIREMENTS. Arctic species are plants of open, unforested areas, and usually they are species with high light requirements, unable to survive under shrub or forest canopy.

4. SOIL CONDITIONS. This affects the arctic element to the same extent as all other plant species. The distribution of serpentine and limestone has a very pronounced effect on the occurrence of a large group of species.

5. PHOTOPERIODISM. Little information is available on the effect of day length on the distribution of arctic species. However, its effect seems to be negligible with respect to our problem. This factor can at most prevent the occurrence of arctic species on Newfoundland, and it will certainly never cause the occurrence of an extremely long day plant at more southern latitudes.

6. ARIDITY OF CERTAIN COASTAL HABITATS. Fernald (1933, p. 123-7), commenting on the occurrence of the arctic element at sea level in northwestern Newfoundland, remarks that its presence is a result of the aridity and the calcareous nature of the soil rather than the coldness of the climate. The calcareous soils are undoubtedly an important factor governing the distribution of certain arctic plants, but it is hard to believe that the aridity of these sites is more important than the low summer temperatures. The coastal zone is remarkably cold, and the distribution of most species appears to be closely related to it. Those species whose restriction to the northwestern section of the Great Northern Peninsula does not appear to be controlled by low summer temperature only are also species of wet sites, such as *Carex microglochin, C. capitata, and C. chordorrhiza.*

7. CONTINENTALITY OF CLIMATE. The species mentioned above have a preference for continental climates. They may require low winter temperatures, or a rapid change from winter to summer. The warmer summers of continental climates can hardly play a role here. If this were the case, then these species would undoubtedly occur also at low elevations farther south along the west coast.

TYPES OF DISTRIBUTION

A. ON EXPOSED HEADLANDS ALONG THE COAST, EXPOSED PARTS OF THE BARRENS OF EASTERN NEWFOUNDLAND,

AND AT HIGH ELEVATIONS ELESWHERE, BECOMING PROGRESSIVELY MORE COMMON TOWARD THE NORTHERN PART OF THE LONG RANGE MOUNTAINS.

This type of distribution is shown by species which can find suitable soil conditions in any part of the province, i.e., they are species of acidic soils and those indifferent in this respect. They seem to be limited chiefly by high summer temperatures, but thrive well in both oceanic and more continental parts of the island.

Loiseleuria procumbens	*Diapensia lapponica*
Empetrum eamesii	*Silene acaulis*[9]
Lycopodium selago	*Lycodium annotinum* var. *pungens*
Carex bigelovii	*Betula borealis*
Juncus trifidus	*Vaccinium uliginosum*
Arctostaphylos alpina	*Cetraria nivalis*
Sphagnum lindbergii	*Alectoria nigricans*
Cetraria cucullata	*Alectoria nitidula*
Alectoria ochroleuca	*Lobaria scrobiculata* (as a ground inhabiting species)

B. RESTRICTED TO THE HIGHLANDS OF ST. JOHN, AND SOMETIMES A FEW OTHER HIGH AREAS IN THE WESTERN PART OF THE ISLAND.

This group consists of species of acid soils. Their occurrence is also chiefly controlled by summer temperatures, they require definitely lower temperatures than the species of Group A.

Salix herbacea	*Cassiope hypnoides*
Sibbaldia procumbens	*Phyllodoce caerulea*
Deschampsia atropurpurea	*Hierochloe alpina*

C. ALONG THE WEST COAST FROM ST. GEORGE'S BAY TO THE NORTHERNMOST TIP OF THE GREAT NORTHERN PENINSULA.

These species occur at higher elevations in the south but they come down to sea level in the northern areas. They are all basiphilic species, and their distribution is deter-

[9]Distinctly more common in limestone and serpentine areas.

mined by the occurrence of limestone or serpentine. Some are restricted to calcareous habitats (Ca), others occur on both serpentine and calcareous soils (Ca + Mg).

Oxytropis foliolosa (Ca)
Dryas integrifolia (Ca)
Carex terrae-novae (Ca)
Salix vestita (Ca)
Saxifraga aizoon (Ca)
Arenaria humifusa (Ca + Mg)
Potentilla nivea (Ca)
Arenaria rubella (Ca + Mg)
Salix cordifolia (Ca + Mg)
Cetraria tilesii (Ca)
Hedysarum alpinum (Ca)
Carex rupestris (Ca)
Saxifraga oppositifolia (Ca)
Cerastium beeringianum (Ca + Mg)
Arenaria dawsonensis (Ca)
Armeria labradorica (Ca + Mg)
Kobresia simpliciuscula (Ca)
Castilleja septentrionalis (Ca + Mg)
Polygonum viviparum (Ca)
Solidago multiradiata (Ca + Mg)
Rhododendron lapponicum (Ca + Mg)

D. RESTRICTED TO THE NORTHERN PART OF THE GREAT NORTHERN PENINSULA.

High summer temperatures appear to be the main factor limiting these species to this part of the island. Another factor, here vaguely described as continentality, is also important, at least for the first two species.

Carex chordorrhiza
Carex capitata
Salix reticulata (Ca)
Bartsia alpina (Ca)
Carex microglochin (Ca)
Pyrola grandiflora (Ca)
Primula egaliksensis (Ca)
Habenaria straminea (Ca)
Carex bicolor (Ca)
Saxifraga cespitosa (Ca)

E. RESTRICTED TO SERPENTINE AREAS.

The serpentine areas have a very sparse vegetation cover, and competition is of little importance on these sites. They are bleak, exposed habitats, locally with severe frost churning in fall and winter but the average summer temperatures in the low lying areas (300-400ft.) are a few degrees higher than those prevailing in the coastal parts of southeastern Newfoundland. Evidently, these species do not require lower summer temperatures than the species of group A. They occur on these sites because of the lack of competition, the basic soils, and their ability to tolerate frost churning.

Lychnis alpina
Adiantum pedatum var. *aleuticum*

A large number of basiphilic species occur both on the serpentine and limestone soils (see under C). It should be realized that there are several other species limited to the serpentine soils which do not belong to the floral elements discussed in this paper.

F. SUB-ARCTIC HABITATS, BUT ALSO ON UNSTABLE SOILS, CLIFFS, AND RIVER BEDS AT LOWER ELEVATIONS.

Competition appears to be the main factor controlling the distribution of these species, although some of them require basic soils.

Trisetum spicatum	*Carex atrofusca*
Saxifraga aizoides	*Anemone parviflora*
Luzula spicata	*Carex scirpoidea*

Epilobium latifolium (known only from river gravels in Newfoundland.)

G. RATHER FREQUENT THROUGHOUT, ALTHOUGH DISTINCTLY MORE COMMON AT HIGHER ELEVATIONS.

A very large number of species belongs to this category. The following are a few examples.

Thalictrum alpinum	*Scirpus hudsonianus*
Rubus chamaemorus	*Carex capillaris*
Selaginella selaginoides	*Rubus arcticus*
Rubus acaulis	*Tofieldia pusilla*

A number of species show distribution patterns intermediate between the groups discussed above. Intermediate ranges between groups A and B are most common; to this category belong: *Betula minor*, *Betula glandulosa*, *Salix uva-ursi*, and *Carex rariflora*. All of them show a very marked increase in abundance to the north, and they are rare or absent east of the Long Range Mountains.

Glacial and Post-glacial History as a factor in Explaining The Distribution Patterns

Most of the distribution patterns of northern and southern elements on the Island of Newfoundland can be explained adequately by the existing climatic and edaphic conditions. The ecological factors controlling this species distribution were analyzed in the previous section; in the following, the role of the historical factor will be discussed in more detail.

The importance of historical factors is often overemphasized in explaining the distribution of species (Böcher, 1943, 1951). Undoubtedly, the Wisconsin glaciation and the post-glacial climatic changes have had a pronounced influence on the composition of the present flora of Newfoundland, as they have had on the floras of all glaciated regions. There are probably a few species on the island today whose presence is the result of the post-glacial climatic optimum; there are others which may have taken advantage of the low sea level during late glacial times, and there are certainly many species which are absent due to the glacial epoch. However, it is well to remember that there is a large speculative element in all theories based on history. Often these theories are very attractive, but equally often it is not necessary to resort to far-fetched hypotheses to explain the present distribution of species, provided one pays proper attention to their ecology.

It is almost impossible to write about the origin of the Newfoundland flora, without mentioning the admirable pioneer work of Fernald. An extensive literature has built itself around his controversial theories, and the last word has certainly not been said about it. I will restrict myself to a very brief description of Fernald's ideas as far as they concern the subject of the paper, followed by my own views. A detailed discussion of this subject can be found in Marie-Victorin (1938), Raup (1941), Deevey (1949), Dahl

(1946), Dansereau (1950), Wynne-Edwards (1937-1939), Rousseau (1949). A discussion on the distribution and the origin of the so-called "Cordilleran" element in the flora of Newfoundland has been omitted here on purpose since the problem is of an entirely different nature.

A point of interest in Fernald's theories on the origin of the Newfoundland flora (1911, 1918a, 1918b, 1925, 1926, 1933) is his explanation of the presence of the Coastal Plain element. In his early writings, Fernald (1918) believed that the Coastal Plain element had migrated northward toward the end of the glacial period over a land bridge, approximately following the continental shelf. This land bridge was very sandy, and only species with low nutrient requirements could use it. Thus it was well suited for the species of acid soils which make up the Coastal Plain element but not for other southern species.

Later Fernald (1933, p. 95-107) revised this theory, mainly since his nunatak theory (Fernald, 1925), as an explanation of the occurrence of the Cordilleran element in eastern Canada, had received so much approval of both geologists and botanists, whereas his post-glacial land bridge theory had few supporters. He postulated that the Coastal Plain species had reached Newfoundland during the Tertiary period over the then emerged continental shelf. Subsequently, they survived the glacial period on nunataks, unglaciated refugia occurring as islands in the continental ice sheet.

At present it is obvious that all of Newfoundland, including its highest peaks, has been covered with ice at some time or another during the glacial epoch (MacClintock and Twenhofel, 1940). The other nunatak areas in northeastern North America are equally unjustified (Flint et al., 1942; Odell, 1938; Abbe, 1936; Deevey, 1949). In addition to this, many so-called nunatak indicators have been found in the "gap" of the Canadian Shield during recent years (Rousseau, 1948, 1949; Scoggan, 1950; Raymond, 1950). Although the existence of genuine nunataks on Newfoundland is extremely unlikely, it is quite well possible that certain floral elements survived the glaciation in coastal habitats, especially along the Atlantic shore.

However, it is not necessary to resort to such speculations to explain the distribution of these species. The Coastal Plain element does not appear to be a relic flora, which is restricted to the bleak eastern and southern parts of the island owing to the occurrence of acidic soils (Fernald, 1911, 1918). In my opinion, it occurs on Newfoundland because it is made up of oceanic and sub-oceanic species which are unable to tolerate the severe winters of most of the adjacent continent. Severe snow drifting in the barren areas may even permit these species to occur farther inland than would be otherwise possible. A few species with an unusual gap in their distribution, e.g. *Sphagnum molle* and *S. macrophyllum*, could well have covered more of the island during the post-glacial climatic optimum.

A second point of interest in Fernald's theories is his explanation of the absence of many species of nutrient-rich soils occurring commonly on the adjacent Canadian mainland. He attributed their absence to the inability of these species to cross the Cabot Strait between Cape Breton Island and Newfoundland. He reasoned further, that owing to their higher demands on soil fertility these species could not make use of the land bridge as the Coastal Plain species did. "Thus", he states, "typical Canadian plants, unless their range extends to the north side of the Strait of Belle Isle[10], are absent from the island" (Fernald, 1911).

Clearly this point of view cannot be defended any longer. A large group of species, notably those with high nutrient requirement in groups A, B, C, and D do not occur on the Northern Peninsula and consequently they must have reached Newfoundland from the south (see also p. 32). Thus the Cabot Strait cannot be considered a very effective barrier.

[10]This Strait separates Newfoundland from southern Labrador; it is only eleven miles at its narrowest point and thus it can be much easier bridged by diaspores than the seventy mile wide Cabot Strait.

Those species present on the adjacent mainland (Roland, 1942; Dore and Roland, 1941) but absent on the Island of Newfoundland are all species of tolerant hardwood forests, e.g., *Acer saccharum, Fagus grandifolia, Epifagus virginiana, Quercus borealis, Ulmus americana* and *Sanguinaria canadensis.*

Even in the climatically favorable southwestern part of Newfoundland the vegetative season starts almost two weeks later than in Cape Breton Island. Therefore, it seems more reasonable to attribute the absence of these species to the shortness of the vegetative season rather than to their inability to cross the Cabot Strait.

On Newfoundland the drier alder thickets are the habitats most closely resembling the tolerant hardwood forests. It is interesting to note that the few tolerant hardwood species which do reach Newfoundland all occur in alder thickets, e.g., *Claytonia caroliniana* and *Smilacina racemosa.*

There is one group of species with southern affinities whose distribution is rather enigmatic. It includes species as *Pinus resinosa, Carex houghtonii* and *Gaultheria procumbens* (Group Cb) but also *Chimaphila umbellata*[11]. All of them occur on a number of widely separated or isolated stations where they can be very common. It is difficult to understand the present distribution of these species without assuming that they once covered a larger part of the island. This could have been the case during a warm post-glacial period. Evidence for such a climatic optimum has been collected for other parts of northeastern America (Deevey, 1949). Livingstone and Livingstone (1958) and Schofield (1960) have shown that a distinctly warmer period has occurred on Cape Breton Island. During this period. *Quercus* and several other hardwoods were much more common than today, and even *Carya* pollen has been found in these

[11]Recent addition to the flora of Newfoundland. Collected by R. S. van Nostrand at New Bay Lake (central Newfoundland), and by the author near Flat Bay Brook (West Coast), both in 1958. There is an unverified record of its occurrence near Hall's Bay.

deposits. This period was followed by a slightly cooler and more humid period in which *Tsuga* was a prominent component of the forest, and from then on the climate gradually deteriorated.

Although no evidence for a climatic optimum is available for Newfoundland, it seems reasonable to assume that this warmer climate also affected the island, thus creating conditions for a more widespread occurrence of species such as *Pinus resinosa*. In the absence of pollen analytical studies or fossil records from Newfoundland we can only speculate on this subject. It can only be said with confidence that the present climatic conditions are unfavorable for these species for otherwise they would have spread from their present locations. The latter applies also to the southern species which are known from a single locality only (Group G.) *Oxalis montana*, a species restricted to LaPoile Bay, an isolated bay on the south coast may be an exception in this respect. It has to cross a large area of bleak barren land to reach the forests of the west coast, and it is conceivable, though unlikely, that this is the reason for its absence from the rest of the island.

The occurrence of a post-glacial climatic optimum on Newfoundland may throw some doubt on the previous statement that some of southern species in groups A, B, C, and D must have reached the island across the Cabot Strait. Could not their northern limit have occurred in Labrador during this warm period, so that they could have crossed the Strait of Belle Isle and spread into Newfoundland from the north? Wenner's (1947) pollen analytical studies in Labrador and northern-most Newfoundland seem to indicate that this is very unlikely. He found no evidence of important climatic changes after the area became covered with a forest vegetation. Presumably, the hypsothermal period occurred before the climate in southern Labrador had ameliorated sufficiently to permit the growth of a forest vegetation.

The widespread occurrence of a great number of arctic and sub-arctic species occurring on the island can be satisfactorily explained by the climatic conditions, as has been done in the description of the distribution types. Their common occurrence at sea level in coastal areas is due to the very low summer temperatures prevailing in these regions. Temperature measurements with sucrose ampoules (Pallmann *et al*, 1940) carried out by the author in 1961, have shown that the average temperatures during the vegetative season in coastal barrens are equal to those on the highest peaks of the Table Mountain at Bonne Bay, the Lewis Hills and the Gaff Topsails.

A peculiar mingling of arctic and southern species can be seen in the coastal habitats, as already remarked by Fernald (1911). However, in the author's opinion this is a result of the present day climatic conditions rather than the presence of a relic Coastal Plain element in an essentially northern vegetation. The arctic species occur there because of the low summer temperatures, whereas the Coastal Plain species are present because of the oceanic climate, and in spite of the low summer temperatures to which they are adapted.

Summary

The flora of Newfoundland contains many species with northern and southern affinities. The ecological factors controlling the distribution of these floral elements are discussed in some detail followed by a description of the distribution patterns within Newfoundland.

Most of the species distributions can be satisfactorily explained by the present climatic and edaphic conditions. The Coastal Plain element, should not be considered as a relic flora restricted to southern Newfoundland because of soil conditions but rather as a flora consisting of oceanic species unable to tolerate extreme winter temperatures.

The absence of some southern species, notably those of northern hardwood forests should be attributed to unfavorable climatic conditions and the absence of the hardwood forest floor habitat rather than to isolation. The number of species which did reach Newfoundland across the Cabot

Strait is so great that it can hardly be considered an effective barrier for most species.

The peculiar distribution of *Pinus resinosa, Chimaphila umbellata, Gaultheria procumbens* and *Carex houghtonii* can only be explained by assuming that these species were widespread during the post-glacial climatic optimum. The subsequent deterioration in climate restricted these species to a few isolated areas with relatively warm soils.

SOMMAIRE

La flore de Terre-Neuve comprend un grand nombre de plantes du sud et de plantes arctiques et arctiques-alpines. Les facteurs écologiques que régissent la répartition des éléments de la flore de l'île font l'objet d'une étude détaillée que l'auteur fait suivre d'une description du mode naturel de répartition des diverses plantes dans l'île de Terre-Neuve.

Pour la plupart des plantes, la répartition des espèces peut être attribuée ans crainte d'erreur aux conditions locales actuelles du climate et du sol. La flore de la plaine côtiére ne doit pas être regardée comme une flore reliquale restreinte au sud-est de Terre-Neuve par suite des conditions particulières du sol, mais plutôt comme une flore composée d'espèces océaniques qui ne peuvent pas survivre aux températures hivernales extrêmes.

L'absence de certaines espèces du sud, l'absence notamment de certaines espèces des forêts de feuillus du nord, est attribuable aux conditions climatiques défavorables et à l'absence du milieu caractéristique des forêts de feuillus, plutôt qu'a l'isolement. Le nombre d'espèces qui se sont établies dans l'île de Terre-Neuve après avoir traversé le détroit de Cabot est tellement éléve que l'on croit difficilement que le détroit puisse constituer un sérieux obstacle à la propagation de la plupart des espèces.

La répartition bizarre des espèces *Pinus resinosa, Chimaphila umbellata, Gaultheria procumbens et Carex houghtonii* ne peut être attribuée que à la répartition de ces espèces dans toute l'île durant une période post-glaciaire, alors que

les conditions climatiques étaient les plus favorables à leur reproduction. Le climat beaucoup plus rude qui a suivi cette période a confiné la survivance de ces espèces dans quelques poches isolées où le sol est rélativement moins froid.

RESEARCH OFFICER,
FOREST RESEARCH BRANCH,
DEPARTMENT OF FORESTRY, CANADA.
ST. JOHNS, NEWFOUNDLAND

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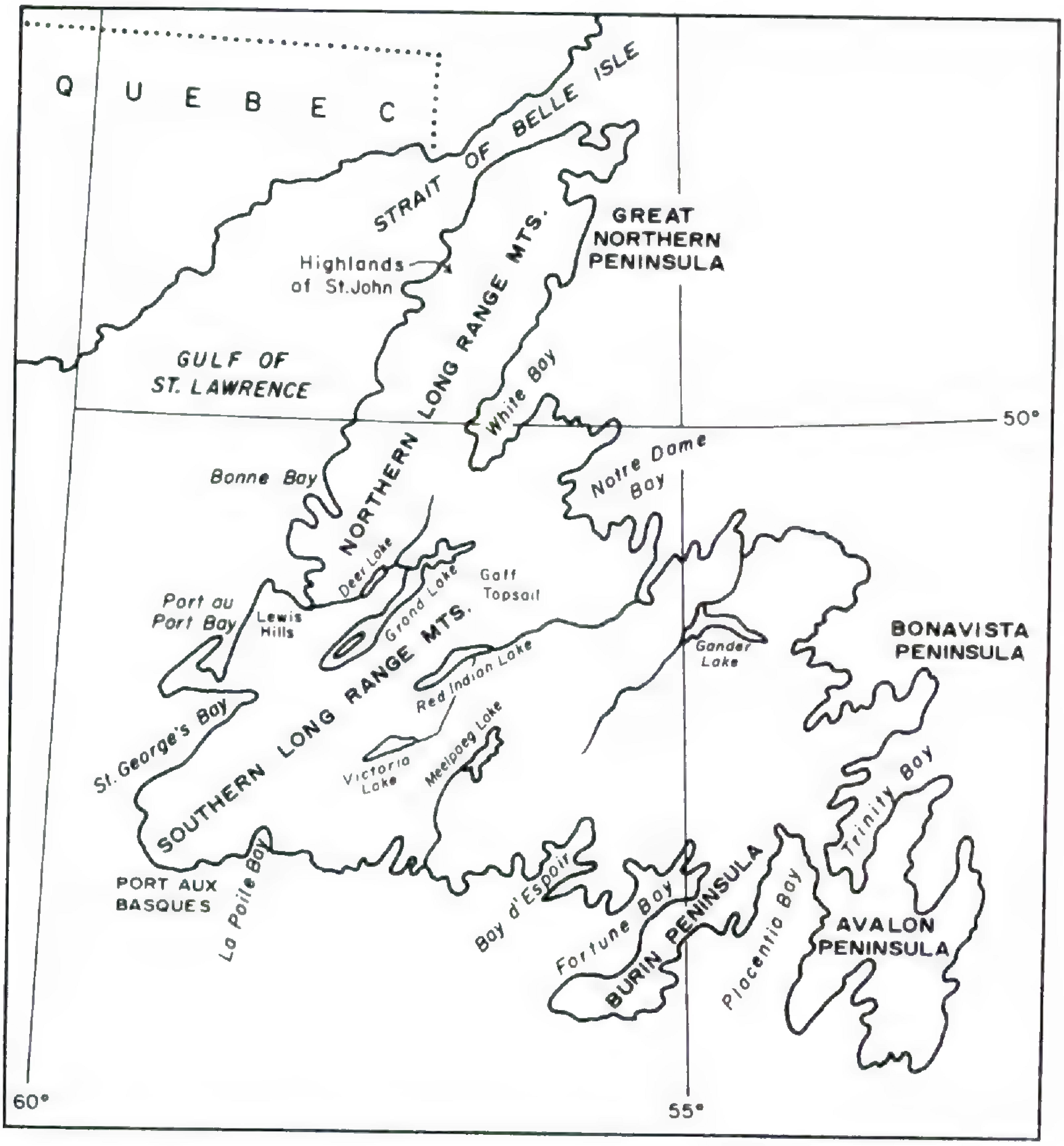


Figure 6. Map of Newfoundland showing geographical features mentioned in text.

THE MOUNTAIN ELEMENT IN THE FLORA OF THE PENINSULA OF VIRGINIA*

A. M. HARVILL, JR.

The Peninsula of Virginia is a narrow neck of land about 60 miles long lying southeast of Richmond. It is bounded by Hampton Roads and the Chesapeake Bay on the east, by the York River estuary on the northeast, and by the James River on the southwest. Although some of the earliest floristic work in this country was done on The Peninsula of Virginia, little was accomplished after the colonial period until Professor and Mrs. E. J. Grimes made extensive collections in 1921-22. Professor M. L. Fernald and his colleagues did some collecting in the area some years later, but it was largely by-passed by them for the richer possibilities to the south of the James River. The writer was fortunate to have the opportunity to study the distribution of plants on The Peninsula while at the College of William and Mary in Williamsburg in the summer of 1964.

A very intriguing phytogeographic element in the flora of the region is composed of species which occur on the coastal plain and are rare or unknown on the piedmont of Virginia, but reoccur in the mountains of the Virginia-Carolina area. This element has a long history in the literature and is discussed in some detail by Pennell (1935), Braun (1937), Fernald (1937), and by other botanists.

Recent botanical activity in Virginia and the Carolinas enable us to gain a clearer picture of the phytogeographic relations and history of the coastal plain - mountain element and some eighteen species with this distribution pattern are discussed in this paper. These species are placed in 4 groups, (1) wide-ranging, (2) chiefly of northern distribution, (3) chiefly of southern distribution, or (4) endemic to the Virginia-Carolina area. Within these groups the species are

*The writer is indebted to Professor A. B. Massey for information on some species in the Virginia Polytechnic Institute herbarium, and to Dr. C. F. Lane of Longwood College for reading the manuscript.

arranged according to their distribution in the Carolinas (Radford, Ahles and Bell, 1964) because the distribution of the flora of the Carolinas appears to offer some possibilities for an explanation of some of the disjunct distributional patterns in the Virginia flora.

DISJUNCT SPECIES OF THE PENINSULA OF VIRGINIA

I. Wide-ranging species north and south.

Species of the piedmont and mountains in the Carolinas: *Actaea pachypoda* Ell.; *Agrimonia pubescens* Wallr.; *Campanula americana* L.; *Dirca palustris* L.; and *Sanicula marilandica* L.

Species chiefly of the coastal plain and mountains in the Carolinas: *Habenaria ciliaris* (L.) R. Br.

II. Species generally of northern distribution.

Species of the piedmont and mountains in the Carolinas: *Isotria medeoloides* (Pursh) Raf. and *Lathyrus venosus* Muhl.

Species of the coastal plain, piedmont and mountains in the Carolinas: *Comptonia peregrina* (L.) Coulter.

Species chiefly in the mountains in the Carolinas: *Aralia racemosa* L.

III. Species generally of southern distribution.

Species of the piedmont and mountains in the Carolinas: *Monotropsis odorata* Ell.

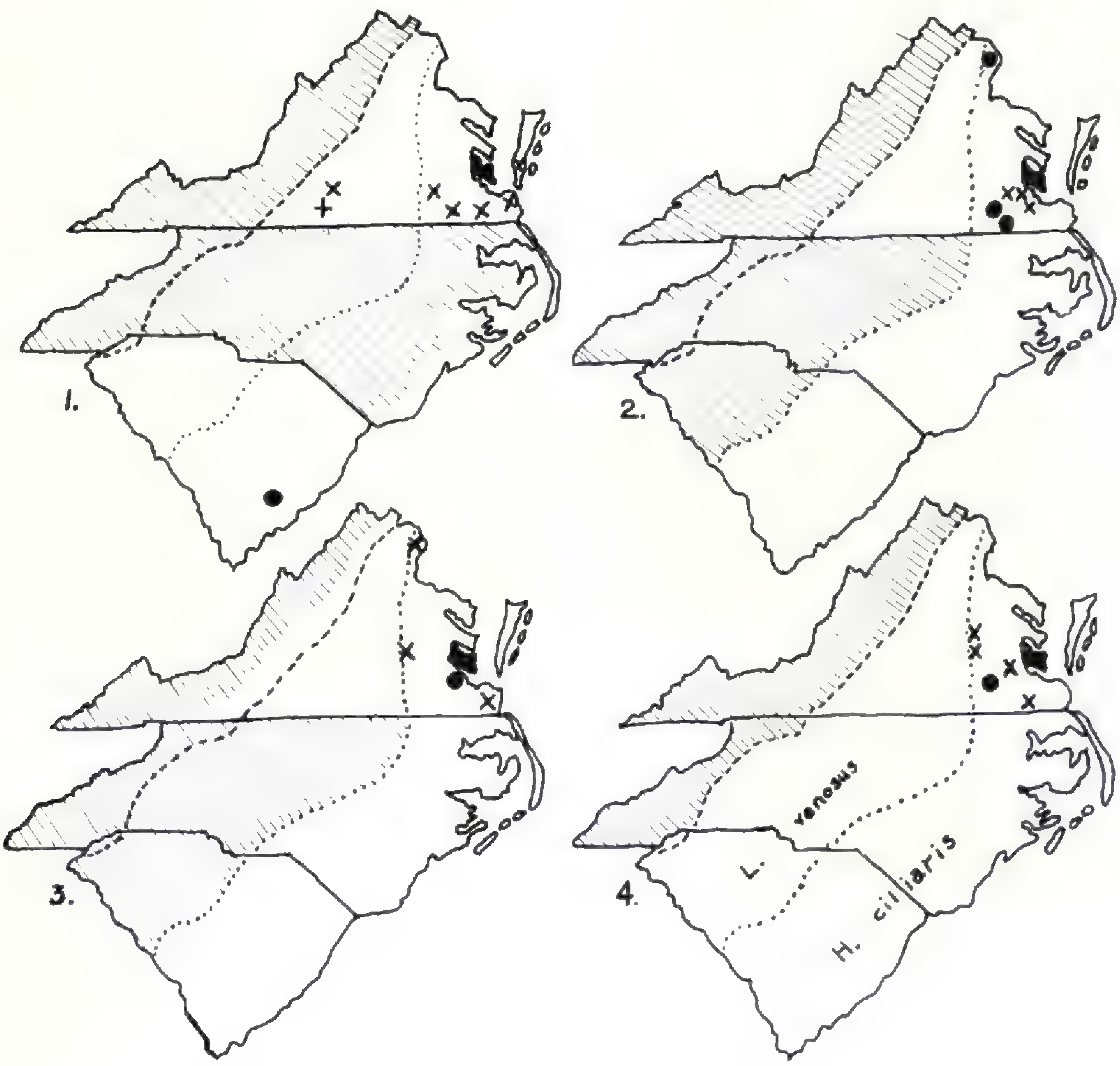
Species of the coastal plain, piedmont and mountains in the Carolinas: *Callicarpa americana* L.; *Galax aphylla* L.; *Helenium brevifolium* (Nutt.) Gray (including *H. curtissii* Gray) and *Magnolia tripetala* L.

Species chiefly in the mountains in the Carolinas: *Parnassia asarifolia* Vent. and *Stewartia ovata* (Cav.) Weath.

IV. Endemic to the Virginia-Carolina area: *Chelone cuthbertii* Small. Apparently bicentric, the known occurrence of the *Chelone* is on the coastal plain of Virginia and in the mountains of North Carolina.

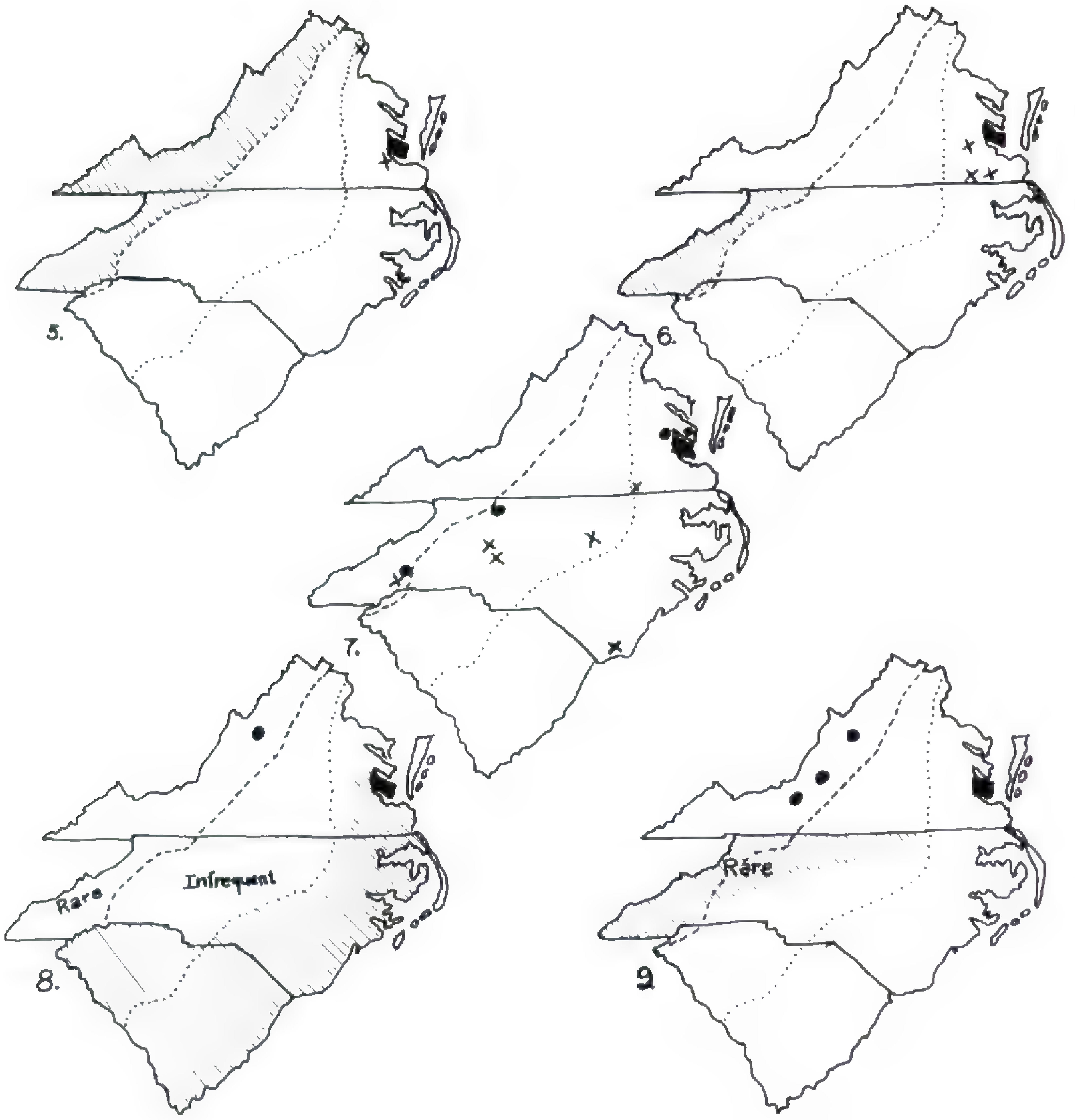
Other species of The Peninsula belong to the coastal plain-mountain element but their distribution is as yet not so well documented. Also, numerous other species found south of the James River on the coastal plain have disjunct colonies in the mountains but are not included in this study.

Five of the eighteen species mapped in this paper are known from the mountains of the Carolinas, but not from those of Virginia; they are *Helenium brevifolium, Isotria medeoloides, Monotropsis odorata, Stewartia ovata* and *Chelone cuthbertii.*



Figs. 1-4. DISTRIBUTION IN VIRGINIA AND THE CAROLINAS OF SPECIES WHICH ARE DISJUNCT ON THE PENINSULA OF VIRGINIA. The Peninsula is solid black. Shaded areas represent the occurrence of all species mapped in the figure. The coastal plain is east of the dotted line; the mountains are west of the dashed line; between them is the piedmont. Fig. 1. • = *Magnolia tripetala*; X = *Galax aphylla*; and *Comptonia peregrina*. Fig. 2. • = *Sanicula marilandica*; X = *Campanula americana*; and *Actaea pachypoda*. Fig. 3. • = *Dirca palustris*; and X = *Agrimonia pubescens*. Fig. 4. • = *Lathyrus venosus*; and X = *Habenaria ciliaris*.

The species *Galax aphylla* occurs very locally in the southern piedmont of Virginia with stations in Campbell and Pittsylvania counties. The type of distribution shown by *Galax* is characteristic of several species occurring on The Peninsula; i.e., widespread on the coastal plain and in the mountains but with very local colonies on the piedmont of



Figs. 5-9. Explanation under Figs. 1-4. Fig. 5. X = *Aralia racemosa*; and *Parnassia asarifolia*. Fig. 6. X = *Chelone cuthbertii*; and *Stewartia ovata*. Fig. 7. • = *Isotria medeoloides*; and X = *Helenium brevifolium*. Fig. 8. • = *Callicarpa americana*. Fig. 9. • = *Monotropsis odorata*.

Virginia. Baldwin (1941) shows that the coastal plain populations in Virginia are tetraploid and those of the mountains are diploid. It would be interesting to know the chromosome numbers of the very local piedmont populations. The chromosome complements of isolated populations of the other species with disjunct distribution would also be of considerable interest. Significant genetical differences can be expected in plants which are isolated in small colonies.

Mapping the eighteen species discussed in this paper suggested some conclusions on the reasons for the disjunct distribution of the species and may provide some clues to the history of floristic movements in the area which is now Virginia.

The coastal plain of Virginia is relatively rich in species, the mountains somewhat poorer, and the piedmont is the poorest. Moreover, the piedmont of Virginia is poorer floristically than the piedmont areas to the south of it. Many species generally distributed in the Carolinas become more restricted in distribution in Virgnia. Of the three physiographic provinces dealt with here, this northward restriction or limitation in distribution is most marked in the piedmont. The piedmont of Virginia appears as an island which is poor in numbers of species within the richly diversified floras surrounding it.

Many of the Virginia species with a disjunct distribution have persisted in bogs and in soils influenced by underlying Miocene shells. It would seem from the available data that the soil conditions, topography, and climatic conditions of the coastal plain and the mountains of Virginia provided refugia where many plants persisted during the climatic stresses of the Pleistocene, such refugia being rare or absent in the piedmont. Isolation could be expected to decrease the number of biotypes in the colonies (Hultén, 1937) and result in populations with little variability and a lack of aggressiveness. Such populations apparently have narrow edaphic tolerances and are specialized for the soil conditions in which they have persisted and cannot compete successfully with other species in areas of differing edaphic values.

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LONGWOOD COLLEGE
FARMVILLE, VIRGINIA

DISCOVERY OF THE MASSACHUSETTS FERN IN WISCONSIN

THOMAS G. HARTLEY

An interesting discovery made in a recent survey of the flora of the "Driftless Area"* was the Massachusetts fern, *Thelypteris simulata* (Davenp.) Nieuwl. An abundance of this species was found growing in low sandy woods in the old bed of Glacial Lake Wisconsin in Jackson County, Wisconsin. Collections were made in 1958 and 1960 at two localities about eight miles apart: near Rudd's Hills, Section 35, Millston Twp. (*Hartley 4029*), and north of Wildcat Mound, Section 22, Millston Twp. (*Hartley 4819* and *9600*). Duplicates of these collections have been distributed to the following herbaria: State University of Iowa, University of Wisconsin, Gray Herbarium, United States National Herbarium, Rancho Santa Ana Botanic Garden, University of Minnesota, University of Michigan, University of Illinois, Wisconsin State College at Eau Claire, and Wisconsin State College at LaCrosse.

My collections appear to be the first authentic records of this species west of West Virginia. There are reports of it from the dune country of northwestern Indiana by Pepoon (1927) and Peattie (1930), but Fassett (1933) has pointed out that the Umbach collection upon which these were based was misidentified marsh fern, *Thelypteris palustris*. The accompanying map shows the distribution of *Thelypteris simulata* as represented by the Wisconsin collections and collections at the Gray Herbarium, New England Botanical Club Herbarium, United States National Herbarium and the Wiegand Herbarium of Cornell University.

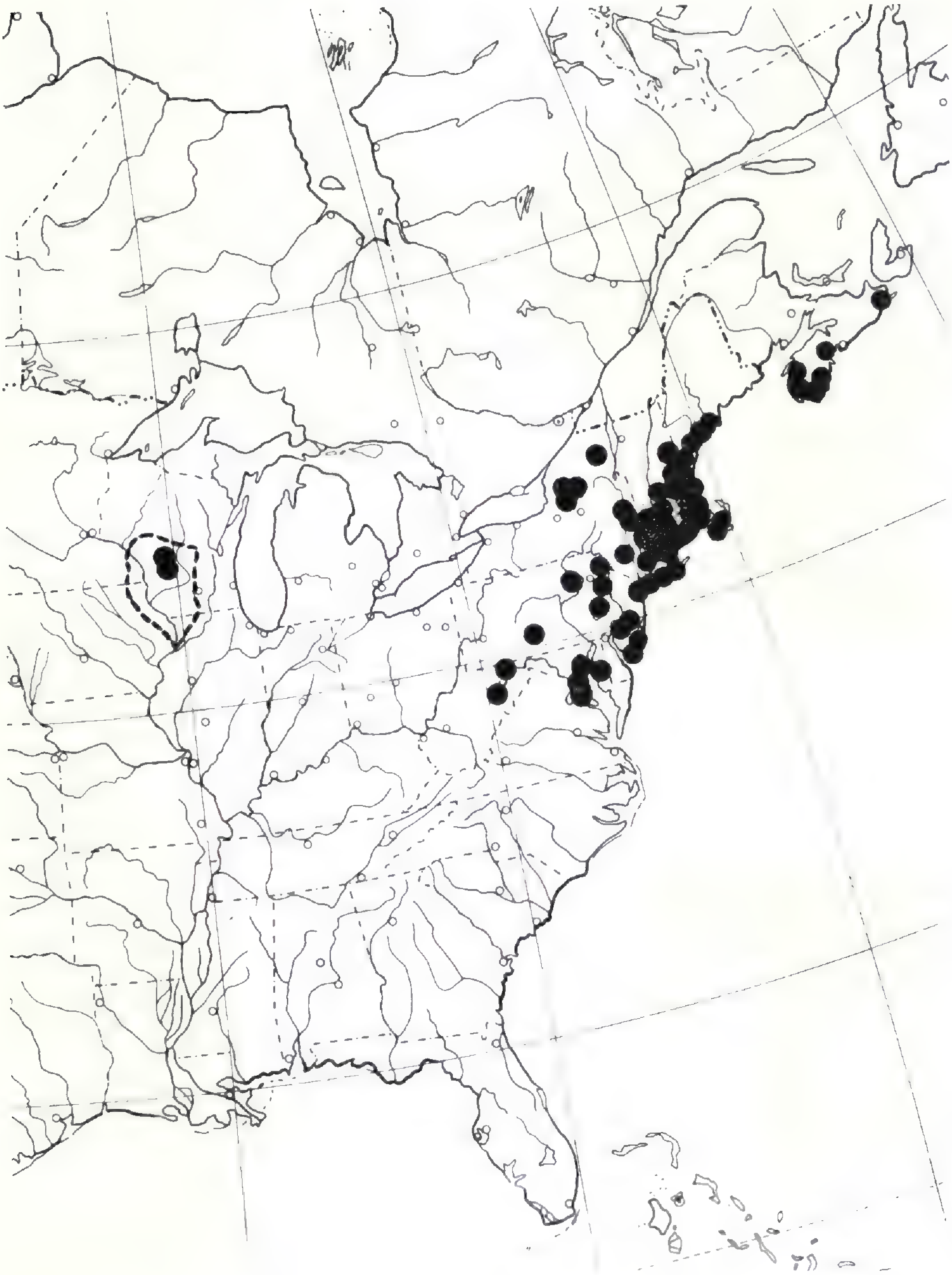
The "Driftless Area" of the Upper Midwest is completely surrounded by glaciated territory and apparently was not covered by continental glaciation during the Pleistocene epoch. Within the belts covered by continental ice sheets of

*A dissertation for the degree of Ph. D. at the State University of Iowa, Iowa City, was based on this survey.

Massachusetts fern, *Thelypteris simulata* (Davenp.) Nieuwl., in Jackson County, Wisconsin. (*Hartley 9600.*) Plate 1317

northeastern North America and northwestern Europe there is no similar region of substantial size which was left bare of glacial ice. As delimited in this survey, the "Driftless Area" covers approximately 15,000 square miles of southwestern Wisconsin and adjacent Minnesota, Iowa and Illinois. The inclusion of northeastern Iowa and southeastern Minnesota requires figurative usage of the name since older ice sheets, generally believed to have been Kansan and Nebraskan, are thought to have covered these areas.

The old bed of Glacial Lake Wisconsin covers approximately 1,825 square miles in the northeastern section of the



Distribution of the Massachusetts fern, *Thelypetris simulata* (Davenp.) Nieuwl. The broken line surrounding the Wisconsin stations indicates the limits of the "Driftless Area."

"Driftless Area." The lake is believed to have been formed when glacial ice of the Cary substage of the Wisconsin stage of the Pleistocene dammed up the Wisconsin River in the region of the Baraboo Range. Radio-carbon dates from material in various Cary deposits in the North Central States (Flint and Deevey, 1951 and Flint and Rubin, 1955) indicate that this occurred about 15 thousand years ago. Pollen studies from bogs in the region (Hansen, 1937) show that the lake had drained and was supporting vegetation before the advance of the Valders ice into northeastern Wisconsin, an event that is dated at about 11 thousand years. Botanically this old lake bed is extremely interesting. There are vast areas of black spruce bogs with surrounding meadows of ericads and open sphagnum; cold, soft-water streams and flowages; dry, sandy jack pine-scrub oak barrens; and open sandy plains, prairies and blowouts. Woodlands of the type occupied by *Thelypteris simulata* are frequent in eastern Jackson County. The dominant trees of these woodlands are *Acer rubrum*, *Pinus strobus*, *Quercus alba* and *Betula papyrifera*, with an understory of *Nemopanthus mucronata*, *Ilex verticillata*, *Hamamelis virginiana* and *Pyrus americana*. The woodland floor is often sphagnous and otherwise characterized by such species as *Lycopodium clavatum*, *Lycopodium complanatum*, *Dryopteris cristata*, *Osmunda cinnamomea*, *Osmunda regalis*, *Carex brunnescens*, *Carex debilis*, *Carex emmonsii*, *Carex folliculata*, *Carex intumescens*, *Carex trisperma*, *Cinna latifolia*, *Clintonia borealis*, *Cypripedium acaule*, *Panax trifolius*, *Cornus canadensis*, *Trientalis borealis*, *Coptis groenlandica*, *Rubus hispidus* and *Viola incognita*. The presence of white oak is interesting and perhaps indicates a less highly acid environment than is found in most poorly-drained areas of this region.

Morphologically, *Thelypteris simulata* is more or less intermediate between *Thelypteris palustris* and the New York fern, *Thelypteris noveboracensis*. W. H. Wagner, Jr. (1963), has suggested that it may have originated as an allopolyploid, pointing out that *T. palustris* has $n=35$ and

T. noveboracensis has $n=27$ and that in material of *T. simulata* from Maryland he found that $n=64$. Dr. Wagner reasons that the two extra chromosomes (n should $= 62$ in the allopolyploid) may indicate a considerable lapse of time since the original hybridization during which two aneuploid changes might have taken place. He also studied the Wisconsin material (*Hartley 9600*) and noted that the chromosome number ". . . . could not be determined exactly, but the number is very close to or the same" as that of the Maryland material.

This information provides us with the attractive possibility of independent origin as explanation for the disjunct distribution of this species. Though only one of the parents, *Thelypteris palustris*, is known to occur in Wisconsin, there is the possibility that they were both there at some time during or since the Pleistocene. The extant range of *T. noveboracensis* extends to counties bordering the eastern and southern shores of Lake Michigan in Michigan, Indiana and Illinois and these areas are similar, floristically, to the old bed of Glacial Lake Wisconsin.

Another possible explanation for this distribution is that the Wisconsin population is a relict of a more extensive late or post-Pleistocene distribution. Considerable fluctuation in size of the Great Lakes occurred during late Wisconsin times and this apparently provided, at times, more or less continuous habitats along which many species could migrate inland. When subsequent changes destroyed intervening habitats, disjunct patterns of distribution resulted. This explanation is particularly applicable to a number of Atlantic Coastal Plain species of open sandy habitats in the old bed of Glacial Lake Wisconsin and may apply to *Thelypteris simulata* as well.

Long distance dispersal must, of course, be considered as a third possibility, though it seems less likely since the prevailing winds are from the west rather than the east and woodlands of the type occupied by this species are more or less "closed" with regard to competition.

The curators of the Gray Herbarium, New England Botanical Club Herbarium, United States National Herbarium and the Wiegand Herbarium of Cornell University are thanked for the loan of herbarium material, information and permission to examine specimens. Thanks are also extended to Dr. Rolla M. Tryon, Jr., for his assistance in the identification of the Wisconsin material of this species and to the National Science Foundation for financial aid.

ARNOLD ARBORETUM,
HARVARD UNIVERSITY

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A THIRD SUBSPECIES IN THE ARTEMISIA TRIDENTATA COMPLEX*

Alan A. Beetle and Alvin Young

A recent monograph of the Section Tridentatae of *Artemisia* recognized two subspecies of *Artemisia tridentata* (Beetle, 1960). Need for the naming of a third subspecies in the *A. tridentata* complex is now recognized. This subspecies is intermediate in ecology, morphology, and distribution between *A. tridentata* subsp. *vaseyana* and *A. tridentata* subsp. *tridentata*. In some field situations all may grow together. Credit must be given to the techniques of thin-layer chromotography for final separation of these closely related types.

Young (1965) found this undescribed subspecies to have the "widest distribution of any occurring in Sublette County, Wyoming." He says it is "a dwarf shrub with small leaves, often suggestive of *A. nova,* with flower and fruit characters similar to representatives of *A. tridentata* subsp. *tridentata*. The chromatographic data show that it is more closely related to *A. tridentata* subsp. *tridentata* than to *A. nova*. The most distinguishable feature of the chromatogram is the presence of a heavy absorption cone extending from R_f-.12 to R_f-.30. In the field this newly recognized subspecies is found associated with *A. tridentata* subsp. *tridentata* but always occupying the poor sites (*e.g.* shallow soils of hilltops and flats).

A. tridentata subsp. (**wyomingensis**) subsp. nov.

Subspecies inter *A. tridentata* subsp. *tridentata* et *A. tridentata* subsp. *vaseyana* intermedia; arbuscula, usque ad 1 m. longa; numquam propagata ut *A. tridentata* subsp. *vaseyana*; folia angustata cuneata, tridentata, 1 - 2 cm. longa; panicula angusta; floreres 5 - 8.

"Type: Wyoming, Sublette County, North of Pinedale, and ½ mile North of Daniel Junction, growing on Pleistocene gravels, and forming a sagebrush-thickspike-wheatgrass community, collected July 20, 1964 by Alvin L. Young No. 105, and deposited in the Rocky Mountain Herbarium.

*Published with approval of the Director, Wyoming Agricultural Experiment Station, as Journal Paper No. 263.

This collection was chosen as the type because it was itself identified through thin-layer chromatograhpy and because it is representative of the subspecies.

The particular subspecific epithet for it is given because the major portion of the distribution of the plant is within the state of Wyoming and because the research leading to its recognition was carried out there.

Recognition of this third subspecies in the *A. tridentata* complex will help to sharpen the management picture since the sites occupied by the three subspecies are somewhat different, and the increase in grass following their control by chemicals is, therefore, different.

ARTEMISIA TRIDENTATA

subspecies *tridentata* basin big sagebrush	subspecies *wyomingensis* Wyoming big sagebrush	subspecies *vaseyana* mountain big sagebrush
the common big sage brush at 5,000 ft. or below	the commonest big sagebrush in Montana and Wyoming and n. Colorado at 5,000 to 7,000 feet	the common big sagebrush at 7,000 feet and above
no tendency to layer	no tendency to layer	strong tendency to layer
dry, deep-soil sites	dry, shallow-soil sites	deep-soil snowfall areas of mountnain slopes
heads few-flowered	heads intermediate	heads many-flowered
heads paniculate	heads intermediate	heads spikate
leaves narrowly lanceolate	leaves narrowly cuneate	leaves broadly cuneate

RANGE MANAGEMENT SECTION
UNIVERSITY OF WYOMING
LARAMIE

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GEOCAULON LIVIDUM IN NEW ENGLAND

In July 1964 the Gray Herbarium asked me if I could assist the late Dr. Hans Stauffer of Zurich, Switzerland in finding *Geocaulon lividum* (Richards.) Fern, in the White Mountains. Dr. Stauffer came to my camp in Dummer, New Hampshire, and we spent two days searching for it on Imp Mt. and Mt. Clinton with no success.

Geocaulon has not been collected frequently in New England; the herbarium of the New England Botanical Club contains fifteen collections, the Gray Herbarium five, three of which are duplicates of sheets in the Botanical Club, and the herbarium of the Boston Society of Natural History has seven, all duplicates. The most recent collection was made in 1941 but most of the collections were made prior to 1910. These collections come from twelve localities, Lubec and Roque Bluffs in coastal Washington County, Maine, Katahdin in Piscataquis County, Bald Mt. in Somerset County, Mts. Abraham and Saddleback in Franklin County and Goose Eye in Oxford County; Mt. Ingalls, Imp Mt., Mt. Clinton and the Basin Rim in Cöos County, New Hampshire; and Mt. Mansfield in Lamoille County, Vermont.

My acquaintance with the species was limited to finding it once on Katahdin in 1928. On 27 August 1964 I searched for the plant on the Basin Rim and found it growing on the slopes of both Mt. Meader and Mt. Royce and a week later I visited Goose Eye and Mt. Carlo in the Maine portion of the Mahoosuc Trail and found five stations. In June 1965 I revisited Mt. Clinton and finally found a few sterile stems about a quarter of a mile south of the new Mizpah Hut. A month later I again found the species on the Bondcliff Trail in Lincoln, Grafton County, New Hampshire. Apparently this is the first record for Grafton County. I was unable to find *Geocaulon* in what appeared to be favorable sites on Mt. Lafayette and Mt. Kinsman in Grafton County. The following collections are on deposit in the herbarium of the New England Botanical Club: MAINE, Oxford County, north slope of Mt. Carlo, Riley, *Harris 26803,* 1 September 1964; NEW

HAMPSHIRE, Cöos County, Webster Cliff Trail 1/4 mile south of Mizpah Hut, Bean Grant, *Harris 27387*, 22 June 1965; Grafton County, Bondcliff Trail near trail to Guyot Shelter, Lincoln, *Harris 27687*, 20 July 1965.

Geocaulon lividum is not an easy species to find. The leaves, borne on low herbaceous stems, resemble very closely the leaves of blueberries and the two grow frequently together. However my initial discovery of the plant on the Basin Rim came when I noticed some foliage in the undergrowth with the characteristic purplish color that the leaves of the closely related *Comandra umbellata* assume in the late summer. The flowers are inconspicuous and drop early in the season, on the Basin Rim on 11 June 1965 they were past their prime. The berry-like fruit are showy but apparently scarce in the White Mountains. I could find only about a dozen fruit on over 500 stems I examined on the Basin Rim in August 1964 and the same ratio seemed to hold on Goose Eye and Mt. Carlo. On 31 August 1965 on the Basin Rim I could not find a single fruit on more than 1000 stems although in June some of the stems bore as many as twenty flowers or immature fruit. Gray's Manual describes the fruit as being scarlet; all I have seen have been yellow-orange.

Pease in the *Flora of Northern New Hampshire* states the habitat as, "mossy bogs on the upper parts of the secondary mountains, local (somewhat similar in distribution to *Rubus Chamaemorus*)." I found one station on Mt. Carlo in a mossy bog but all the other stations were in damp but not boggy, rather open low spruce and fir forest. On Mt. Meader some of the plants are growing in thin mossy wooded soil on ledges. *Rubus Chamaemorus* is abundant in the Mahoosucs and on Mt. Clinton but I never found *Geocaulon* growing with it. The stations varied in elevation from about 2500 feet on the Basin Rim to 4100 feet on Mt. Guyot. On Mt. Royce the stand of *Geocaulon*, which is the largest one I have found, is at an altitude only a few feet higher than a grove of mature fruiting *Quercus rubra* and *Epigaea repens*, var. *glabrifolia* is growing with the *Geocaulon*. Many of the black spruces forming the forest cover of this station are heavily infected with *Arceuthobium pusillum*.

A thorough search for the plant in favorable habitats may reveal that *Geocaulon lividum* is a much more common plant in northern New England than present collections indicate.

STUART K. HARRIS
BOSTON UNIVERSITY

FURTHER NOTES ON CHAMAECYPARIS THYOIDES IN NEW HAMPSHIRE

Since the publication of my note (Rhodora 63:281-285), some additional stations in central New Hampshire have been visited, and it may be of interest to describe these briefly. These will be numbered consecutively as additions to the list previously reported.

6a. Robb Reservoir, Stoddard. Elevation 1,275. A half mile from the previously recorded station for *Chamaecyparis thyoides* in Stoddard thirteen additional clumps of these trees were found in April 1963. They were mingled with a thin stand of red maple on the northeast side of an open bog thru which the outlet of Rye Pond flows into Robb Reservoir. The cedars appeared to be sprouts from old stumps and are possibly survivors of a former larger stand that may have been killed by flooding. No reproduction or young trees were observed.

7. Ring Brook, Sutton. Elevation 950 feet. This station for *Chamaecyparis thyoides* covers an area of about 22 acres in a swamp forming the headwaters of Ring Brook. It begins about one quarter mile west of the intersection of Baker Hill Road with Chalk Pond road leading from Sutton to Lake Sunapee. The stream was dammed by beavers a few years ago resulting in the death or severe injury of red spruce and white pine but leaving red maple and the cedar little affected. On the West side of the swamp the red maple

has suppressed the cedars which are consequently very small. Many of the larger trees in this station display cankers due to infection with *Gymnosporangium* sp. The ground is either bare or covered with a growth of sphagnum which indicates the severity of the recent flooding.

8. Moose Brook, Hancock. Elevation 825 feet. This small stand of cedars is located along the first half mile of Moose Brook as it leaves Norway Pond and flows thru a rather wide flood plain. This plain has been the site of beaver activity in the past and is now occupied by a dam a few hundred yards upstream from the bridge on Longview Road. A seven-stem clump of cedars 4″ to 6″ in diameter along with a smaller double stemmed tree occur 150 ft. southeast of the dam while on the opposite bank 200 ft. downstream there are three 5″ cedars. These trees have been over-topped by a high forest of white pine, red maple and hemlocks and it is doubtful if they can long survive this competition. Farther downstream are two groups opposite each other only 100 yards from the highway. However, they have been girdled one to six inches wide near the base possibly by beavers. It is reported that there was formerly an extensive cedar swamp on this stream and if so these few trees are doubtless the remnants.

The associated vegetation near the beaver dam consists almost wholly of white pine, gray birch, and red maple with some alder and one pitch pine. The ground cover of *Cassandra*, *Kalmia angustifoliia* and other ericaceous shrubs is interesting as it suggests a former wet swamp soil that has been gradually built up by the repeated flooding of beaver dams until upland species have been able to invade the site.

9. Shedd Brook, Hillsboro. Elevation 970 feet. Scattered trees of *Chamaecyparis thyoides* occur along Shedd Brook beginning about 300′ east of the Hillsboro-Windsor town line. The brook here meanders thru a marshy plain which shows evidence of intermittent flooding probably by beavers. Much of the sparse stock of red maples is dead as well as some of the cedars. There are five or six large cedars 8 to

12 inches d.b.h. and up to fifty ranging from two to five inches in diameter. Some of these latter appear to be sprouts from old stumps. The trees are scattered along both sides of the brook for half a mile with rarely more than three or four in a clump.

The finding of *Chamaecyparis thyoides* in these localities emphasizes the point that one should not be dogmatic in stating that the tree does not occur in any wetland in this region without a thorough search.

Specimens from the above stations are deposited in the Herbaria of the University of New Hampshire and the New England Botanical Club.

HENRY I. BALDWIN
HILLSBORO, NEW HAMPSHIRE

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New scientific names and combinations are printed in bold face type