problem in identification but the caption on the specimen is sketchy: "Fimbristylis squarrosum e collect Amer. Loefl. dedit Ortega."

According to Koyama (1961), this small sedge is but a variant of *Fimbristylis aestivalis* (Retzius) Vahl. Both are diminutive, eligulate, and have similar akenes, inflorescence, and spikelet shapes. However, *F. aestivalis* is smoother, and lacks the elongate-recurved midrib character of bract, also the recurved fimbriate character of style base that is so distinctive in *F. squarrosa*. I feel that these constitute specific rather than varietal differences, hence am retaining the previous nomenclature. Only experimentation with the two entities can decide the matter. For purposes of comparison I have drawn typical examples of both (see plates 40a, 40b).

41. FIMBRISTYLIS VAHLII (Lam.) Link, Hort. Berol. 1: 287. 1827.

Scirpus vahlii Lam., Ill. 1: 139. 1791.

Isolepis vahlii (Lam.) H.B.K., Gen. & Sp. 1: 221. 1816.

Fimbristylis congesta Torr., Ann. Lyc. N. Y. 3: 345. 1836.

Fimbristylis vincentii Steud., Syn. Cyp. 109. 1855.

Scirpus apus A. Gray, Proc. Am. Acad. 10: 78. 1874.

Fimbristylis apus (A. Gray) S. Wats., Bot. Calif. 2: 224. 1880.

Caespitose low annual, the culms to 1.5 dm. tall (usually much lower). Leaves 1/3 as long as the scape to equalling or exceeding it, the blades linear-filiform, spreading recurved less than 1 mm. broad, somewhat involute, the backs with several prominent, raised veins often with small, stiff, ascending hairs, the margin somewhat thickened and similarly hairy. Leaf sheath broad, stramineous or pale brown, usually smooth or with a scattering of small hairs, the margin scarious, entire, passing gradually into the blade. Ligule absent. Scapes stiffly ascending, wiry, slightly broader than the leaves, glabrous, many-ribbed, subterete. Spikelets lance-ovoid, linear-ellipsoidal or oblong, 0.5-1.0 cm. long, usually acute, pale greenish-brown, 3-8 in a dense terminal cluster, this subtended by several leaf-like involucral bracts, these always exceeding the inflorescence and usually at least the length of the basal leaves. Fertile bracts ovate-lanceolate or oblong-lanceolate, glabrous, stramineous or pale green, the midrib conspicuous, dark green, and pointed beyond the scale as a short, erect or slightly recurved, mucro. Stamen 1, the anther less than 0.5 mm. long. Style 2-branched, much longer than the akene, subterete, the base swollen, the surface smooth, or papillate from about the midpoint to the point of branching. Akene obovoid, tumid, 0.5-0.7 mm. long pale, sometimes slightly iridescent, reticulate, the individual rectangular cells arranged horizontally in 5-7 vertical rows on a side.

Fine sands, silts or clays, usually alluvial or shoreline situations, often on areas of disturbed bottomland, South Carolina south to northern Florida, west to Texas; scattered localities in inland states (Kentucky, Illinois, Missouri, Arkansas, Oklahoma and Kansas); in the western United States, California and Arizona; Mexico and into Central America beyond the range of this study.

Type: "Habitat in America meridionali, nec in Hispania" (Vahl, Enum. 2: 263). Not seen by writer.

Fimbristylis vahlii together with the extremely rare *F. perpusilla* Harper, comprise the two most diminutive species of the genus in North America. It is very much a weed, being most often found on fine textured, often alluvial, soil such as would be recently exposed by receding water. In Texas and Louisiana it is most often seen around farm ponds, artificial lakes, backwaters of rivers and streams, or borrow pits. It is most often in association with such *Fimbristylis* as *F. autumnalis, F. miliacea* and *F. annua,* but is found further west in the United States than any of these although its occurrence in the western United States is sporadic. Fruiting plants may develop from seed in a few weeks time, an indication that this is a species extremely efficient in getting the most out of the sort of temporary habitat it occupies.

42. FIMBRISTYLIS PERPUSILLA Harper in Small, Fl. SE. U. S. 188. 1903.

Solitary or tufted, low glabrous annual, the culms to 8 cm. tall (usually lower). Leaves from 1/3 the length of the scape to equalling or exceeding it, the blades linear-filiform, less than 1 mm. broad, spreading involute, the backs with 3, prominently raised veins, the margin composed of similar, ciliate-scabrid, veins; sheath much broader, with an entire, broad, scarious margin, this converging with the blade at an acute angle. Ligule absent. Scapes stiffly ascending, wiry, slightly broader than the leaf blades, many-ribbed, flattened to subterete. Spikelets ovoid to subglobose, 2-4 mm. long, greenish-brown, blunt, in a simple to compound panicle of cymules this subtended by several, leaflike involucral bracts, the longest exceeding the inflorescence. Fertile bracts lanceolate or oblong, thin and stramineous, save for a prominent, broad, greenish midrib, this exserted as an elongate ascending to somewhat recurved cusp. Stamens 1, the anthers 0.2 mm. long. Style 2-branched, about the length of the akene or slightly longer, subterete, the base not swollen, the surface smooth. Akene oblong, slightly curvate, terete, 0.4-0.6 mm. long, pale brown with some iridescent tints, finely reticulate, the reticule made up of about 12 vertical rows of many narrowly rectangular slightly concave horizontal cells, the longitudinal lines more prominent than the horizontal.

Alluvium of borders of pineland ponds, Sumter and Seminole counties Georgia.

Type: U. S. A. GEORGIA. SUMTER CO.: prostrate on muddy bottom of exsiccated pine barren pond near Leslie, *R. M. Harper 1729.* Holotype at NY, examined by writer.

Taxonomically, this species could be confused in northern America only with *F. vahlii,* but differs from it in its more open inflorescence and in its narrower, banana-shaped, fruit. It bears a striking resemblance to the Asian *F. dipsacea,* differing from it only in its more ascending-tipped fertile scales and in the lack of bladder-like projections of pericarp (see figure 42B). One can see from a comparison of specimens of the two that they are un-

44. FIMBRISTYLIS **argillicola** Kral, sp. nov.

Perennis caespitosa usque 1 m. alta, culmis basi bulbosis cum foliis exterioribus squamiformibus. Folia propria plantam 1/3-2/3 aequantia, laminis anguste linearibus (ad 1 mm. latis) laevibus (marginibus ciliato-scabridis exceptis). Spiculae lanceol-ovoideae vel ellipsoideae castaleae vel brunneae (vivo atratae). Achaenia lenticulari-obovoidea vel obpyriformia ca. 1.5 mm. longa.

Caespitose perennial, erect or ascending at most to 1 meter tall, the bases of the culms bulbous, the outer leaves of a clump scale-like. Leaves 1/3-2/3 the length of the plant, the blades narrowly linear (rarely exceeding 1 mm.), involute, smoothish, pale green, the nerves of the lower surface numerous and raised, the margin pale, thickened, upwardly ciliate-scabrid, at least toward the base and apex; sheathing portion of the leaf broad, smooth, stramineous to dark brown, thickened, but with a pale brown scarious margin, this entire, its apex passing into the blade at an acute angle. Ligule of hairs absent. Scapes slender, little wider than leaves, multicostate, smooth, subterete below, somewhat flattened toward the apex. Longest bract of the involucre shorter than the inflorescence, the blade similar in character to that of leaves. Spikelets lance-ovoid, or ellipsoidal, 0.7-1.2 cm. long, (1-) 3-5 (-7), all but the central one in an open umbellate system of ascending peduncles, castaneous to dull brown. Fertile bracts broadly ovate, entire smooth, or with a few short hairs apically around the midrib, the midrib itself paler, either pale green or stramineous, this usually exserted as a short cusp. Stamens usually 2, rarely 3, the anthers 1.5-2.0 mm. long, apiculate, the filaments broad and flattened, but narrowing apically at point of attachment with anthers. Style 2-branched, flattened, fimbriate from at least its midpoint to the point of branching. Akene lenticular-obovoid, or obpyriform about 1.5 mm. long, a pale to deep brown, rather finely scalariform-foveate or reticulate, the individual cells horizontally rectangular, arranged in numerous, vertical lines; surface of akene usually verrucose. Joint of akene short, usually persistent on fruit.

Type: MEXICO. MICHOACAN. Just west of Puente Rio de Turundeo, w. of Tuxpan on heavy wet soil of boggy swale in relict prairie by highway 15, *R. Kral 25509.* Holotype at MICH.

Moist to rather dry, often somewhat brackish, heavy soils of original grasslands, Mexico, in the states of Guerrero, Mexico, D. F., Jalisco, Michoacan, Durango, Zacatecas, Aguascalientes, Puebla, Guanajuato. Particularly abundant in the lake country of Jalisco.

This species has often been identified as *F. pentastachya* Boeck. the type locality of which is in the state of Vera Cruz, a state in which this plant does not seem to occur. It differs from *F. pentastachya* by its smoother foliage, its darker coloured spikelets, and in the character of its old leaf bases which is not fibrous-shreddy. *F. pentastachya* has much paler, reddish brown spikelets, and is well marked by the fibrous character of its old leaf bases. While *F. pentastachya* is a plant of savanna development in oak or oak-pine forest, *F. agrillicola* is definitely a plant of native grassland. The former is a plant of rather loose textured soils, while the latter grows on heavy black gumbo-type clay.

The best growth of *F. argillicola* is on alkaline soils. In the lake country around Guadalajara it is frequent in association with brackish soil plants. In the greenhouse it responds best to fine-texture, alkaline or circumneutral, potting medium. Flowering plants may be grown from seed in a few months. As is the case with *Abildgaardia,* the seedlings quickly develop numbers of close-set and bulbous-based lateral offshoots. Flowering scapes usually do not form until rosettes of such offshoots are well developed.

45. FIMBRISTYLIS PENTASTACHYA Boeck., Flora 40: 36. 1857.

Perennial to 1 meter tall, the culms bulbous-based, solitary or in small tufts, usually also with bases invested in a fibrous ramentum of old leaf bases. Leaves 1/2-3/4 the length of the mature scapes, spreading-recurved, lax, the blades linear, flat to somewhat involute, with several prominent ribs on the backs and two marginal ribs, the margins ciliate, particularly toward the apex and base of the blade, with pale, stout and rather long, ascending or upwardly appressed, trichomes, the upper and lower surfaces similarly pubescent toward the base of the blade; sheaths broad at the base, the old sheaths becoming fibrous, a deep reddish-brown, the margins subscarious, pubescent on the backs, and tapering gradually or abruptly to the blade, here copiously pubescent with pale, crisped trichomes. Ligule not evident. Scapes about the width of the leaf blades, rather lax, subterete and multicarinate below, many-ribbed and somewhat flattened distally, smooth. Longest bract of the inflorescence similar in texture and indument to leaves, somewhat shorter than to longer than the inflorescence. Mature spikes ovoid to ellipsoidal, acute, ca. 1 cm. long, 3-7 (usually 5), all but the central ones pedunculate in open simple umbell-like cymes, the individual peduncles ascending, to 4 cm. long. Fertile scales ovate, smooth, reddish-brown save for a paler, scarious edge and a paler or sometimes greenish midrib, rounded or obtusely angled, the margin entire or ciliate apically. Midrib of 5, often conspicuous, close-set nerves, this exserted as a short mucro on the lower scales, otherwise included. Stamens 3, anthers about 3 mm. long. Styles 2-branched, the edges fimbriate above the mid-point and to the bases of the style branches. Akene lenticular-obovoid, 1.5-2.0 mm. long, brown, rather flat to somewhat tumid, the surface reticulate, the cells broadly or narrowly rectangular, horizontal, in several longitudinal lines, the surface irregularly dotted with pale, dome-like or irregularly shaped warts.

Red, sandy-clay soils of pine or oak-pine savannas, lower elevations in both the Sierra Madre Oriental and Occidental of Mexico in the states of Guerrero, Jalisco, Michoacan, Oaxaca, Veracruz.

Type locality: Veracruz, Mexico ("ex hb. Schultzii Bip."). The identification of *F. pentastachya* has to be based upon the type description rendered by O. Boeckeler (1860) in that the actual specimen (or specimens) was de-

Type locality: Jamaica "In Jamaicae fluviis." Based on figure in Sloane, Hist. Jam. pl. 76.

In North America confined to the coastal marshes of the Caribbean Islands and Mexico. A common salt-marsh sedge along the Atlantic in both Central and South America.

I treat this species as distinct from *F. castanea* (Michx.) Vahl in that it usually has narrower spikelets in more diffuse inflorescence together with a more robust habit. Admittedly the two entities are quite similar in many respects and it is therefore a strong temptation to treat them as conspecific. However, my mind was changed as a result of a trip to Mexico via the gulf coast of Texas. The plants of the Texas coast are not much different than those of the coasts of the other Gulf and Atlantic states. In the state of Tamaulipas, Mexico, plants of vastly different appearance are to be seen along the coast in similar habitat to that occupied by *F. castanea* in the U. S. These are, on the average, much taller, with a more reddish quality to the living spikelets and with much narrower (often smaller) spikelets in much larger and more diffuse inflorescences. This sort of plant is continuous along the Atlantic coast of Mexico until one reaches the Yucatan peninsula, where (at the tip of Yucatan) stands of the "castanea" type again appear. Both types cohabit coastal areas of the Bahamas and of Cuba. I am faced with the sort of situation that is clear in the field, yet hard to demonstrate on the basis of herbarium specimens. As Svenson has stated, all the "spadicea" complex have very similar akenes (this complex includes taxa here treated as *F. caroliniana, F. puberula, F. castanea, F. inaguensis, F. thermalis* in addition to *F. spadicea*).

48. FIMBRISTYLIS CASTANEA (Michx.) Vahl, Enum. 2: 292. 1805.

Scirpus castaneus Michx., Fl. Bor.-Am. 1: 31. 1803.

Fimbristylis cylindricum Vahl, Enum. 2: 293. 1805.

Fimbristylis spadicea (L.) Vahl var. *castanea* (Michx.) A Gray, Man. ed. 5. 566. 1867.

Densely caespitose perennial to 1.5 (-2.0) m. tall, the bases of the plant castaneous, deep set in substratum, the outer leaves of a tuft and the older leaves persistent as imbricated scales. Leaves from 1/3 the length of the culms to nearly as long, the blades usually very narrowly linear (rarely to 2 or 3 mm. broad), ascending, thick (often semicircular in cross section), most frequently involute, smooth, particularly toward the base, the nerves on the back numerous and indistinct, but the marginal nerve or nerves ciliate scabrid with ascending, stout-based, hairs, sheathing portion of the leaf broad, (broadening gradually toward the base) a pale brown, dark brown or very deep lustrous reddish-brown, thick and rigid, the margin broad, thin or even scarious, entire save for the truncate or rounded, ciliate apex. Ligule of hairs either absent or incomplete, but a colour change evident on the upper surface of the leaf at the collar. Scapes slender, wand-like, as wide as the blades or somewhat wider, many-ribbed, terete toward the base of the plant, subterete, oval, or elliptical in the cross section upwardly. Longest bract of the involucre usually shorter than the inflorescence or about the length of the inflorescence (rarely longer), the blade somewhat flattened, ciliate-scabrid. Spikelets usually ovoid or lance-ovoid, very rarely cylindrical, 0.5-1.0 cm. long, rarely longer, the mature ones usually pale to dark brown, dull, in a dense to open ascending or spreading umbellate compound system of cymes. Fertile bracts broadly ovate, smooth, brown, usually dull, the margin entire or becoming erose with age, the apex rounded; veins of the mid-portion of the scale obscure, or visible as faint pale lines, these, converging apically to form a short mucro. Stamens 2 or 3, the anthers about 2 mm. long. Style 2-branched, flattened, fimbriate from the base to the point of branching. Akene lenticular-obovoid or obpyriform, 1.5-2.0 mm. long, reddish-brown or dark brown, often lustrous, scalariform-foveate or reticulate, the individual cells almost isodiametric or horizontally rectangular, usually arranged in numerous, fine, vertical rows.

Type locality: "Florida." (Herbarium Richard, at P).

Moist sands or muck of coastal marshes, duneswales, or estuary banks (rarely alkaline situations inland), Long Island south along the Atlantic coast into the Florida Keys, and along the Gulf Coast south and west into Mexico (Tamaulipas); Yucatan peninsula; the Bahamas; Cuba.

Fimbristylis castanea is invariably found in brackish marsh and, save in the state of Florida, seems never to be found far from the existing seacoast. Along the Atlantic coast in the southeastern and Gulf United States it may be found in proximity to two other perennial species, *F. caroliniana* and *F. puberula*. It may be distinguished from both by being caespitose rather than rhizomatous (*F. caroliniana* produces slender rhizomes while *F. puberula* produces thick, knotty rhizomes or more rarely slender rhizomes in addition). It is also to be distinguished on the basis of habitat, being a true denizen of brackish marsh, while *F. caroliniana* is usually in drier or less alkaline situations and F. puberula in turn frequents more acid habitats inland. Occasionally, where there has been much mechanical disturbance of coastal areas where the habitats of all three are contiguous, one may find all three growing together on the freshly disturbed surface.

F. castanea and *F. spadicea* overlap in the Bahamas, Cuba and parts of Mexico. However, as fine as the differences are which (in my opinion) distinguish the two, these differences appear to hold (see discussion under *F. spadicea*).

49A. FIMBRISTYLIS PUBERULA (Michx.) Vahl var. PUBERULA, Enum. 2: 292. 1805.

Scirpus puberulus Michx., Fl. Bor. Am. 1: 31. 1803.

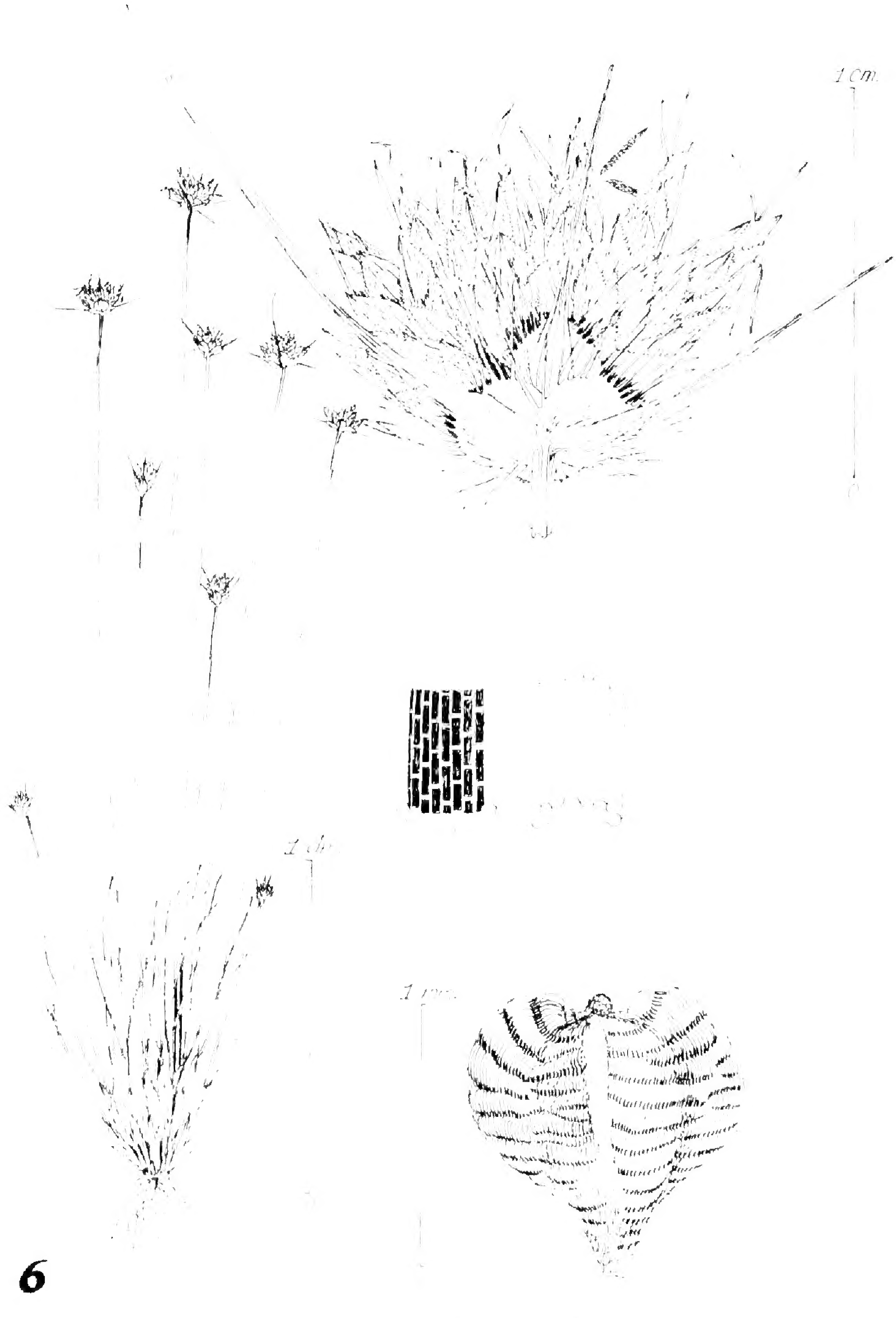
Isolepis drummondii Torr. & Hook.: Torr., Ann. Lyc. N. Y. 3: 350. 1836.

Fimbristylis drummondii (Torr. & Hook) Boeck., Flora 41: 603. 1836.

Fimbristylis anomala Boeck., Flora 43: 242. 1860.

Fimbristylis multistriata Boeck., Flora 43: 1860.

Fimbristylis spadicea (L.) Vahl var. *puberula* (Michx.) Chapm., Fl. S. US. 522. 1860.



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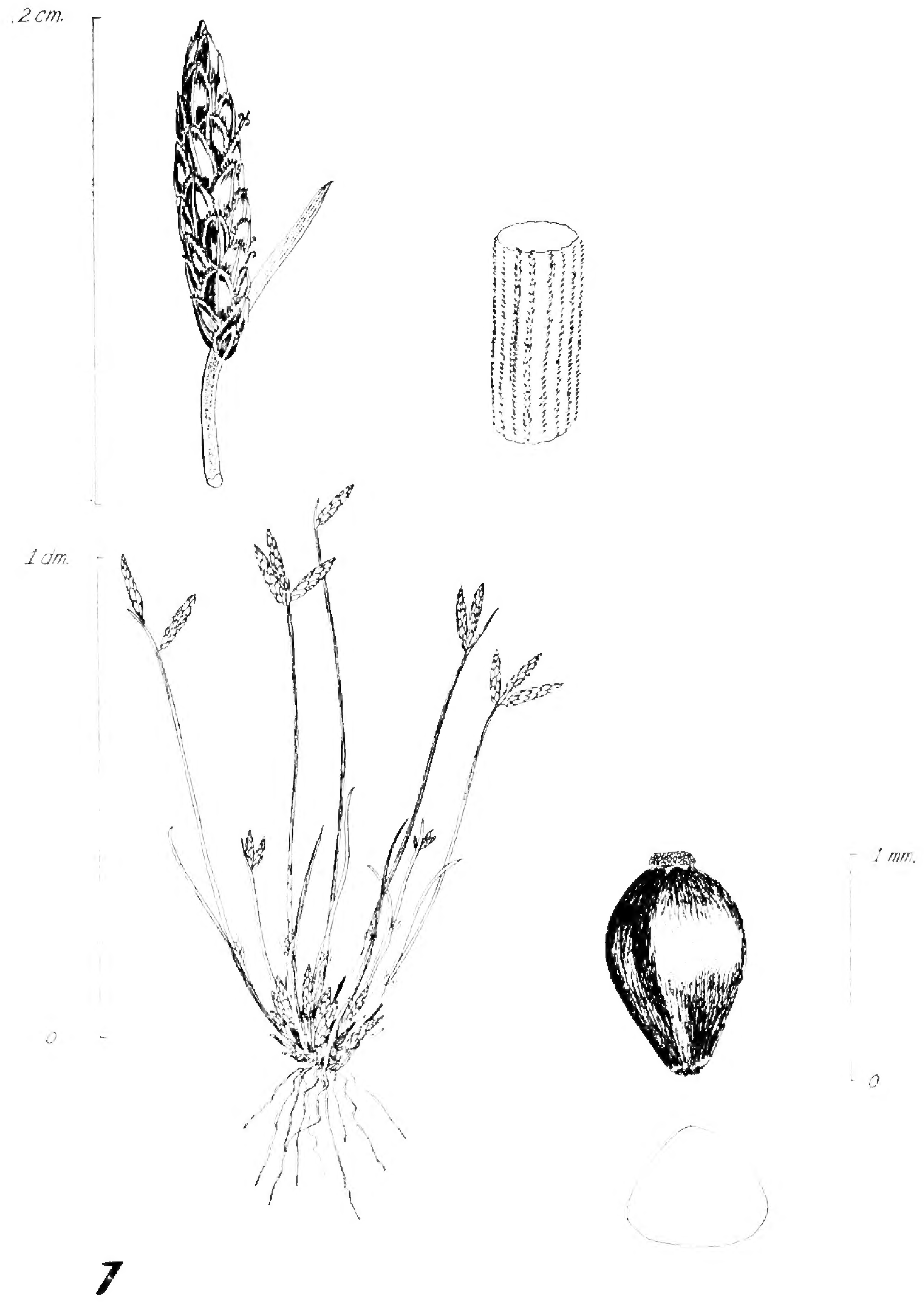
6. BULBOSTYLIS WAREI



7. BULBOSTYLIS FLOCCOSA

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CONTENTS

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VASCULAR PLANTS OF GRAND TETON NATIONAL PARK, WYOMING REVISED 1968

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In January, 1958 the author published the first annotated checklist of vascular plants of Grand Teton National Park listing 605 species. In the intervening ten years many Park Service practices and policies have changed. The Park Service in cooperation with Montana State University has initiated several ecological studies on vegetation within the park boundaries. Such research projects indicate that the Park Service is now appreciating fully that vegetation is a living, dynamic complex and cannot be preserved as an archeological site can be preserved. Stone (1965) pointed out that even the most uniform vegetation is a mosaic created by local variations in the environment and by prior events as fire, drought and insect infestation. In view of new wildlife management practices and ever expanding human use within the park, a new look at existing vascular plants species is now necessary. This new annotation list is based upon the collecting efforts of many researchers reaching many areas of the park which had been poorly understood before. Since 1958 a concerted effort has been made by the writer to particularly collect specimens in the isolated subalpine and alpine regions of the Teton Range.

An addendum list to the first checklist is not given because so many nomenclatural changes have been made, and it was felt that annotations regarding many species needed amplification. The reader is referred to Shaw (1958) and Oswald (1966) for data concerning the topography and climate. New concepts on the park's plant communities are emerging from the studies of Laing (1961), Merkle (1962, 1963) and Oswald (1966), and therefore the writer has not attempted to revise his previous analysis of the vegetative types of the park.

ACKNOWLEDGMENTS

I offer my sincere thanks to the Grand Teton Natural History Association for financial support in publishing this catalogue of plants, and particularly to Chief Naturalist, Willard E. Dilley, whose interest and photography have made completion of the project possible.

Gerrit Davidse, James L. Reveal and Noel H. Holmgren have kindly checked some or all of my material respectively of the *Viola, Eriogonum* and *Castilleja* for which I am most grateful.

The curator of the Intermountain Herbarium, Professor Arthur H. Holmgren, has given invaluable assistance and constructive criticism

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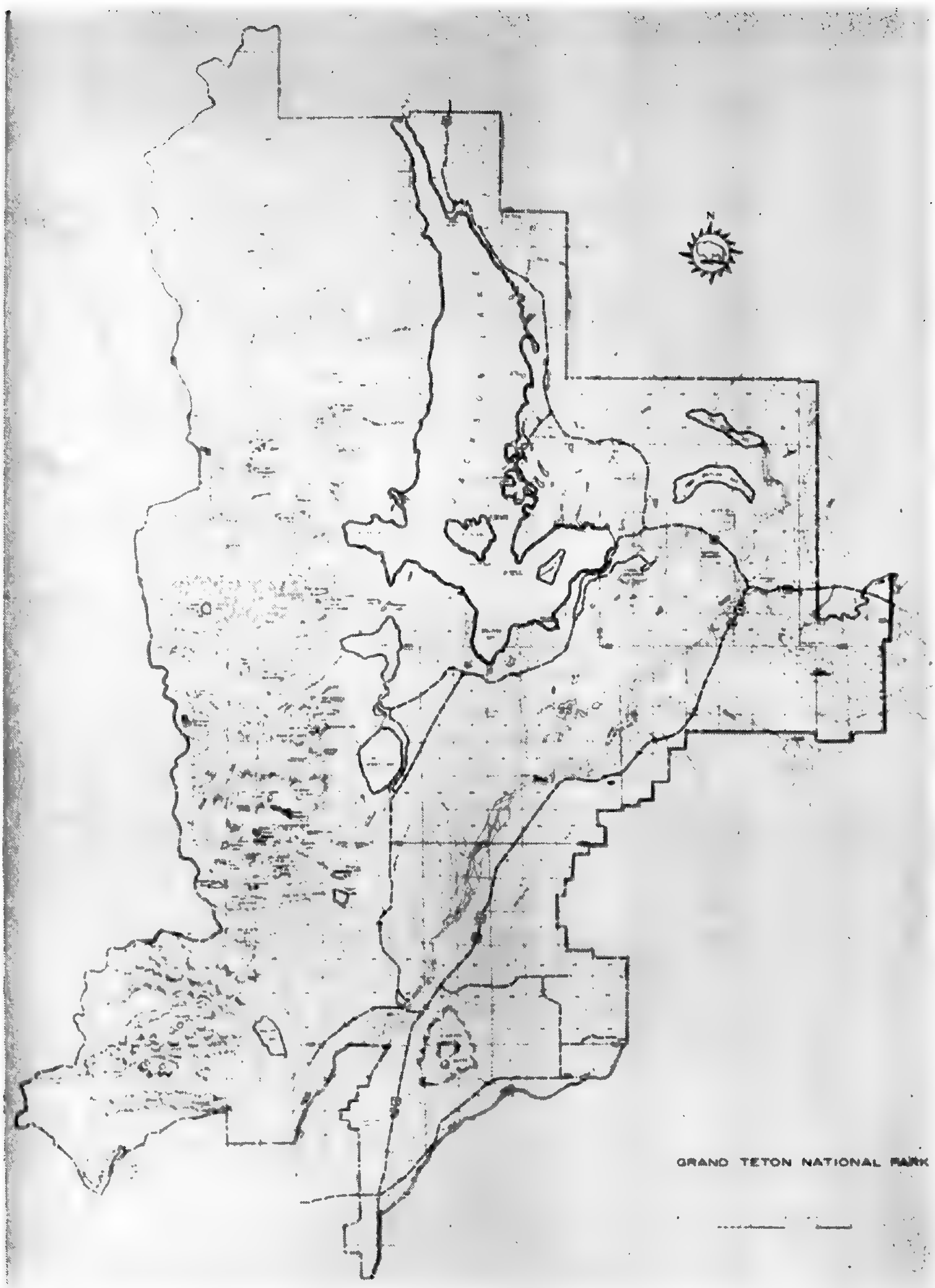

throughout the duration of the study. I also give thanks to my wife, Marion A. Shaw, and Mrs. Kay B. Gamble for proofreading and typing the manuscript.

Valley and Teton Range of Grand Teton National Park, showing sage-brush and two limber pines.

EXPLANATIONS AND ARRANGEMENT OF THE FLORA

The following list includes all the species, subspecies and varieties of vascular plants of which I have seen specimens, or in a few instances those species seen by reliable observers. In most cases an attempt has been made to include the abundance of each species and its usual habitat. Rare, infrequent, frequent, common, and abundant are the relative terms used.

Families are arranged alphabetically within subdivisions, classes or subclasses. A similar arrangement is followed for genera within families and species within genera. Naturalized species are preceded by an asterisk.

The synonomy is not complete, and includes only those synonyms which are most apt to be used in recent taxonomic references. Common names are given only after the first species in a genus or only if it is genuine or does not repeat the generic name. In the majority of citations one or two collector's initials and numbers are given. The following abbreviations apply:

LCA—Loren C. Anderson
AAB—Alan A. Beetle
WED—Willard E. Dilley
JBF—J. B. French
BH—Bryan Harry
JM—John Merkle
ETO—Edward T. Oswald
FWP—Frank W. Pierson
RJS—Richard J. Shaw
WGS—William G. Solheim
HVT—Harry V. Truman

The nomenclature and taxonomy follow Hitchcock et al. (see Literature Cited and Consulted), with supplementation from Holmgren and Reveal (1966). Common names are taken from Holmgren and Reveal.

ANNOTATED LIST

SPHENOPSIDA

EQUISETACEAE

EQUISETUM ARVENSE L. Horsetail. Locally common in wet areas along the trail on the west side of Jenny Lake. RJS 931, JFR 891.

EQUISETUM HYEMALE L. Infrequent in the Wildlife Range. JFR 2905.

EQUISETUM LAEVIGATUM A. Br. [*E. kansanum* Schaffn.] Common in the sedge meadow of the Wildlife Range. RJS 950, JFR 1404.

EQUISETUM VARIEGATUM Schleich. Infrequent in the Wildlife Range. JFR 2206.

LYCOPSIDA

ISOETACEAE

ISOETES BOLANDERI Engelm. var. PYGMAEA (Engelm.) Clute. Quillwort. Rare in small pond east of Colter Bay Maintenance Area. RJS 1488.

LYCOPODIACEAE

LYCOPODIUM ANNOTINUM L. Club Moss. Rare on the west sides of Jenny and Leigh Lakes. RJS 879, 886.

SELAGINELLACEAE

SELAGINELLA DENSA Rydb. Spikemoss. Common in the sagebrush flats and in some major canyons up to 9,700 ft. LW 1395, RJS 1492.

PTEROPSIDA

FILICES

MARSILEACEAE

MARSILEA MUCRONATA A. Br. [*M. oligospora* Goodding, *M. vestita* Hook. and Grev.] Pepperwort. Locally frequent in small ponds of the valley floor. RJS 1020, 1258.

OPHIOGLOSSACEAE

BOTRYCHIUM COULTERI Underw. Grapefern. Rare near outlet of Jenny Lake. LW 1695.

POLYPODIACEAE

ADIANTUM PEDATUM L. Maidenhair. Frequent along stream on south facing slope two miles up Waterfall Canyon. RJS 1000.

ATHYRIUM ALPESTRE (Hoope) Rylands var. AMERICANUM Butters. Ladyfern. Frequent by small streams in the North Fork Cascade Canyon. RJS 1571.

ATHYRIUM FILIX-FEMINA (L.) Roth. Frequent along streams draining into the valley lakes, also up to 7,500 ft. in the major canyons. RJS 1003, ETO 1323.

CHEILANTHES SILIQUOSA Maxon. Lipfern. Frequent in rocks on the south facing slope of Waterfall Canyon. 7,500 ft. RJS 1001.

CRYPTOGRAMMA ACROSTICHOIDES R. Br. Rockbrake. Frequent in the lower portions of the major canyons, including Avalanche and Cascade Canyons. RJS 939, 1490.

CYSTOPTERIS FRAGILIS (L.) Bernh. Brittle Bladderfern. Infrequent in rock crevices in Cascade Canyon and the slopes of Symmetry Spire. RJS 973, JFR 3001.

DRYOPTERIS DISJUNCTA (Ledeb.) Morton. Woodfern. Frequent in wet areas at the mouths of the major canyons. RJS 1002, 1430.

POLYSTICHUM LONCHITIS (L.) Roth. Hollyfern. Frequent in rocks in major canyons and couloirs up to 9,000 ft. RJS 966, 1574, LW 1752.

PTERIDIUM AQUILINUM (L.) Kuhn var. PUBESCENS. Underw. Bracken. Frequent on talus slopes of the major canyons up to about 8,000 ft., including Waterfall Canyon. RJS 999, LW 1323.

WOODSIA SCOPULINA D. C. Eaton. Frequent in talus slopes up to 8,000 ft., major canyons. RJS 551, JFR 2998.

GYMNOSPERMAE

CUPRESSACEAE

JUNIPERUS COMMUNIS L. var. SAXATILIS Pall. Mountain Juniper. Frequent on the east shore of String Lake, mouth of Cascade Canyon, and Wildlife Range. RJS 1345.

JUNIPERUS SCOPULORUM Sarg. Common on Blacktail Butte and in the Gros Ventre river bottoms. WED.

PINACEAE

ABIES LASIOCARPA (Hook.) Nutt. Subalpine Fir. Abundant on moraines and mountains up to timberline. RJS.

PICEA ENGELMANNII Parry. Engelmann Spruce. Common on the west shores of the valley lakes and throughout the canyons up to about 8,500 ft. RJS.

PICEA PUNGENS Engelm. Abundant along Snake River. RJS.

PINUS ALBICAULIS Engelm. Whitebark Pine. Common in the canyons above 8,000 ft. RJS.

PINUS CONTORTA Dougl. Abundant throughout the valley, in pot holes and on moraines. RJS 881 (see *Arceuthobium*, *Loranthaceae*).

PINUS FLEXILIS James. Frequent on the moraines. RJS.

PESUDOTSUGA MENZIESII (Mirb.) Franco. Douglas Fir. Common on the moraines and in the canyons below 8,500 ft. RJS.

ANGIOSPERMAE

DICOTYLEDONEAE

ACERACEAE

ACER GLABRUM Torr. Rocky Mt. Maple. Infrequent on west shore of Jenny Lake, also on slopes between Laurel and String Lakes. LW 1344.

ANACARDIACEAE

RHUS RADICANS L. [*R. toxicodendron* of American authors. *Toxicodendron radicans* (L.) Kuntze] Poison Ivy. Locally frequent in rocky outcropping 150 yds. south of Hotspring Area, west side of Jackson Lake. RJS 1340.

APOCYNACEAE

APOCYNUM ANDROSAEMIFOLIUM L. Dogbane. Frequent around the shores of the valley lakes. RJS 663, LW 1679.

BERBERIDACEAE

BERBERIS REPENS Lindl. [*Mahonia repens* G. Don] Creeping Barberry. Frequent around the shores of the valley lakes. LW 1692.

BETULACEAE

ALNUS TENUIFOLIA Nutt. Thinleaf Alder. Frequent around shores of the valley lakes and along the Snake River. RJS 621, JFR 2205.

BETULA GLANDULOSA Michx. Birch. Infrequent in meadows of the valley and some canyons. RJS 737, JFR 2547.

BETULA OCCIDENTALIS Hook. Rare on south end of Blacktail Butte, about 6,600 ft. RJS 1448.

BORAGINACEAE

CRYPTANTHA AFFINIS (A. Gray) Greene. Common in waste places throughout the valley. LW 1201, JFR 1640a.

CRYPTANTHA TORREYANA (A. Gray) Greene. Dry flats, Double Diamond Ranch. LW 1616.

CRYPTANTHA WATSONII (A. Gray) Greene. Frequent in disturbed sites at Colter Bay Village. RJS 1558.

*CYNOGLOSSUM OFFICINALE L. Hound's Tongue. Infrequent south end of Jenny Lake road. RJS.

ERITRICHIUM NANUM (Vill.) Schrad. var. ELONGATUM (Rydb.) Cronq. Locally frequent above 10,000 ft. on such peaks as Grand Teton, Middle Teton, and Disappointment. RJS 748, 861.

HACKELIA DIFFUSA (Lehm.) I. M. Johnst. Stickseed. Frequent in aspen groves of the Wildlife Range. JFR.

HACKELIA FLORIBUNDA (Lehm.) I. M. Johnst. Common in waste places. JFR 1635.

HACKELIA JESSICAE (McGreg.) Brand. Frequent along the Snake River. RJS 507.

HACKELIA PATENS (Nutt.) I. M. Johnst. Common on roadside cuts near Park Headquarters and Bradley Lake moraine. RJS 506, LW 765.

LAPPULA REDOWSKII (Hornem.) Greene. Stickseed. Disturbed areas along Snake River. ETO 1116.

LITHOSPERMUM RUDERALE Dougl. Gromwell. Frequent along Snake River extending out into the sagebrush flats. RJS.

MERTENSIA CILIATA (James) G. Don. Bluebell. Common in moist places in the major canyons up to 9,000 ft. RJS 1016.

MERTENSIA OBLONGIFOLIA (Nutt.) G. Don. Common in the sagebrush flats throughout the valley. WED.

MYOSOTIS LAXA Lehm. Forget-Me-Not. Locally frequent, cobblestone river bottom south of Park Hdqts. RJS 1525.

MYOSOTIS SYLVATICA Hoffm. var. ALPESTRIS (F. W. Schmidt) Koch. Infrequent in rocky soil, Skyline Trail. LCA 159.

PLAGIOBOTHRYS SCOULERI (Hook. & Arn.) Johnst. var. PENICILLATUS (Greene) Cronq. [*P. cognatus* I. M. Johnst. *P. cusicki* Greene] Popcorn Flower. Locally frequent in pond east of Colter Bay Fire Cache. RJS 919, 1516, LW 1628.

CACTACEAE

OPUNTIA FRAGILIS (Nutt.) Haw. Brittle Prickly-pear. Frequent on banks of Snake River in area of Deadman's Bar. RJS 880.

CALLITRICHACEAE

CALLITRICHE VERNA L. [*C. palustris* of American authors, not L.] Waterstarwort. Common on pools and adjacent mud of the Wildlife Range. JFR 1513.

CAMPANULACEAE

CAMPANULA ROTUNDIFOLIA L. Bluebell. Common along roadsides throughout the valley, also in coniferous forests. RJS 984.

PORTERELLA CARNOSULA (Hook. & Arn.) Torr. Locally frequent in shallow water at the margin of ponds, from Signal Mt. north. RJS 870, 1498.

CAPRIFOLIACEAE

LINNAEA BOREALIS L. ssp. LONGIFLORA (Torr.) Hulten. Twinflower. Locally frequent in shade of lodgepole pine forest; ¼ mile south of Signal Mt. Campground, 6,800 ft. RJS 722, 1510.

LONICERA INVOLUCRATA (Rich.) Banks. Bearberry Honeysuckle. Frequent around the shores of the valley lakes. RJS 629.

LONICERA UTAHENSIS S. Wats. Common in the coniferous forest of the valley and canyons. RJS 1200.

SAMBUCUS RACEMOSA L. ssp. PUBENS (Michx.) House var. MELANOCARPA (A. Gray) McMinn. [*S. melanocarpa* A. Gray] Elderberry. Frequent around the shores of the valley lakes and along the Snake River. JFR, RJS 987.

SAMBUCUS RACEMOSA L. ssp. PUBENS (Michx.) House var. MICROBOTRYS (Rydb.) Kearney & Peebles. [*S. microbotrys* Rydb.] Frequent 2 miles up Indian Paintbrush Canyon, also Death Canyon.

SYMPHORICARPOS ALBUS (L.) Blake var. LAEVIGATUS (Fern.) Blake. [*S. rivularis* Suksd.] Snowberry. Frequent in sagebrush flats and moraines of the valley. JFR.

SYMPHORICARPOS OCCIDENTALIS Hook. Frequent in moist aspen groves of the Wildlife Range. JFR 3013.

SYMPHORICARPOS OREOPHILUS A. Gray var. UTAHENSIS (Rydb.) A. Nels. [*S. vaccinioides* Rydb., *S. tetonensis* A. Nels., *S. rotundifolius*, A. Gray.] Frequent in sagebrush flats and moraines of the valley. RJS 530, ETO 1189.

CARYOPHYLLACEAE

*AGROSTEMMA GITHAGO L. Corn-Cockle. Rare in disturbance sites Willow Flats Overlook. RJS 1495.

ARENARIA CONGESTA Nutt. Sandwort. Common in the sagebrush flats and moraines of the valley; also at Timberline Lake. LW 1200, RJS 1583.

ARENARIA LATERIFLORA L. Infrequent in moist shaded areas of the valley. WGS 3925, RJS 1188.

ARENARIA NUTTALLII Pax. Rare on very top of divide between South Cascade and Alaska Basin, 10,000 ft. RJS 1012.

ARENARIA OBTUSILOBA (Rydb.) Fern. [*A. sajanensis* Schlecht.] Frequent above timberline on major peaks. RJS 1586, LCA 216.

CERASTIUM ARVENSE L. Mouse-Ear Chickweed. Frequent near Sawmill Ponds on the Wilson Road, also Snake River bottom. LW 1116, RJS 1190.

LYCHNIS ALBA Mill. Campion. Waste areas Biological Station. ETO 1166.

SAGINA SAGINOIDES (L.) Karst. Pearlwort. Common in streambeds and waste places in Pacific Creek area. LW 1734.

SILENE ACAULIS L. Moss Silene. Frequent in rocks around alpine lakes, up to 10,000 ft. RJS 679.

SILENE MENZIESII Hook. ssp. MENZIESII. Infrequent in moist shaded areas of the valley. RJS 645, 1410.

*SILENE NOCTIFLORA L. Rare, horse concession on Cottonwood Creek. RJS 692.

SILENE PARRYI (S. Wats.) C. L. Hitchc. & Maguire. Infrequent in canyons above 9,500 ft. RJS 687, LW 1699.

SPERGULARIA RUBRA (L.) J. & C. Presl. Sandspurry. Common in the open areas of the sagebrush flats. JFR 1938, RJS 501.

STELLARIA CALYCANTHA (Ledeb.) Bong. Starwort. Major canyons of the range. JFR 3003.

STELLARIA LONGIFOLIA Muhl. Frequent in the shrub-swamp of the Wildlife Range. JFR.

STELLARIA LONGIPES Goldie. Common in the meadows of the Wildlife Range. JFR 1835, ETO 1171.

CELASTRACEAE

PACHISTIMA MYRSINITES (Pursh) Raf. Mountain Lover. Common on moraines and shores of the valley lakes and extending up to 9,000 ft. in mts. RJS 1562, LW 1134.

CERATOPHYLLACEAE

CERATOPHYLLUM DEMERSUM L. Hornwort. Frequent near the outlet of Two Ocean Lake, also Swan Lake. WGS 4500, RJS 710½.

CHENOPODIACEAE

*CHENOPODIUM ALBUM L. Lambsquarter. Locally common in waste places. JFR 1656.

*CHENOPODIUM ATROVIRENS Rydb. Disturbed roadside near Jackson Lake Dam. JFR 2649.

*CHENOPODIUM CAPITATUM (L.) Asch. Locally common in waste places. JFR 2197.

*KOCHIA SCOPARIA (L.) Schrad. Summer Cypress. Common in waste places of the valley. JFR.

*MONOLEPIS NUTTALLIANA (Schult.) Greene. Poverty Weed. Common in waste places of the valley. RJS 1552, JFR 2198.

*SALSOLA KALI L. var. TENUIFOLIA Tausch. Russian Thistle. Common in waste places of the valley. JFR 2514.

COMPOSITAE

ACHILLEA MILLEFOLIUM L. ssp. LANULOSA (Nutt.) Piper. Yarrow. Abundant throughout the valley and lower portions of the major canyons. RJS.

ACHILLEA MILLEFOLIUM L. ssp. LANULOSA (Nutt.) Piper var. ALPICOLA (Rydb.) Garrett. Infrequent in tundra above 10,000 ft. RJS 877, 1591.

AGOSERIS AURANTIACA (Hook.) Greene var. AURANTIACA. False Dandelion. Frequent up to 9,000 ft., in the major canyons. RJS 976.

AGOSERIS AURANTIACA (Hook.) Greene var. PURPUREA (A. Gray) Cronq. Frequent on first terrace above Pacific Creek and north slope of Signal Mt. JFR 936, WGS 4083.

AGOSERIS GLAUCA (Pursh) Raf. var. GLAUCA. Frequent, morainal soil; Colter Bay Apartment Area. RJS 1451.

AGOSERIS GLAUCA (Pursh) Raf. var. LACINIATA (D. C. Eaton) Smiley. Frequent in the meadows of the Wildlife Range. JFR 2181.

ANAPHALIS MARGARITACEA (L.) Benth. & Hook. Pearl Everlasting. Frequent ¼ mile above main bridge, Indian Paintbrush Canyon, 8,400 ft. RJS 878.

ANTENNARIA ALPINA (L.) Gaertn. var. MEDIA (Greene) Jeps. Pussytoes. Amphitheater Lake. JM 62-68.

ANTENNARIA APRICA Greene. Frequent in Cascade Canyon, also at the Wildlife Range. LW 1225, JFR 2146.

ANTENNARIA ARIDA E. Nels. Common in the sagebrush flats near Moose. LW 1639, JFR 2169.

ANTENNARIA CORYMBOSA E. Nels. Common in the sagebrush flats west of Moose. JFR 2227.

ANTENNARIA DIMORPHA (Nutt.) Torr. & Gray. Infrequent in sagebrush flats of the valley. JFR 1877.

ANTENNARIA LUZULOIDES Torr. & Gray. Frequent on rocky flats of valley and slopes of the Teton Range. JFR 2115, LW 744, 1220, RJS 1519.

ANTENNARIA PARVIFOLIA Nutt. Common on dry terraces of the Pacific Creek area. JFR 961.

ANTENNARIA RACEMOSA Hook. Common on the north exposure of Signal Mt. and major canyons. JFR 2750, RJS 1560.

ANTENNARIA ROSEA (Eat.) Greene. Common in sagebrush flats and moraines of the valley. RJS 533, JFR 1021.

ANTENNARIA UMBRINELLA Rydb. Frequent near outlet of Schoolroom Glacier Lake, 10,000 ft. RJS 1028.

ARNICA CHAMISSONIS Less. ssp. FOLIOSA (Nutt.) Maguire. Locally common in moist places in timber, Snake River bottoms. LW 1332.

ARNICA CORDIFOLIA Hook. Common in the coniferous forests of the valley. JFR 1921.

ARNICA LATIFOLIA Bong. Frequent in the major canyons, 7,000 to 8,000 ft. LW 1667.

ARNICA LONGIFOLIA D. C. Eaton ssp. LONGIFOLIA. Locally common in canyons and couloirs from 7,500 ft. to 10,000 ft. RJS 969, LW 1404.

ARNICA MOLLIS Hook. var. MOLLIS. Frequent in bog west of Taggart Lake. LW 1191.

ARNICA PARRYI A. Gray. Frequent in Moose Ponds west of Moose. WGS 3905.

*ARTEMISIA ABROTANUM L. Sagebrush. Remaining from previous cultivation. JFR 2533.

ARTEMISIA ARBUSCULA Nutt. Locally common on valley floor north of Park Hdqts. JFR 1380, 2215.

ARTEMISIA CANA Pursh: ssp. CANA var. VISCIDULA Osterh. Locally common along the Snake River. RJS 982, JFR 1131.

ARTEMISIA DRACUNCULUS L. [*A dracunculoides* Pursh] Infrequent in waste places of the valley. JFR 2763.

ARTEMISIA FRIGIDA Willd. Gravelly ridges above Triangle X Ranch. AAB 14731.

ARTEMISIA LUDOVICIANA Nutt. ssp. CANDICANS (Rydb.) Keck. Frequent along the Snake River. RJS 954, JFR 3061.

ARTEMISIA LUDOVICIANA Nutt. ssp. LUDOVICIANA var. LATILO-

BA Nutt. Frequent in Wildlife Range and Death Canyon. RJS 982, ETO 1344.

ARTEMISIA NORVEGICA Fries ssp. SAXATALIS (Besser) Hall & Clements. Frequent on east slope of Static Peak south of Timberline Lake 10,200 ft. RJS 1579.

ARTEMISIA TRIDENTATA Nutt. Abundant throughout the valley. JFR 948.

ASTER ALPIGENUS (Torr. & Gray) A. Gray var. HAYDENII (Porter) Cronq. Frequent on the shores of alpine lakes and on some mountain summits. RJS 990, 1508, LCA 529.

ASTER CAMPESTRIS Nutt. Common along Snake River. LW 1638, JFR 1452.

ASTER CANESCENS Pursh. Common in sagebrush flats of the valley. JFR 1369, RJS 1256.

ASTER CHILENSIS Nees ssp. ADSCENDENS (Lindl.) Cronq. Common on dry terraces above Pacific Creek. JFR 950.

ASTER CONSPICUUS Lindl. Common on the north side of Signal Mt. JFR 2737.

ASTER ENGELMANNII (D.C. Eaton) A. Gray. Frequent around the shores of the valley lakes and in the major canyons up to 9,000 ft. RJS 1010, LW 921.

ASTER FOLIACEUS Lindl. var. APRICUS A. Gray. Infrequent in the lodgepole pine forest of the valley. JFR 1054.

ASTER FOLIACEUS Lindl. var. PARRYI (D.C. Eaton) A. Gray. Common in the pothole area of the valley. JFR 1550.

ASTER HESPERIUS A. Gray var. LAETEVIRENS (Greene) Cronq. [*A. coerulescens* DC. var. *l.* Cronq.] Common in the sedge grass meadow of the Wildlife Range. JFR 887.

ASTER INTEGRIFOLIUS Nutt. Common throughout the valley floor, also collected in the Lake Solitude area. LW 1707, JFR 2667.

ASTER OCCIDENTALS (Nutt.) Torr. & Gray var. OCCIDENTALIS. Common in the streamside forest. JFR 883.

ASTER PERELEGANS Nels. & Macbr. Frequent in outwash plain and extending up the mountains. LW 899.

BALSAMORHIZA MACROPHYLLA Nutt. Balsamroot. Rare, ½ mile north of Menor's Ferry. WED 2868.

BALSAMORHIZA SAGITTATA (Pursh) Nutt. Abundant in sagebrush flats and on moraines of the valley. JFR 2879.

BIDENS CERNUA L. Beggar-tick. Common along west shore of upper Sawmill Pond, one mile south of Moose. RJS 759.

BRICKELLIA GRANDIFLORA (Hook.) Nutt. Frequent on the lower portions of the canyon trails. RJS 676.

*CARDUUS NUTANS L. Bristlethistle. Gros Ventre road near east park boundary. WED 64-6.

CHAENACTIS ALPINA (Gray) M. E. Jones. Infrequent on Skyline Trail above 9,000 ft. and Garnet Canyon. RJS 548, 1480.

CHAENACTIS DOUGLASII (Hook.) H. & A. Frequent along Snake River Bottom. LW 1150, JFR 2694.

*CHRYSANTHEMUM LEUCANTHEMUM L. Infrequent Beaver Creek residential area. WED 2824.

CHRYSOPSIS VILLOSA (Hook.) Nutt. Golden Aster. Infrequent in the loose gravel of the Snake River and Pilgrim Creek. RJS 1409, LW 1315, JFR 2526.

CHRYSOTHAMNUS NAUSEOSUS (Pall.) Britt. Rabbitbrush. Abundant on the east side of the Snake River. JFR 2658, RJS 1347.

*CIRSIUM ARVENSE (L.) Scop. Thistle. Common in waste places. JFR 1653.

CIRSIUM EATONI (A. Gray) Robinson. Frequent in the talus slope of the major canyons. RJS 997, JM 63-72.

CIRSIUM FOLIOSUM (Hook.) DC. [*C. drummondii* T. & G.] Common in wet meadows throughout the valley. JFR 1330.

*CIRSIUM VULGARE (Savi) Tenore. Infrequent in Moose residential area. WED 2952.

*CONYZA CANADENSIS (L.) Cronq. Infrequent in waste places. JFR 2538.

CREPIS ACUMINATA Nutt. Hawk's Beard. Infrequent in streambeds and under lodgepole pine. JFR 2245, LW 1240.

CREPIS ATRIBARBA Heller. North slope of Signal Mt. WGS 4084.

CREPIS MODOCENSIS Greene. Frequent in sagebrush, Sawmill Ponds area. RJS 620, 833.

*CREPIS TECTORUM L. Frequent along Snake River. JFR 2525.

ERIGERON COMPOSITUS Pursh. Daisy; Fleabane. Rocky alpine meadow, South Cascade Canyon, 10,300 ft. and Amphitheater Lake. JBF 40, JM 62-108.

ERIGERON DIVERGENS Torr. & Gray. Common in the sagebrush flats and the Snake River bottom. LW 1630, ETO 1315.

ERIGERON EATONII A. Gray. Frequent in rocks near Hidden Falls. LW 1104.

ERIGERON GLABELLUS Nutt. Frequent along the Snake River. JFR 884.

ERIGERON LEIOMERUS A. Gray. Infrequent in sub-alpine and alpine meadows above 9,000 ft. LW 912, LCA 533.

ERIGERON LONCHOPHYLLUS Hook. Infrequent along streams north of Jackson Lake Dam. RJS 951.

ERIGERON OCHROLEUCUS Nutt. Frequent in the sagebrush areas of the Wildlife Range. JFR.

ERIGERON PEREGRINUS (Pursh) Greene ssp. CALLIANTHEMUS (Greene) Cronq. Frequent on the shores of sub-alpine lakes above 9,000 ft. RJS 992, LW 1348.

ERIGERON PUMILUS Nutt. ssp. INTERMEDIUS Cronq. Common in the sagebrush flats throughout the valley. RJS 908.

ERIGERON SPECIOSUS (Lindl.) DC. var. MACRANTHUS (Nutt). Cronq. Common in sagebrush flats and along the Snake River. LW 1661, 1331.

ERIOPHYLLUM LANATUM (Pursh) Forbes var. INTEGRIFOLIUM (Hook.) Smiley. Common in the sagebrush flats and on the moraines of the valley. RJS 532.

GNAPHALIUM MICROCEPHALUM Nutt. Cudweed; Everlasting Rare, north facing slope, one mile below Hanging Lake in Snowshoe Canyon. RJS 1422.

GNAPHALIUM PALUSTRE Nutt. Common along Snake River. LW 1401, JFR 874.

*GRINDELIA SQUARROSA (Pursh) Dunal. Gumweed. Common in waste places. JFR 2531.

HAPLOPAPPUS ACAULIS (Nutt.) A. Gray. Goldenweed. Infrequent west side of Blacktail Butte. ETO 1141.

HAPLOPAPPUS SUFFRUTICOCUS (Nutt.) A. Gray. Infrequent two miles up Avalanche Canyon, also in Alaska Basin. RJS 688, 1352.

HELIANTHELLA QUINQUENERVIS (Hook.) A. Gray. Locally common on morainal soil on the east shore of Jenny Lake, also in Wildlife Range. RJS 948, JFR 2841.

HELIANTHELLA UNIFLORA (Nutt.) Torr. & Gray. Common on moraines of valley and extending into canyons. LW 1209.

*HELIANTHUS ANNUUS L. Sunflower. Frequent in waste places and on the road to Two Ocean Lake. WED 64-5.

HIERACIUM ALBIFLORUM Hook. Hawkweed. Frequent on trail west side of Jenny Lake. RJS 935, LW 847.

HIERACIUM CYNOGLOSSOIDES Arv. Infrequent on slopes of Symmetry Spire and in the lodgepole pine area of the Wildlife Range. RJS 971.

HIERACIUM GRACILE Hook. Frequent ¼ mile south and east of Timberline Lake. RJS 1582.

HIERACIUM SCOULERI Hook. Frequent in the sagebrush community, Wildlife Range. JFR 3018.

HYMENOXYS GRANDIFLORA (Torr. & Gray) Parker. Frequent along Skyline Trail above 9,500 ft. RJS 665, 1351, LCA 158.

*IVA XANTHIFOLIA Nutt. Sumpweed. Common in waste places. JFR 2648.

LACTUCA PULCHELLA (Pursh) DC. Lettuce. Infrequent along main highway just south of Timbered Island. RJS 873.

*LACTUCA SERRIOLA L. [*L. integrata* (Gren. & Codr.) A. Nels.] Frequent in streambeds and in waste places. JFR 2554.

*MADIA GLOMERATA Hook. Tarweed. Locally common in waste places throughout the valley. RJS 940, JFR 1280.

*MATRICARIA CHAMOMILLA L. Mayweed. Rare roadside cut near Taggart Creek and Teton Park Road. RJS 1441.

*MATRICARIA MATRICARIOIDES (Less.) Porter. Common in waste places throughout the valley. JFR 1279.

MICROSERIS NUTANS (Geyer) Schultz-Bip. Infrequent in Lupine Meadow south of Jenny Lake. RJS 623.

*RATIBIDA COLUMNIFERA (Nutt.) Woot. & Standl. Coneflower. Rare on roadside cut near Jackson Lake Ranger Station. WED 2823.

RUDBECKIA OCCIDENTALIS Nutt. Coneflower. Locally frequent in moist areas around streams and lakes. ETO 1212.

SENECIO CANUS Hook. Groundsel. Infrequent in rocks of tundra above 10,000 ft. RJS 1590, (1438-pubescent form).

SENECIO CRASSULUS A. Gray. Frequent in quaking aspen in area of Two Ocean Lake, also major canyons above 9,400 ft. LW 1647, RJS 1440.

SENECIO CYMBALARIOIDES Nutt. Frequent in the Wildlife Range. JFR 935.

SENECIO DIMORPHOPHYLLUS Greene var. PAYSONI T. M. Barkley. Frequent in main couloir on the east face of Symmetry Spire, 9,000 ft. LW 1027, RJS 965.

SENECIO HYDROPHILUS Nutt. Frequent in the meadows of the Wildlife Range and pond east of Colter Bay Fire Cache. RJS 1527.

SENECIO INTEGERRIMUS Nutt. Common in the sagebrush flats throughout the valley. JFR 1882.

SENECIO PAUPERCULUS Michx. var. THOMSONIENSIS (Greenm.) Boiv. Frequent on west side of valley. RJS 1402, 1216.

SENECIO SERRA Hook. Frequent on the dry bottoms of Cottonwood Creek. LW 1659.

SENECIO SPHAEROCEPHALUS Greene. Disturbed area in Willow Flats north of Jackson Lake Dam. ETO 1334.

SENECIO TRIANGULARIS Hook. Common along streams in Cascade Canyon. LW 1670, 1704.

SOLIDAGO CANADENSIS L. var. SALEBROSA (Piper) M. E. Jones. [*S. lepida DC.*] Goldenrod. Frequent in disturbed areas along Snake River east of Biological Station. JFR 1541.

SOLIDAGO MISSOURIENSIS Nutt. Frequent in the streamside forest of the Wildlife Range. JFR 2832.

SOLIDAGO MULTIRADIATA Ait. [*S. ciliosa* Greene.] Frequent along the Snake River and lower portions of the major canyons. LW 1645, RJS 531.

SOLIDAGA NANA Nutt. Dry hillside in Cascade Canyon. LW 1683.

SOLIDAGO SPATHULATA DC. Common in the meadows east and north of Jackson Lake Dam. JFR 1475.

STEPHANOMERIA TENUIFOLIA (Torr.) Hall. Wirelettuce. Frequent on wet sand and rocky bars of the Snake River. LW 1321.

*TANACETUM VULGARE L. Tansy. Frequent along Snake River below Jackson Lake Dam, remaining from previous cultivation. JFR 1654, RJS 1008.

*TARAXACUM OFFICINALE Weber. Dandelion. Abundant throughout the valley. JFR 2007.

TETRADYMIA CANESCENS DC. [*T. inermis* Nutt.] Horsebrush. Locally common in the sagebrush of the valley floor. JFR 2961.

*TRAGOPOGON DUBIUS Scop. Goatsbeard. Disturbance sites throughout the valley. RJS.

*TRAGOPOGON PORRIFOLIUS L. Frequent in waste places and sagebrush flats throughout the valley. JFR 1368.

VIGUIERA MULTIFLORA (Nutt.) Blake. var. MULTIFLORA. Goldeneye. Common along main highway north of Jackson Lake Lodge. RJS 740, 1600, LW 964.

WYETHIA AMPLEXICAULIS Nutt. Mulesears. Frequent along roadside, ¼ mile east of Moose on road to Elk, Wyo. RJS 832.

WYETHIA HELIANTHOIDES Nutt. Frequent in moist meadow, Highway 89, 4 miles north of Colter Bay. RJS 838.

CORNACEAE

CORNUS STOLONIFERA Michx. Redosier Dogwood. Frequent around the shores of the valley lakes, also at Park Hdqts. RJS 1201, JFR 2734.

CRASSULACEAE

SEDUM DEBILE S. Wats. Stonecrop. Frequent along the lower slopes of the range. WED.

SEDUM LANCEOLATUM Torrey. Common in outwash plain. RJS 1225.

SEDUM ROSEA (L.) Scop. ssp. INTEGRIFOLIUM (Raf.) Hult. Frequent in moist meadows and stream banks above 9,000 ft. RJS 1485, 1524.

SEDUM STENOPETALUM Pursh. Common in sagebrush flats. HEB 1896.

SEDUM RHODANTHUM. A. Gray. Frequent in Indian Paintbrush and Snowshoe Canyons above 8,000 ft. RJS 898, 1423.

CRUCIFERAE

ARABIS COBRENSIS M. E. Jones. Rock Cress. Pilgrim Creek. HVT 54171.

ARABIS DRUMMONDII A. Gray. Frequent on moraines and outwash plain of the valley. JFR 2134.

ARABIS GLABRA (L.) Bernh. Frequent in the Wildlife Range and Willow Flats. JFR 1324, ETO 1231.

ARABIS HIRSUTA Scop. Frequent in the meadows of the Wildlife Range. JFR 2137.

ARABIS HOLBOELLII Hornem. var. PENDULOCARPA (A. Nels.) Rollins. Common on the moraines and sagebrush flats. RJS 502, JFR 2176.

ARABIS HOLBOELLII Hornem. var. RETROFRACTA (Graham) Rydb. Disturbance area in Wildlife Range. JFR 1643.

ARABIS LYALLII S. Wats. Frequent in meadows of subalpine lakes above 9,000 ft. JM 63-38, RJS 1593.

ARABIS NUTTALLII Robinson. Frequent in the meadows of the Wildlife Range. JFR 1998.

BARBAREA ORTHOCERAS Ledeb. var. ORTHOCERAS [*B. americana* Rydb.] Wintercress. Infrequent in the Wildlife Range. JFR 2318.

*CAPSELLA BURSA-PASTORIS (L.) Medic. Shepherd's Purse. Common in waste places throughout the park. JFR 1278.

CARDAMINE BREWERI S. Wats. Bittercress. Frequent in the Wildlife Range. JFR 2862.

CARDAMINE OLIGOSPERMA S. Wats. Wildlife Range. ETO 1169.

*CHORISPORA TENELLA (Pall.) DC. West side of highway north of Kelly Road Junction. WED 2825.

DESCURANIA CALIFORNICA (A. Gray) O. E. Schulz. Tansymustard. Teton Glacier Trail. HVT 54367.

*DESCURANIA PINNATA (Walt.) Britt. Frequent in waste places throughout the park. JFR 2155.

DESCURANIA RICHARDSONII (Sweet) O. E. Schulz. Biological Station and Death Canyon. HEB 1878, ETO 1269.

*DESCURANIA SOPHIA (L.) Webb. Frequent in waste places. JFR 1658.

DRABA APICULATA C. L. Hitchc. Rare, east shore of Timberline Lake, 10,400 ft. RJS 1594.

DRABA CRASSA Rydb. Frequent below summit of Middle Teton, 12,300 ft. RJS 1482.

DRABA CRASSIFOLIA Graham. Amphitheater Cirque. JM 62-16.

DRABA LONCHOCARPA Rydb. [*D. nivalis* Lilj. var. *elongata* S. Wats.] Infrequent on talus slopes and rock crevices above 9,000 ft. LW 1018A.

DRABA NEMOROSA L. South side Burnt Ridge. ETO 1050, WED 64-2.

DRABA OLIGOSPERMA Hook. Frequent on rocky slopes and exposed ridges above 10,000 ft. LCA 135, LW 1311.

DRABA STENOLOBA Ledeb. var. NANA (O. E. Schulz) C. L. Hitchc. Common in the Wildlife Range. JFR 1836.

ERYSIMUM CAPITATUM (Dougl.) Greene [*E. asperum* of Intermountain authors in part not (Nutt.) DC., *E. wheeleri* Rothr.] Wallflower. Infrequent on Cascade Canyon switchbacks above Hidden Falls Bridge, 6,800 ft. RJS 845, 641.

*ERYSIMUM CHEIRANTHOIDES L. Infrequent in aspen groves of the Wildlife Range and south slopes of Signal Mt. JFR 1111, ETO 1328.

ERYSIMUM NIVALE (Greene) Rydb. Head of Death Canyon 9,500 ft. HEB 171.

*LEPIDIUM CAMPESTRE (L.) R. Br. Pepperweed. Common in waste places. JFR 1281.

*LEPIDIUM DENSILFLORUM Schrad. var. BOURGEAUANUM (Thell.) C. L. Hitchc. Common in the sagebrush flats of the valley. JFR 2516.

*LEPIDIUM PERFOLIATUM L. Frequent in waste places. JFR 2754.

LESQUERELLA PROSTRATA A. Nels. Bladderpod. Common along Snake River and barren hill north of Kelly Warm Spring. WED 2953, JFR 1807.

NASTURTIUM OFFICINALE R. Br. [*Rorippa nasturtium-aquaticum* Schinz. & Thell.] Watercress. Frequent on delta at the mouth of Cascade Creek, west shore of Jenny Lake. RJS 885, 512.

PHYSARIA ACUTIFOLIA Rydb. [*P. australis* (Pays.) Rollins.] Twinpod. Infrequent on switchbacks just north of the Schoolroom Glacier, South Cascade Canyon, 10,000 ft. RJS 1011.

RORIPPA CURVISILIQUA (Hook.) Bess. Yellowcress. Frequent around edge of pond one mile east of String Lake Picnic Area. RJS 918.

RORIPPA ISLANDICA (Oeder.) Borb. [*R. palustris* (Moench.] Bess. Common in wet areas of the Wildlife Range. JFR 2523.

SMELOWSKIA CALYCINA C. A. Meyer var. AMERICANA (Regel & Herder) Roll. Frequent on switchbacks beside the Schoolroom Glacier, 10,000 ft., South Cascade Canyon, Middle Teton 12,500 ft. RJS 711, 1481.

*THLASPI ARVENSE L. Pennycress. Common in waste places. RJS 637.

THLASPI FENDLERI A. Gray [*T. alpestre* of American authors, not L.] Common in the meadows of the Wildlife Range. JFR 1990.

ELAEAGNACEAE

ELAEAGNUS COMMUTATA Bernh. Silverberry. Frequent along the Snake River. RJS 849, 1238.

SHEPHERDIA CANADENSIS (L.) Nutt. Russett Buffaloberry. Common along the banks of the Snake River and shores of the valley lakes. RJS 985.

ERICACEAE

ARCTOSTAPHYLOS UVA-URSI (L.) Spreng. Bearberry. Frequent in the area of Signal Mountain and Colter Bay. JFR 952, 1254.

GAULTHERIA HUMIFUSA (Grah.) Rydb. Wintergreen. Infrequent on the shores of Bradley, String, and Amphitheater Lakes. LW 1030, RJS 1081.

KALMIA POLIFOLIA Wang. var. MICROPHYLLA (Hook.) Rehd. Alpine Bog Laurel. Frequent on the shores of the valley lakes and some subalpine lakes. RJS 630, LW 894.

MENZIESIA FERRUGINEA Smith var. GLABELLA (A. Gray) Peck. False Huckleberry. Frequent along the shores of the valley lakes. RJS 639, 1219.

PHYLLODOCE EMPETRIFORMIS (Sw.) D. Don. Mt. Heather. Frequent around the shores of lakes above 9,000 ft. RJS 991, 1435.

PHYLLODOCE GLANDULIFLORA (Hook.) Coville. Frequent at Amphitheater Lake, and Holly Lake, above 9,000 ft. LW 896 and 1355, RJS 1231.

PHYLLODOCE × INTERMEDIA (Hook.) Camp. Hybrid between *P.*

glanduliflora and *P. empetriformis,* Holly and Amphitheater Lakes. JM 62-7, 63-21.

VACCINIUM MEMBRANACEUM Dougl. Huckleberry; Blueberry. Abundant in the canyons and around the shores of the valley lakes. LW 929, RJS 1212.

VACCINIUM OCCIDENTALE A. Gray. Infrequent near the outlet of Bradley Lake and small pond east of Colter Bay. RJS 727.

VACCINIUM SCOPARIUM Leib. Abundant in the canyons and on the moraines of the valley. LW 764.

FUMARIACEAE

CORYDALIS AUREA Willd. Locally frequent along Snake River, south of Signal Mountain. RJS 859.

DICENTRA UNIFLORA Kellogg. Steershead. Infrequent in the areas of Park Hdqts. and the Jenny Lake Museum. Jean Dilley 2951.

GENTIANACEAE

FRASERA SPECIOSA Dougl. [*Swertia radiata* (Kellogg) Kuntze.] Green Gentian. Common along Snake River, also such places as Wildlife Range and Blacktail Butte. LW 1722.

GENTIANA AFFINIS Griseb. Frequent along Snake River. RJS 675.

GENTIANA AMARELLA L. Frequent in streambed with mosses on north side of Signal Mountain and south of Colter Bay. RJS 979, 1417.

GENTIANA CALYCOSA Griseb. Frequent in major canyons above 8,000 ft. RJS 988, 668.

GENTIANA DETONSA Rottb. var. UNICAULIS (A. Nels.) C. L. Hitchc. [*G. thermalis* Kuntze.] Frequent along small streams in willow areas one mile north of Moran. RJS 658.

SWERTIA PERENNIS L. Frequent along stream in South Fork of Death Canyon 8,500 ft. RJS 738.

GERANIACEAE

GERANIUM NERVOSUM Rydb. Common along Snake River and open xeric sites of the moraines. RJS 643.

GERANIUM RICHARDSONII Fisch. & Trautv. Frequent on stream banks or moist areas such as String Lake, and road to Two Ocean Lake. RJS 556.

HALORAGIDACEAE

HIPPURUS VULGARIS L. Marestail. Infrequent in ponds and pools north of Jackson Lake Dam. RJS 657, 921.

MYRIOPHYLLUM SPICATUM L. var. EXALBESCENS (Fern.) Jeps. (*M. exalbescens* Fern.) Water Milfoil. Swan Lake. WGS 3998.

HYDROPHYLLACEAE

HYDROPHYLLUM CAPITATUM Dougl. Waterleaf. Frequent on moraines in such areas as Park Hdqts., Jenny Lake Campground, and Wildlife Range. RJS 613.

NEMOPHILA BREVIFLORA A. Gray. Locally common along shore of Snake River at Menor's Ferry. RJS 746.

PHACELIA FRANKLINII (R. Br.) A. Gray. Margin of lodgepole pine, Wildlife Range. JFR 2196.

PHACELIA HETEROPHYLLA Pursh. Common in waste places. RJS 923.

PHACELIA HASTATA Dougl. var. ALPINA (Rydb.) Cronq. [*P. leucophylla* Torr.] In rocks of subalpine areas. RJS 962, JM 63-63.

PHACELIA SERICEA (Grah.) A. Gray. Frequent in the major canyons of the range. RJS 661.

HYPERICACEAE

HYPERICUM FORMOSUM HBK. ssp. SCOULERI (Hook.) C. L. Hitchc. St. John's Wort. Frequent in the major canyons above 8,000 ft. RJS 666, 1419.

LABIATAE

AGASTACHE URTICIFOLIA (Benth.) Ktze. Gianthyssop. Common on moraines of the valley lakes. LW 1662, RJS 513.

DRACOCEPHALUM PARVIFLORUM Nutt. [*Moldavica parviflora* (Nutt.) Britt.] Dragonhead. Infrequent along the banks of the Snake River and disturbance sites at Colter Bay. HEB 65, RJS 1556.

MENTHA ARVENSIS L. var. GLABRATA (Benth.) Fern. Mint. Infrequent along the Snake River. RJS 667.

PRUNELLA VULGARIS L. Selfheal. Frequent along Snake River below Moose, also along east shores of Leigh and String Lakes. RJS 539.

SCUTELLARIA GALERICULATA L. Skullcap. Frequent in the meadows north of the Jackson Lake Dam, and Christian Pond Area. RJS 980, JFR 10153.

LEGUMINOSAE

ASTRAGALUS AGRESTIS Dougl. Locoweed. Frequent in the sedgegrass meadow of the Wildlife Range. JFR 1137, ETO 1277.

ASTRAGALUS ALPINUS L. Common along the Snake River and upper canyons. RJS 1025, LW 759.

ASTRAGALUS BISULCATUS (Hook.) A. Gray. Infrequent, east park boundary. RJS 526.

ASTRAGALUS CANADENSIS L. var. BREVIDENS (Gand.) Barneby. Sandy river bottom, near Bar BC Ranch. LW 1342.

ASTRAGALUS MICROCYSTIS A. Gray. Dry west slopes of Blacktail Butte. ETO 1359.

ASTRAGALUS MISER Dougl. var. HYLOPHILUS (Rydb.) Barneby. Frequent along Snake River. RJS 1186, 631.

ASTRAGALUS PURSHII Dougl. var. GLAREOSUS (Dougl.) Barneby. Frequent in the Wildlife Range. JFR 1833.

ASTRAGALUS REVENTUS A. Gray. Sandy, south slope of Blacktail Butte. ETO 1357.

ASTRAGALUS TEGETARIUS S. Wats. Frequent on scree slopes above 10,000 ft. RJS 855, 1456.

ASTRAGALUS TERMINALIS S. Wats. Common on the dry terraces above the Snake River. RJS 915.

*CARAGANA ARBORESCENS Lam. Siberian Pea Tree. Remaining from cultivation in the Wildlife Range. JFR 1647.

GLYCYRRHIZA LEPIDOTA (Nutt.) Pursh. Licorice. Common along the Snake River bottoms. LW 1340, RJS 1408.

HEDYSARUM BOREALE Nutt. var. BOREALE. Sweetvetch. Locally frequent south of Spread Creek Bridge on Hwy. 89. RJS 1486.

HEDYSARUM OCCIDENTALE Greene. Frequent on trail at the head of So. Cascade Canyon and on the slopes of Symmetry Spire. RJS 750, 970.

*LOTUS CORNICULATUS L. Bird's Foot Trefoil. Locally frequent at Jackson Lake Lodge. RJS 1165.

LUPINUS ARGENTEUS Pursh ssp. PARVIFLORUS (Nutt.) Phillips. Lupine. Common on the east shore of Jackson Lake and along the Snake River. RJS 981, JFR 2118.

LUPINUS LEPIDUS Dougl. var. UTAHENSIS (S. Wats.) C. L. Hitchc. *(L. caespitosa* Nutt.) Infrequent Hedrick's Pond, Jackson Hole Highway and Colter Bay. RJS 1152.

LUPINUS SERICEUS Pursh. Abundant throughout the valley. RJS 656, LW 1621.

*MEDICAGO LUPULINA L. Black Medick. Common in waste places throughout the valley. JFR 2263.

*MEDICAGO SATIVA L. Common in waste places of the Wildlife Range. JFR 2529.

*MELILOTUS ALBA Desv. Sweetclover. Common along the highways and waste places. JFR 2534.

*MELILOTUS OFFICINALIS (L.) Lam. Common along the highways and waste places. RJS 945.

OXYTROPIS CAMPESTRIS (L.) DC. [*O. alpicola* M. E. Jones] Crazyweed. Limestone, head of Death Canyon, 10,000 ft. HEB 1886.

OXYTROPIS DEFLEXA (Pall.) DC. var. FOLIOLOSA (Hook.) Barneby. Frequent below summit of Table Mt. 10,900 ft. LCA 525.

OXYTROPIS DEFLEXA (Pall.) DC. var. SERICEA Torr. & Gray. Frequent along the Snake River. LW 1341, 1646.

*TRIFOLIUM HYBRIDUM L. Clover. Common in waste places of the Wildlife Range. JFR 1207.

TRIFOLIUM LONGIPES Nutt. var. REFLEXUM A. Nels. [*T. rydbergii* Greene.] Frequent in moist meadows east of Jackson Lake. LW 1632.

*TRIFOLIUM PRATENSE L. Common in waste places of the Wildlife Range. JFR 1537.

*TRIFOLIUM REPENS L. Frequent in waste places of the valley. HEB 186, ETO 1279.

VICIA AMERICANA Muhl. Vetch. Frequent along the Snake River. RJS 916.

LENTIBULARIACEAE

UTRICULARIA VULGARIS L. Bladderwort. Rare in beaver pond ¼ mile south of Jackson Lake Dam on main highway. RJS 659.

LIMNANTHACEAE

FLOERKEA PROSERPINACOIDES Willd. Falsemermaid. Infrequent in the Wildlife Range. JFR 1999.

LINACEAE

LINUM LEWISII Pursh. Flax. Frequent in the area of the Wildlife Range, Jackson Lake Lodge and infrequent in upper area of South Cascade Canyon. RJS 710, 1023.

LOASACEAE

MENTZELIA DISPERSA S. Wats. Blazing-Star. Locally frequent on dry slopes throughout the valley. RJS 1017, 1252.

MENTZELIA LAEVICAULIS (Dougl.) Torr. & Gray. Frequent on dry hillside above Highway 89, 7 miles south of Jackson. RJS 751, also reported in Moran area by C. Jepson.

LORANTHACEAE

ARCEUTHOBIUM AMERICANUM Nutt. Dwarf Mistletoe. Frequent parasite on lodgepole pine around the valley lakes. RJS 881.

MALVACEAE

ILIAMNA RIVULARIS (Dougl.) Greene var. DIVERSA (A. Nels.) C. L. Hitchc. [*Sphaeralcea rivularis* (Dougl.) Torr.] Globemallow. Common along roadsides and disturbed areas. RJS 978.

MENYANTHACEAE

MENYANTHES TRIFOLIATA L. Buckbean. Locally common in pond, Pacific Creek Rd. WGS 3665.

MORACEAE

*HUMULUS AMERICANUS Nutt. Hops. Frequent in some disturbed areas of old ranches of the valley. JFR 1655, 2624.

NYMPHAEACEAE

NUPHAR POLYSEPALUM Engelm. Yellow Pondlily. Common in beaver ponds of the valley. RJS 655.

ONAGRACEAE

CIRCAEA ALPINA L. var. PACIFICA (Asch. & Magnus) M. E. Jones. Frequent in deep shade Death Canyon Trail at Phelps Lake level. RJS 1597.

EPILOBIUM ADENOCAULON Hausskn. Willow-Weed. Common in wet places of the Wildlife Range. LW 861, JFR 1579.

EPILOBIUM ALPINUM L. Frequent in couloirs and canyons above 8,000 ft. RJS 975, 1576, LW 1034.

EPILOBIUM ANGUSTIFOLIUM L. Abundant along roadsides throughout the valley. JFR 1212.

EPILOBIUM GLANDULOSUM Lehm. Aspen grove in Wildlife Range. JFR 1508.

EPILOBIUM LATIFOLIUM L. Frequent by streams in Garnet Canyon and the upper part of South Cascade Canyon, 9,500 ft. WGS 3958, RJS 741.

EPILOBIUM MINUTUM Lindl. Frequent on Phelp's Lake moraine. RJS 1544.

EPILOBIUM PANICULATUM Nutt. Frequent in sagebrush, Blacktail Butte, and slopes of Signal Mt. RJS 917, ETO 1353.

EPILOBIUM SUFFRUTICOSUM Nutt. Frequent in gravel of the Snake River bottom. LW 1338, RJS 1227.

GAYOPHYTUM NUTTALLII Torr. & Gray [*G. diffusum* Torr. & Gray] Ground Smoke. Frequent in disturbed areas throughout the valley. RJS 1214.

OENOTHERA CAESPITOSA Nutt. Evening Primrose. Infrequent in roadside cuts of the valley. WGS 4449.

OENOTHERA BREVIFLORA Torr. & Gray. Locally frequent in mud, north end of Swan Lake. RJS 1477, WGS 4937.

OENOTHERA HETERANTHA Nutt. Frequent in the meadows of Wildlife Range and south of Signal Mt. RJS 913.

OENOTHERA HOOKERI Torr. & Gray var. ORNATA (A. Nels.) Munz. Frequent along main highway between Jenny Lake and south boundary. RJS 540, ETO 1352.

OENOTHERA PALLIDA Lindl. Infrequent on trail to fire lookout on Blacktail Butte. RJS 693.

ZAUSCHNERIA GARRETTII A. Nels. Firechalice. Frequent on rocky ledges in such canyons as Death, Waterfall, and Cascade, up to 7,500 ft. RJS 680, 994.

OROBANCHACEAE

OROBANCHE FASCICULATA Nutt. Broomrape. Infrequent as a parasite on big sagebrush throughout the valley floor. RJS 649, 955.

OROBANCHE LUDOVICIANA Nutt. Infrequent in Wildlife Range. JFR 1195.

OROBANCHE UNIFLORA L. var. MINUTA (Suksd.) Beck. Rare in wet mossy places in the mouth of Cascade Canyon. RJS 647, LW 665.

OXALIDACEAE

*OXALIS DILLENII Jacq. [*O. stricta* L.] Woodsorrel. Rare along Snake River below dam. RJS 1553.

PAEONIACEAE

PAEONIA BROWNII Dougl. Peony. Rare at south end of Jenny Lake near boat dock, also at Taggart Creek and Teton Park Road. RJS 617, 1445.

PLANTAGINACEAE

*PLANTAGO LANCEOLATA L. Plantain. Locally common in waste places of the valley. JFR 2655.

*PLANTAGO MAJOR L. Locally common in waste places of the valley. RJS 983.

POLEMONIACEAE

COLLOMIA LINEARIS Nutt. Common in the sagebrush flats and moraines throughout the valley. RJS 514.

GILIA AGGREGATA (Pursh) Spreng. [*Ipomopsis aggregata* (Pursh) V. Grant.] Common in gravelly soil, usually associated with big sagebrush, throughout the valley floor. RJS 505, 837.

LEPTODACTYLON PUNGENS (Torr.) Nutt. Prickly Phlox. Infrequent in the sagebrush flats south of Signal Mt. RJS 1541.

LINANTHASTRUM NUTTALLII (A. Gray) Ewan. Frequent in Death Canyon and southern peaks of the range above 7,500 ft. RJS 669.

LINANTHUS HARKNESSII (Curran) Greene. Frequent on the Phelp's Lake moraine. RJS 1543.

LINANTHUS SEPTENTRIONALIS Mason. Infrequent, Snake River bottom and Wildlife Range. LW 1636, ETO 1105.

PHLOX HOODII Rich. Outwash plain, vicinity of Moose. ETO 1156.

PHLOX MULTIFLORA A. Nels. Frequent, Highway 89, north boundary of park, also Elk Ranch. JFR 2291.

PHLOX PULVINATA (Wherry) Cronq. [*P. caespitosa* of Intermountain authors not Nutt.] Infrequent on ledges above Amphitheater Lake, 9,800 ft. LW 1353, 909.

PHLOX LONGIFOLIA Nutt. Frequent in the big sagebrush throughout the valley. RJS 503, 1540.

POLEMONIUM OCCIDENTALE Greene. Frequent in wet areas in the vicinity of the Sawmill Ponds, also east of Jackson Lake Lodge. RJS 546.

POLEMONIUM PULCHERRIMUM Hook. var. PULCHERRIMUM. In sandy depression on terrace above Pacific Creek, Wildlife Range. JFR 2208.

POLEMONIUM VISCOSUM Nutt. Frequent at elevations above 9,000 ft. RJS 549, LCA 213.

POLYGONACEAE

ERIOGONUM CERNUUM Nutt. Pothole area south of Signal Mt. AAB 14,787.

ERIOGONUM HERACLEOIDES Nutt. Frequent at Colter Bay Village. RJS 1160.

ERIOGONUM OVALIFOLIUM Nutt. var. DEPRESSUM Blank. Frequent near summits of Storm & Ice Pts., 10,000 ft. RJS 1584, 1577.

ERIOGONUM UMBELLATUM Torr. var. SUBALPINUM (Greene) M. E. Jones. Common on the outwash and moraines throughout the valley. RJS 858, 1207, 1237.

OXYRIA DIGYNA (L.) Hill. Frequent in talus slopes of the major canyons from 8,500 to 10,000 ft. LW 910, RJS 1569.

POLYGONUM AMPHIBIUM L. Knotweed. Locally common in ponds north of Jackson Lake Dam. RJS 654.

*POLYGONUM AVICULARE L. [*P. buxiforme* Small.] Common in waste places. JFR 2764.

POLYGONUM BISTORTOIDES Pursh. Common in the meadows north of Colter Bay and frequent in the mountains above 9,000 ft. RJS 515, 1587.

POLYGONUM COCCINEUM Muhl. Locally common in shallow pond one mile north of Colter Bay Village. RJS 1494.

POLYGONUM DOUGLASII Greene. Locally frequent in rocks above John Graul Mine, 3 miles up Webb Canyon; also in disturbance areas of the valley. RJS 957, 1489.

POLYGONUM KELLOGGII Greene. Dry pool near Swan Lake. WGS 4938.

POLYGONUM MINIMUM S. Wats. Infrequent in rocks on slopes of Symmetry Spire, 7,200 ft. and Webb Canyon. LW 1402, RJS 963, 1487.

POLYGONUM VIVIPARUM L. South facing slope of Table Mt. LCA 538.

*RUMEX ACETOSELLA L. Dock. Common in waste places throughout the valley. JFR 2113, LW 746.

*RUMEX CRISPUS L. Frequent in waste places. JFR 1659.

RUMEX FUEGINUS Phil. [*R. maritimus* of American authors not L.] Infrequent in the Wildlife Range. JFR 2550a, LW 1648.

RUMEX PAUCIFOLIUS Nutt. Common in the Wildlife Range. JFR 1874.

RUMEX SALICIFOLIUS Weinm. [*R. mexicanus* Meisn., *R. triangulivalvis* (Danser) Rech.] Frequent in disturbed areas throughout the valley. RJS 691.

PORTULACACEAE

CLAYTONIA LANCEOLATA Pursh. Springbeauty. Common in the valley in the big sagebrush and lodgepole pine communities, also in higher canyons. JFR 2037.

CLAYTONIA MEGARRHIZA (A. Gray) Parry. Buck Mt., 11,000 ft. Mrs. Huebner (no number).

LEWISIA PYGMAEA (A. Gray) Robins. Locally frequent in sagebrush north of Timbered Island, also on Table Mt. RJS 743, LCA 523.

LEWISIA TRIPHYLLA (S. Wats.) Robins. Infrequent in wet moss ¼ mile below Hidden Falls. RJS 646, 909.

SPRAGUEA UMBELLATA Torr. var. CAUDICIFERA A. Gray. Pussy Paws. Infrequent on secondary trail east of saddle south of Static Peak, 9,500 ft. RJS 1588, LCA 218.

PRIMULACEAE

ANDROSACE FILIFORMIS Retz. Rockjasmine. Shore of Jackson Lake and Signal Mt. LW 1626, ETO 1099.

ANDROSACE SEPTENTRIONALIS L. var. SUBULIFERA A. Gray. Infrequent along stream, Beaver Creek Housing Area. RJS 699.

ANDROSACE SEPTENTRIONALIS L. var. SUBUMBELLATA A. Nels. Frequent at the head of Death Canyon, also reported at the Wildlife Range. HEB 220.

DODECATHEON CONJUGENS Greene. Shooting Star. Frequent in the sagebrush flats, especially around the Jenny Lake region. RJS 610, LW 2178.

DODECATHEON PULCHELLUM (Raf.) Merrill ssp. PULCHELLUM [*D. pauciflorum* Greene.] Frequent on moist open slopes above 9,000 ft. RJS 1474, LW 916.

PRIMULA PARRYI A. Gray. Frequent along stream banks in the higher canyons and on mountain slopes above 9,000 ft. LW 897, 1303.

PYROLACEAE

CHIMAPHILA UMBELLATA (L.) Barton var. OCCIDENTALIS (Rydb.) Blake. Pipsissewa. Frequent along the shores of such lakes as Leigh, String, and Jenny. RJS 662, 1244.

HYPOPITYS MONOTROPA Crantz. [*Monotropa hypopitys* L.] Rare in deep shade, west side Leigh Lake. RJS 1433, 730.

MONESES UNIFLORA (L.) A. Gray [*Pyrola uniflora* L.] Woodnymph. Rare around the shores of valley lakes (west of Leigh Lake). RJS 1432, LW 1388.

PTEROSPORA ANDROMEDEA Nutt. Pinedrops. Frequent around the shores of the valley lakes. RJS 729.

PYROLA ASARIFOLIA Michx. Shinleaf. Frequent in the coniferous forest of the valley. RJS 544, 1228.

PYROLA DENTATA Smith. Rare on dry hillsides above Amphitheater Lake, 10,000 ft. LW 1025.

PYROLA MINOR L. Rare in alpine area at head of Avalanche Canyon. LW 1026.

PYROLA PICTA Smith. Death Canyon. HVT 54388.

PYROLA SECUNDA L. Frequent around the shores of the valley lakes. RJS 543, LW 1693.

PYROLA VIRENS Schweigg. Infrequent on Bradley Creek and north slope of Signal Mt. LW 1329, WGS 4090.

RANUNCULACEAE

ACONITUM COLUMBIANUM Nutt. Monkshood. Locally common in wet areas and along streams in the valley and extending into the major canyons up to 9,000 ft. LW 1393.

ACTAEA RUBRA (Ait.) Willd. ssp. ARGUTA (Nutt.) Hult. [*A. arguta* Nutt.] Baneberry. Frequent in the major canyons and around the shores of the valley lakes. RJS 695, 1599, LW 672.

ANEMONE MULTIFIDA Poir. var. MULTIFIDA [*A. globosa* Nutt.] Frequent along the Snake River. RJS 856, 1187.

ANEMONE MULTIFIDA Poir. var. TETONENSIS (Porter) C. L. Hitchc. Infrequent in alpine tundra, i.e. Schoolroom Glacier and Mt. Hunt. RJS 1029, 927.

AQUILEGIA CAERULEA James. Columbine. Common in the major canyons and moist alpine area. LW 1672.

AQUILEGIA FLAVESCENS S. Wats. Infrequent in moist alpine meadows. JM 62-45, LW 1350, 918.

CALTHA LEPTOSEPALA DC. Frequent in alpine and subalpine meadows above 8,500 ft. RJS 651, 1564.

CLEMATIS COLUMBIANA (Nutt.) Torr. & Gray. Virgin's Bower. Infrequent along Pilgrim Creek and Cascade Canyon. RJS 519, 848.

CLEMATIS HIRSUTISSIMA Pursh. Infrequent in the valley and in some of the higher canyons above 9,000 ft. RJS 615, 928.

CLEMATIS LIGUSTICIFOLIA Nutt. Infrequent on trail, two miles up Death Canyon, 7,500 ft. RJS 755.

DELPHINIUM NELSONI Greene. Larkspur. Common in gravelly soil throughout the valley. A critical species treated in different ways. LW 1113, RJS 835.

DELPHINIUM OCCIDENTALE (S. Wats.) S. Wats. Frequent along second Saw Mill Pond, 1¼ mile southwest from Moose. WGS 4055, RJS 857.

MYOSURUS MINIMUS L. Mousetail. Across the Snake River from University of Wyoming Biological Station. WGS 3889.

RANUNCULUS ACRIFORMIS A. Gray var. MONTANENSIS (Rydb.) L. Benson. Buttercup. Frequent in wet places, north and east of Jackson Lake Dam. RJS 634, 1447.

RANUNCULUS AQUATILIS L. var. CAPILLACEUS (Thuill.) DC. Frequent in pools and sluggish streams throughout the valley. JFR 870.

RANUNCULUS CYMBALARIA Pursh. Common in wet places of the Wildlife Range. ETO 1151, JFR 869.

RANUNCULUS ESCHSCHOLTZII Schlecht. var. ALPINUS (Wats.) C. L. Hitchc. Frequent in alpine area above 9,700 ft. RJS 1021, 1454.

RANUNCULUS ESCHSCHOLTZII Schlecht. var. ESCHSCHOLTZII. Frequent in Glacier Gulch and Indian Paintbrush Canyon above 8,500 ft. RJS 1153a, 1233.

RANUNCULUS ESCHSCHOLTZII Schlecht. var. SUKSDORFII (A. Gray) L. Benson. Frequent on the east shore of Lake Solitude, 9,024 ft. RJS 952, LW 922.

RANUNCULUS FLAMMULA L. var. FILIFORMIS (Michx.) Hook. Frequent at edge of shallow ponds north of Colter Bay Village. RJS 1496.

RANUNCULUS GLABERRIMUS Hook. Frequent in the Wildlife Range. JFR 1931.

RANUNCULUS INAMOENUS Greene. Frequent in sedge meadow of Wildlife Range, also Park Hdqts. RJS 624.

RANUNCULUS JOVIS A. Nels. Abundant in the early spring on the sagebrush flats throughout the valley floor. LW 1074, RJS. 905.

RANUNCULUS MACOUNII Britton. Irrigated meadow on Elk Ranch. JFR 2317, LW 851.

RANUNCULUS NATANS C. A. Meyer. Common in wet places of the Wildlife Range. JFR 1496, RJS 1603.

RANUNCULUS SCELERATUS L. var. MULTIFIDUS Nutt. Common in wet places of the Wildlife Range. JFR 1507.

THALICTRUM FENDLERI Engelm. Meadow-Rue. Frequent in the coniferous forest on the moraines of the valley and extending into major canyons. RJS 626, 1466.

THALICTRUM OCCIDENTALE A. Gray. Frequent in wet areas of the Wildlife Range. JFR 2079.

THALICTRUM SPARSIFLORUM Turcz. Infrequent on the west shore of Jenny Lake. LW 855, RJS 644.

TROLLIUS LAXUS Salisb. Frequent in wet meadows of subalpine and alpine areas of Teton Range. RJS 652, 930.

RHAMNACEAE

CEANOTHUS VELUTINUS Dougl. Snowbrush Ceanothus. Frequent around the shores of the valley lakes. RJS 1218, LW 1207.

RHAMNUS ALNIFOLIA L'Her. Buckthorn. Frequent in the Sawmill Ponds area and on the shore of Jackson Lake. JFR 1634, LW 1192.

ROSACEAE

AMELANCHIER ALNIFOLIA Nutt. Serviceberry. Common along the Snake River and around the shores of the valley lakes. JFR 2875.

CERCOCARPUS LEDIFOLIUS Nutt. Mountain Mahogany. Infrequent in the lower portions of Granite Canyon. HEB 15.

CRATAEGUS DOUGLASII Lindl. var. DOUGLASII. Hawthorn. Frequent along Snake River and Taggart Lake Trail. LW 1213, RJS 1355.

DRYAS OCTOPETALA L. var. ANGUSTIFOLIA C. L. Hitchc. Mountain Avens. Infrequent in rocky soil above 9,500 ft., Schoolroom Glacier, Cascade Canyon, and Indian Lake. RJS 726, 1015.

FRAGARIA VESCA L. var. BRACTEATA (Heller) Davis. [*F. bracteata* Heller] Strawberry. Frequent on the moraines of the valley floor.

FRAGARIA VIRGINIANA Duchn. var. GLAUCA S. Wats. [*F. glauca* Rydb.] Common in sagebrush of the Wildlife Range. JFR 2044.

GEUM MACROPHYLLUM Willd. var. PERINCISUM (Rydb.) Raup. Avens. Frequent in the meadows of the Wildlife Range, Double Diamond Ranch, and Swan Lake. JFR 1152, LW 1219.

GEUM ROSSII (R. Br.) Ser. var. TURBINATUM (Rydb.) C. L. Hitchc. Frequent on Avalanche Canyon Divide, and Timberline Lake, above 10,000 ft. RJS 760, 1592.

GEUM TRIFLORUM Pursh. var. CILIATUM (Pursh) Fassett. Frequent in meadows and sagebrush flats of the valley. RJS 504, JFR 1876.

IVESIA GORDONII (Hook.) Torr. & A. Gray. Frequent on divide of Upper Death Canyon, Timberline Lake and dry stream bed ½ mile south of Colter Bay. RJS 758, 1598.

PETROPHYTUM CAESPITOSUM (Nutt.) Rydb. Rockmat. Rare on Madison limestone on north end of Blacktail Butte. RJS 1475.

*PHYSOCARPUS MALVACEUS (Greene) Kuntze. Ninebark. Recent introduction planted at Jackson Lake Lodge. RJS 1605.

POTENTILLA ANSERINA L. Cinquefoil. Frequent on mud flats of Jackson Lake one mile above Lizard Point. RJS 1006.

POTENTILLA ARGUTA Pursh ssp. CONVALLARIA (Rydb.) Th. Wolf. Frequent in the meadows of the Wildlife Range. JFR 1031.

POTENTILLA BREVIFOLIA Nutt. Infrequent in alpine areas such as Timberline Lake and Paintbrush-Leigh Canyon Divide. RJS 1596, 1437.

POTENTILLA CONCINNA Rich. var. RUBRIPES (Rydb.) C. L. Hitchc. (*P. rubricaulis* Lehm.) Infrequent on Static Peak and Table Mt., above 9,500 ft. LCA 220, 429.

POTENTILLA DIVERSIFOLIA Lehm. Common in the meadows of the Wildlife Range, Amphitheater Lake. JFR 1996, LW 911.

POTENTILLA FLABELLIFOLIA Hook. Common in meadows of Holly Lake Cirque. JM 63-7.

POTENTILLA FRUTICOSA L. Common along Snake River and frequent in the canyons. RJS 517.

POTENTILLA GLANDULOSA Lindl. ssp. GLABRATA (Rydb.) Keck. Frequent in meadows on road to Two Ocean Lake. RJS 632.

POTENTILLA GLANDULOSA Lindl. ssp. PSEUDORUPESTRIS (Rydb.) Breit. Frequent in major canyons above 7,500 ft. JM 63-28, LW 1673.

POTENTILLA GRACILIS Dougl. var. ELMERI (Rydb.) Jeps. Frequent in meadows north of Park Hdqts. JFR 1203.

POTENTILLA GRACILIS Dougl. var. GLABRATA (Lehm.) C. L. Hitchc. [*P. g.* Dougl. ssp. *nuttallii* Keck.] Common in the meadows of the Wildlife Range. RJS 625.

POTENTILLA NIVEA L. Frequent on Static Peak, south facing slope. LCA 214.

POTENTILLA NORVEGICA L. [*P. monsveliensis L.*] Infrequent on bank of Snake River east of Jackson Lake Dam. JFR 2524.

POTENTILLA PALUSTRIS (L.) Scop. Locally common at water's edge, eastern shore of Arizona Lake (at end of dirt road). RJS 1528.

PRUNUS VIRGINIANA L. var. MELANOCARPA (A. Nels.) Sarg. Chokecherry. Common along Snake River and on the moraines of the valley. JFR 2209.

PURSHIA TRIDENTATA (Pursh) DC. Bitterbrush. Common in the sagebrush flats of the valley, south of Moose. RJS 509, 1542.

ROSA WOODSII Lindl. Rose. Common along the banks of the Snake River. JFR 2537.

RUBUS IDAEUS L. ssp. SACHALINENSIS (Levl.) Focke. [*R. strigosus*

Michx.] Raspberry. Infrequent along Snake River, also frequent in talus slopes of the major canyons. RJS 996, JFR 2521.

*RUBUS LACINIATUS Willd. Gravelly bank of Snake River near site of old town of Moran; a possible escaped cultigen. JFR 2521.

RUBUS PARVIFLORUS Nutt. Common on the moraines and abundant in the lower portions of the major canyons. JFR 2553.

SIBBALDIA PROCUMBENS L. Frequent on shores of subalpine lakes above 9,000 ft. RJS 715, 1566.

SORBUS SCOPULINA Greene. Mountain Ash. Common on the lower slopes of the mountains and along the shores of the valley lakes. JFR 2860, LW 1232.

SPIRAEA BETULIFOLIA Pall. var. LUCIDA (Dougl.) C. L. Hitchc. [*S. lucida* Dougl.] Frequent on the moraines and shores of the valley lakes. LW 1397.

SPIRAEA DENSIFLORA Nutt. Frequent on mountain slopes and in the major canyons up to 9,000 ft. RJS 1229.

RUBIACEAE

GALIUM APARINE L. var. ECHINOSPERMUM (Wallr.) Farw. Bedstraw. Half a mile northeast of Biological Station. ETO 1128.

GALIUM BIFOLIUM S. Wats. Frequent under the aspen at the Wildlife Range. RJS 912.

GALIUM BOREALE L. Common on the moraines of the valley. JFR 2831, LW 1326.

GALIUM TRIFIDUM L. Frequent in the Wildlife Range. JFR 1545.

KELLOGGIA GALIOIDES Torr. Infrequent in the main couloir on the east face of Symmetry Spire, 7,600 ft. RJS 964.

SALICACEAE

POPULUS ANGUSTIFOLIA James. Narrowleaf Cottonwood. Common along the Snake River. JFR 1631.

POPULUS BALSAMIFERA L. Frequent along Snake River and in the Wildlife Range. JFR 1354.

POPULUS TREMULOIDES Michx. Abundant in the moist habitats throughout the valley. RJS.

POPULUS TRICHOCARPA Torr. & Gray. Frequent three miles up Cascade Canyon, 8,000 ft. RJS 650.

SALIX ARCTICA Pall. [*S. petrophila* Rydb.] Willow. Frequent on the shores of alpine lakes above 9,000 ft. RJS 993, 1514, LW 1708.

SALIX BEBBIANA Sarg. var. PERROSTRATA (Rydb.) Schneid. Moose Post Office area. HEB.

SALIX CASCADENSIS Cockerell. Infrequent in meadows and on talus slopes around subalpine lakes. JM 63-75, 62-40.

SALIX COMMUTATA Bebb. Frequent in Wildlife Range. JFR 1236-7.

SALIX DRUMMONDIANA Barr. var. SUBCOERULEA (Piper) Ball. Common along the Snake River. JFR 2257.

SALIX EXIGUA Nutt. ssp. MELANOPSIS (Nutt.) Cronq. [*S. melanopsis* Nutt.] Frequent in the Wildlife Range. JFR 1160, 1812.

SALIX GEYERIANA Anderss. Abundant along the Snake River. JFR 2771; LW 1104.

SALIX GLAUCA L. Infrequent at Amphitheater Cirque and Holly Lake. JM 62-1, 63-8.

SALIX LASIANDRA Benth. var. CAUDATA (Nutt.) Sudw. [*S. caudata* Heller.] Frequent along the Snake River. RJS 1229a, JFR 2768.

SALIX NIVALIS Hook. Infrequent in meadow around Holly Lake. JM 63-15.

SALIX PSEUDOCORDATA (Anderss.) Rydb. Common in the Wildlife Range. JFR 975.

SALIX PHYLICIFOLIA L. ssp. PLANIFOLIA (Pursh) Hiitonen [*S. planifolia* Pursh] Bog west of Taggart Lake. LW 1194.

SALIX RIGIDA Muhl. [*S. lutea* Nutt., *S. mackenziana* (Hook.) Barr.] Infrequent in the Wildlife Range. JFR 2260.

SALIX SCOULERIANA Barratt. Frequent in the Wildlife Range. JFR 2738.

SALIX TWEEDYI Ball. Frequent along Cascade Creek. LW 1686.

SALIX WOLFII Bebb. Frequent in the Wildlife Range. JFR 1979a.

SANTALACEAE

COMANDRA PALLIDA A. DC. [*C. umbellata* of western authors not (L.) Nutt.] Common in big sagebrush at such places as Windy Point, Timbered Island and Moose. RJS 826, 1446.

SAXIFRAGACEAE

HEUCHERA PARVIFOLIA Nutt. var. UTAHENSIS (Rydb.) Garrett. Alumroot. Infrequent on trail, Phelps Lake Lookout, also Blacktail Butte. RJS 673, LW 1757.

LITHOPHRAGMA BULBIFERA Rydb. Woodland Star. Frequent in the sagebrush flats of the valley. JFR 2004, RJS 906.

LITHOPHRAGMA PARVIFLORA (Hook.) Nutt. Frequent in wet meadow near Two Ocean Lake. RJS 636.

MITELLA PENTANDRA Hook. Frequent along stream in the major canyons. RJS 1568, LW 1196.

MITELLA STAUROPETALA Piper [*M. stenopetala* Rydb.] Infrequent on Lakes Trail. RJS 640, LW 770.

PARNASSIA FIMBRIATA Konig. Grass-of-Parnassus. Frequent around the shore of Jenny Lake and along banks of streams in the canyons. RJS 685.

PARNASSIA KOTZEBUEI Cham. var. PUMILA Hitchc. & Ownbey. Holly Lake Cirque, east bank. JM 63-96.

PARNASSIA PALUSTRIS L. var. MONTANENSIS (Fern. & Rydb.) C. L. Hitchc. Holly Lake Cirque. JM 63-32.

PARNASSIA PARVIFLORA DC. Frequent in wet areas below the Jackson Lake Dam. RJS 674, 1421.

RIBES INERME Rydb. Whitestem Gooseberry. Wildlife Range. JFR 1267.

RIBES LACUSTRE (Pers.) Poir. Wildlife Range and some canyons. JM 62-22, JFR 2239.

RIBES MONTIGENUM McClatchie. Head of Death Canyon, also Granite and Waterfall Canyons. RJS 1343.

RIBES PETIOLARE Dougl. Frequent in the mouths of Death and Cascade Canyons. RJS 938.

*RIBES SATIVUM (Reichb.) Syme. Formerly under cultivation near burned ranch building, Wildlife Range. JFR 1648.

RIBES SETOSUM Lindl. Wildlife Range. JFR 1955.

RIBES VISCOSISSIMUM Pursh var. VISCOSISSIMUM. Frequent on the north slope of Signal Mt. and shore of Bradley Lake. JFR 2746, RJS 1221.

SAXIFRAGA BRONCHIALIS L. ssp. AUSTROMONTANA (Wiegand) Piper. Yellowdot Saxifrage. Locally common on boulders in Hidden Falls area, also around subalpine lakes of major canyons. RJS 552, 936.

SAXIFRAGA DEBILIS Engelm. [*S. rivularis* L.] Rare on the ledges above Amphitheater Lake. LW 1011.

SAXIFRAGA FLAGELLARIS Willd. Rare on rock ledges of the Middle Teton and Grand Teton above 12,000 ft. RJS 1478.

SAXIFRAGA OCCIDENTALIS S. Wats. [*S. saximontana* E. Nels.] Frequent along small streams of major canyons. LW 1135, 660.

SAXIFRAGA ODONTOLOMA Piper. [*S. punctata* L. var. *arguta* (D. Don) Engl. & Irmsch.] Frequent along streams of the major canyons. RJS 683, 933.

SAXIFRAGA OPPOSITIFOLIA L. Infrequent on major peaks of the range above 9,500 ft. RJS 851.

SAXIFRAGA OREGANA Howell var. SUBAPETALA (E. Nels.) C. L. Hitchc. [*S. montanensis* Small.] Nine miles north of Jackson Lake Lodge, Hwy. 89. WGS 3709.

SAXIFRAGA RHOMBOIDEA Greene. Frequent in wet loam—major canyons, subalpine lakes and some minor peaks such as Table Mt. LCA 528, RJS 1561.

TELESONIX JAMESII (Torr.) Raf. var. HEUCHERIFORMIS (Rydb.) Bacigalupi. [*Boykinia heucheriformis* (Rydb.) A. Nels.] Frequent in rock crevices in major canyons above 8,500 ft. RJS 677, 1575.

SCROPHULARIACEAE

BESSEYA WYOMINGENSIS (A. Nels.) Rydb. [*B. cinerea* (Raf.) Pennell] Kittentails. Infrequent on tableland at head of Death Canyon, 9,600 ft., and in valley near Cunningham Ranch. HEB 192, RJS 1505.

CASTILLEJA CUSICKII Greenm. Indian Paintbrush. Along Snake River, Wildlife Range. JFR 1429.

CASTILLEJA LINARIAEFOLIA Benth. Frequent in the willows of the Wildlife Range and along Pilgrim Creek. JFR 880, WGS 4604.

CASTILLEJA MINIATA Dougl. Frequent to locally common in the valley, major canyons and subalpine lakes; most common sp.—complex and variable. RJS 1425, LW 1212, 1228.

CASTILLEJA PILOSA (S. Wats.) Rydb. [*C. longispica* A. Nels.] Frequent on morainal soil throughout the valley. RJS 828, 1192.

CASTILLEJA PULCHELLA Rydb. Frequent on higher slopes of saddle between Middle Teton and So. Teton, 11,900 ft. RJS 1484, 1045.

CASTILLEJA RHEXIFOLIA Rydb. Locally common in wet areas north of Moran and at Surprise Lake. RJS 633, LW 1349.

COLLINSIA PARVIFLORA Dougl. Abundant throughout valley, under lodgepole aspen and sagebrush. RJS 1537.

CORDYLANTHUS RAMOSUS Nutt. Birdbeak. Locally common north end of Blacktail Butte. RJS 1461.

LIMOSELLA AQUATICA L. Mudwort. Reported as common, but not seen; Third Creek and slow streams.

*LINARIA DALMATICA (L.) Mill. Toadflax. Rare ½ mile west of Jackson Hole Golf Course. Lou Jones (no number).

*LINARIA VULGARIS Hill. Locally common in waste places throughout the valley. RJS.

MIMULUS FLORIBUNDUS Dougl. Monkey Flower. Rare in Cascade Canyon and Death Canyon up to 8,000 ft. LW 1676.

MIMULUS GUTTATUS DC. Locally common in wet places and stream banks north of Moran on Highway 89. RJS 638.

MIMULUS LEWISII Pursh. Locally common along streams in the higher canyons. RJS 555, LW 1346.

MIMULUS MOSCHATUS Dougl. Frequent in the mouths of the major canyons and on the shore of Swan Lake. LW 1189, RJS 1420.

MIMULUS SUKSDORFII A. Gray. Frequent in Waterfall Canyon and along Snake River, one mile west of Triangle "X" Ranch. RJS 1473.

ORTHOCARPUS LUTEUS Nutt. Owlclover. Common along the Snake River and in the Sagebrush flats. RJS 986, FWP 11935.

PEDICULARIS BRACTEOSA Benth. var. PAYSONII (Pennell) Cronq. Lousewort. Frequent in the coniferous forest from 6,700 ft. up to 9,000 ft. RJS 522, 1452.

PEDICULARIS CONTORTA Benth. Locally frequent in subalpine areas —Stewart's Draw and Indian Paintbrush Canyon. RJS 874, 1589.

PEDICULARIS GROENLANDICA Retz. Common in wet meadows of the north end of the valley and extending up to some subalpine lakes. RJS 682, JM 62-88.

PEDICULARIS PARRYI var. PURPUREA Parry. Frequent in alpine tundra up to 12,000 ft. RJS 1080, 1479.

PEDICULARIS RACEMOSA Dougl. Frequent on moraines of the valley and extending into the canyons to 9,300 ft. RJS 1424, LW 1345.

PENSTEMON ATTENUATUS Dougl. ssp. PSEUDOPROCERUS (Rydb.)

Keck. Beardtongue. Frequent in major canyons and around subalpine lakes. JM 63-33.

PENSTEMON CYANANTHUS Hook. ssp. SUBGLABER (Gray) Penn. Frequent in disturbed areas throughout the valley. RJS 524.

PENSTEMON CYANEUS Penn. Infrequent in disturbance site at Swan Lake. WGS 4915.

PENSTEMON DEUSTUS Dougl. Infrequent on switchbacks above Hidden Falls, Park Hdqts., mouth of Death Canyon. RJS 534.

PENSTEMON MONTANUS Greene. Rare in rocks on switchbacks above Lake Solitude, also at 10,000 ft. in the South Fork of Cascade Canyon. RJS 723.

PENSTEMON PROCERUS Dougl. Frequent in disturbed places throughout the valley. JFR 1306, RJS 523.

PENSTEMON RADICOSUS A. Nels. Infrequent on north end of Blacktail Butte. LW 1755.

PENSTEMON WHIPPLEANUS A. Gray. Frequent on trails in such canyons as Death and Cascade Canyons up to 9,500 ft. RJS 671, 1578, LW 870.

SCROPHULARIA LANCEOLATA Pursh. Figwort. Locally frequent in the following canyons: (by trail always on rocky south facing slopes) Cascade, Garnet, Death and Indian Paintbrush. RJS 844, 876.

*VERBASCUM THAPSUS L. Mullein. Infrequent in disturbed areas around the Jackson Lake Lodge. RJS 1606.

VERONICA AMERICANA Schwein. Speedwell. Frequent on mud of Wildlife Range and area below Hidden Falls. RJS 547.

VERONICA PEREGRINA L. var. XALAPENSIS (HBK.) Penn. Locally frequent in mud of drying pond 300 yds. east of Colter Bay Fire Cache. RJS 1517, LW 1625.

VERONICA SERPYLLIFOLIA L. var. HUMIFUSA (Dicks.) Vahl. Frequent in sedge meadow near Swan Lake. RJS 920.

VERONICA WORMSKJOLDII Roem. & Schult. [*V. alpina* L.] Frequent in upper portions of North and South Cascade Canyons, Surprise Lake and Static Peak. LCA 219, RJS 627.

SOLANACEAE

*HYOSCYAMUS NIGER L. Henbane. Frequent; a recent invader to disturbed areas at Jackson Lake Lodge. RJS 1476.

UMBELLIFERAE

ANGELICA ARGUTA Nutt. [*A. lyallii* S. Wats.] Frequent ½ mile north of Biological Station. WGS 4175.

ANGELICA PINNATA S. Wats. Common on the forested moraines of the valley. RJS 642.

BUPLEURUM AMERICANUM Coult. & Rose. Frequent east shore of Timberline Lake, 10,400 ft. RJS 1585.

CYMOPTERUS HENDERSONII (Coult. & Rose) Cronq. [*Pteryxia hen-*

dersoni C. & R.) M. & C.] Frequent in major canyons above 9,000 ft. RJS 1013, JM 63-10.

HERACLEUM LANATUM Michx. Cowparsnip. Common in moist areas throughout the valley and lower parts of the canyons. HEB 1830.

LIGUSTICUM FILICINUM S. Wats. Frequent in moist aspen groves and coniferous forests of the valley and major canyons. RJS 1007, HEB 278.

LOMATIUM AMBIGUUM (Nutt.) Coult. & Rose. Desert Parsley. Frequent in roadside cuts north of Moose. RJS 1325.

LOMATIUM DISSECTUM (Nutt.) Math. & Const. var. MULTIFIDUM (Nutt.) Math. & Const. Frequent on valley moraines and the North Fork of Cascade Canyon. RJS 1570, JFR 2222.

LOMATIUM MONTANUM Coult. & Rose. Outwash plain east of Moose. ETO 1155.

LOMATIUM SIMPLEX (Nutt.) Macbr. Frequent in the Wildlife Range. JFR 1930.

OROGENIA LINEARIFOLIA S. Wats. Indian Potato. Frequent in sagebrush in vicinity of Park Hdqts. BH 2051.

OSMORHIZA CHILENSIS Hook. & Arn. Sweetroot. Frequent in deep shade back of park Hdqts. RJS 628.

OSMORHIZA DEPAUPERATA Phil. [*O. obtusa* (Coult. & Rose) Fern.] Bank of Bradley Creek, and Wildlife Range. LW 1128, JFR 2071.

OSMORHIZA OCCIDENTALIS (Nutt.) Torr. Common in aspen stands of the Wildlife Range. JFR 2108.

PERIDERIDIA BOLANDERI (A. Gray) A Nels. & Macbr. Sagebrush flats near Moose. JFR 2217.

PERIDERIDIA GAIRDNERI (Hook. & Arn.) Mathias. Yampa. Common throughout the valley floor. RJS 690.

SIUM SUAVE Walt. Waterparsnip. Frequent in ponds of the northern part of the valley. RJS 1572, WGS 4585.

URTICACEAE

URTICA DIOICA L. var. PROCERA (Muhl.) Wedd. [*U. gracilis* Ait.] Stinging Nettle. Abundant along roadsides and other waste places, especially on the Wilson Road just one mile south of Moose. JFR 2195.

VALERIANACEAE

VALERIANA ACUTILOBA Rydb. Valerian. Skyline Pass, 10,500 ft. LCA 157.

VALERIANA EDULIS Nutt. Willow Flats. ETO 1130.

VALERIANA OCCIDENTALIS Heller. Infrequent above Phelps Lake Lookout on Skyline Trail, 9,500 ft. RJS 670.

VIOLACEAE

VIOLA ADUNCA J. E. Smith. Violet. Frequent on the north and east shores of Lake Solitude, 9,024 ft., also on the west bank of the Snake River. RJS 953, 914.

VIOLA CANADENSIS L. var. RUGULOSA (Greene) C. L. Hitchc. Rare in plantings of Colter Bay Amphitheater Stage. RJS 1545.

VIOLA MACLOSKEYI Lloyd [*V. palustris* L.] Infrequent in moist areas on moraines of valley. RJS 937, 1199.

VIOLA PRAEMORSA Doug. ssp. LINGUAEFOLIA (Nutt.) Baker & Clausen [*V. nuttallii* Pursh.] Frequent in moist places in the timber, throughout the valley. RJS 611, LW 1091.

VIOLA PURPUREA Kellogg var. VENOSA (S. Wats.) Brainerd. Frequent on the east shore of Jenny Lake. RJS 618.

MONOCOTYLEDONEAE

ALISMACEAE

SAGITTARIA CUNEATA Sheld. Arrowhead. Frequent on the southeast shore of Two Ocean Lake, also in ponds around Jackson Lake. RJS 949, 1499, LW 1624.

CYPERACEAE

CAREX ABLATA Bailey. Sedge. Cascade Canyon. FWP 11981.

CAREX AQUATILIS Wahl. Common in the sedge meadow around Moran. JFR 997.

CAREX ATHROSTACHYA Olney. Common in the meadows around Moran. JFR 5046.

CAREX ATRATA L. Amphitheater Lake. JM 62-4.

CAREX AUREA Nutt. Common in the Wildlife Range and south to Moose. JFR 2274, RJS & WD 1526.

CAREX BREVIPES W. Boott. Infrequent in woods Amphitheater Cirque. JM 62-96.

CAREX CANESCENS L. Cascade Canyon in wet location. FWP 11982.

CAREX CHALCIOLEPIS Holm. Common in meadows of Amphitheater Cirque. JM 62-47.

CAREX DIANDRA Schrank. Infrequent Swan Lake. WGS 3994.

CAREX DISPERMA Dewey. Fork of Cascade Canyon. HEB 1819.

CAREX DOUGLASII Boott. Common in waste places of the Wildlife Range. JFR 2264.

CAREX EASTWOODIANA Stacey. Common in the big sagebrush of the Wildlife Range. JFR 1442.

CAREX ELYNOIDES Holm. Amphitheater and Surprise Lakes Cirque. JM 62-33.

CAREX FESTIVELLA Mkze. Common in area of Wildlife Range. JFR 991.

CAREX GEYERI Boott. Common in the coniferous forest of the valley and canyons up to 9,700 ft. JFR 1919, JM 63-41.

CAREX HAYDENIANA Olney. Frequent along Spread Creek. JFR 2298.

CAREX HOODII Boott. Cascade Canyon and Wildlife Range. FWP 11986.

CAREX KELLOGGII Boott. Cascade Canyon in wet location. FWP 11983.

CAREX LAEVICULMIS Meinsh. Cascade Canyon in wet location. FWP 11985.

CAREX LANGUINOSA Michx. Frequent in wet areas of the Wildlife Range. JFR 1616.

CAREX LIMNOPHILA Hermann. Frequent in wet areas of the Wildlife Range. JFR 1628.

CAREX MICROPTERA Mkze. Spread Creek and Wildlife Range. JFR 2298, 1571.

CAREX NEBRASKENSIS Dewey. Common in wet areas of the Wildlife Range. JFR 2322.

CAREX NEUROPHORA Mkze. South Fork of Cascade Canyon. HEB 187.

CAREX NIGRICANS C. A. Meyers. Shores of Amphitheater Lake and Holly Lake. FWP 11988, JM 63-93.

CAREX PETASATA Dewey. Meadows of Wildlife Range. JFR 2014.

CAREX PHAEOCEPHALA Piper. Frequent in the meadows of the Wildlife Range. JFR 1571.

CAREX PODOCARPA R. Br. Paintbrush Canyon in rather wet locations. FWP 11992.

CAREX PRAEGRACILIS Boott. Common in Wildlife Range. JFR 2054.

CAREX PYRENAICA Wahl. Webb Canyon near tree line. AAB (no number).

CAREX RAYNOLDSII Dewey. Frequent along Snake River and Death Canyon. ETO 1013.

CAREX ROSSII Boott. Abundant on trail below Surprise Lake. FWP 11989.

CAREX ROSTRATA Stokes. Common in wet areas of the Wildlife Range and Bradley Lake. JFR 1499, RJS 1209.

CAREX TOLMIEI Boott. Major canyons above 8,000 ft. JM 63-46.

CAREX VALLICOLA Dewey. Frequent in the meadows of the Wildlife Range. JFR 2247.

CAREX VESICARIA L. Frequent in wet areas of the Wildlife Range. JFR 1191.

ELEOCHARIS ACICULARIS (L.) Roem. & Schult. Spike Rush. Common on mud near Two Ocean Lake. JFR 2652.

ELEOCHARIS MACROSTACHYA Britton. Common in wet areas of the Wildlife Range and on the shores of String Lake. RJS 958, JFR 2058.

ELEOCHARIS OBTUSA (Willd.) Schult. Frequent in the meadows of the Wildlife Range. JFR 1981.

ELEOCHARIS PAUCIFLORA (Lightf.) Link. Frequent in wet areas of the Wildlife Range. JFR 1967.

ERIOPHORUM VIRIDI-CARINATUM (Engelm.) Fern. Cottonsedge. Locally frequent 1 mile below Columbine Cascade, Waterfall Canyon. RJS 1469.

SCIRPUS ACUTUS Muhl. Bulrush. Common in shallow pond east of Colter Bay Village. RJS 1242.

SCIRPUS SUBTERMINALIS Torr. Rare in beaver ponds along Snake River. JFR 1583.

GRAMINEAE

AGROPYRON ALBICANS Scribn. & Smith. Wheatgrass. Infrequent in the sagebrush flats. AAB 11750.

*AGROPYRON CRISTATUM (L.) Gaertn. Locally frequent in disturbance areas around Colter Bay. RJS 1548.

AGROPYRON DASYSTACHYUM (Hook.) Scribn. Infrequent in sagebrush areas of the Wildlife Range. JFR 1415, ETO 1522.

AGROPYRON SCRIBNERI Vasey. Common on rocky slopes throughout alpine zone and around shores of subalpine lakes. LW 1036, JM 63-71.

AGROPYRON SPICATUM (Pursh) Scribn. & Smith. Frequent near Biological Station. ETO 1004.

AGROPYRON SUBSECUNDUM (Link) A. S. Hitchc. Frequent in the streamside forest of the Wildlife Range. JFR 1638.

AGROPYRON TRACHYCAULUM (Link) Malte. Frequent along the Snake River. RJS 947.

*AGROSTIS ALBA L. Bentgrass. Frequent, moist aspen groves of the Wildlife Range. JFR 1241.

AGROSTIS EXARATA Trin. Frequent in waste places of the Wildlife Range. JFR 1010.

AGROSTIS HUMILIS Vasey. Amphitheater Lake. LW 1480, 1033.

AGROSTIS SCABRA Willd. var. GEMINATA (Trin.) Swallen. Common in waste places throughout the valley. JFR 1426, JM 62-106.

AGROSTIS THURBERIANA A. S. Hitchc. Rare in vicinity of Holly Lake. JM 63-97.

ALOPECURUS AEQUALIS Sobol. Foxtail. Frequent on mud and wet sand in Pacific Creek area. JFR 907.

BECKMANNIA SYZIGACHNE (Steud.) Fern. Sloughgrass. Infrequent near margin of Pacific Creek. JFR 908.

BROMUS ANOMALUS Rupr. Bromegrass. Frequent along Snake River. JFR 1345.

BROMUS CARINATUS Hook. & Arn. Common in the sagebrush flats and Snake River. RJS 942, JFR 1347.

BROMUS CILIATUS L. Common along the Snake River. RJS 944, JFR 1558.

*BROMUS COMMUTATUS Schrad. Infrequent along roadsides of the valley. JFR 2515.

*BROMUS INERMIS Leyss. Common under aspen near Snake River, Wildlife Range. JFR 1245.

*BROMUS JAPONICUS Thunb. Infrequent along roadsides of the Wildlife Range. JFR 3017.

BROMUS MARGINATUS Nees. Frequent in meadow at mouth of Berry Creek. AAB 14247.

*BROMUS TECTORUM L. Common in disturbed areas. JFR 2150.

CALAMAGROSTIS CANADENSIS (Michx.) Beauv. Reedgrass. Common in meadows of the Wildlife Range and west end of Amphitheater Lake. JFR 2660, JM 62-94.

CALAMOGROSTIS INEXPANSA A. Gray. Frequent in damp areas in Wildlife Range. JFR 1608.

CALAMAGROSTIS RUBESCENS Buckl. Frequent in "potholes" of the valley floor. ETO.

CALAMAGROSTIS SCRIBNERI Beal. East side Timbered Island. ETO 1287.

CATABROSA AQUATICA (L.) Beauv. Brookgrass. Along Snake River east of Wildlife Range. C. LaMotte (no number).

CINNA LATIFOLIA (Trev.) Griseb. Woodreed. Cascade Canyon trail, 8,000 ft. JFR 3006.

*DACTYLIS GLOMERATA L. Orchardgrass. Frequent on the banks of the Snake River near Moose. RJS 946.

DANTHONIA CALIFORNICA Boland. Oatgrass. Dry ledges in Cascade Canyon, 7,500 ft. JFR 2994.

DANTHONIA INTERMEDIA Vasey. Frequent in elk pasture of the Wildlife Range and above Amphitheater Lake. JFR 2508, LW 1409.

DANTHONIA UNISPICATA (Thurb.) Munro. Locally frequent to infrequent in sagebrush flats. RJS 956, 1539.

DESCHAMPSIA ATROPURPUREA (Wahl.) Scheele. Hairgrass. Common in major canyons and around subalpine lakes. JM 3012.

DESCHAMPSIA CAESPITOSA (L.) Beauv. Frequent on Moose Island in the Snake River, Wildlife Range, and in Willow Flats. JFR 1180, ETO 1209.

ELYMUS CINEREUS Scribn. & Merr. Wildrye. Common in waste places. LW 1320.

ELYMUS GLAUCUS Buckl. Frequent along the Snake River in the vicinity of Moose. RJS 947.

FESTUCA IDAHOENSIS Elmer. Fescue. Common in sagebrush flats of the valley. JFR 1424.

FESTUCA OVINA L. Frequent on north side of Holly Lake, 9,600 ft. JM 63-60.

GLYCERIA BOREALIS (Nash) Batchelder. Mannagrass. Frequent on margins of small ponds in the Wildlife Range. JFR 1500.

GLYCERIA ELATA (Nash) A. S. Hitchc. Frequent in wet areas of the Wildlife Range. JFR 1566.

GLYCERIA STRIATA (Lam.) A. S. Hitchc. Frequent in Pacific Creek bed. JFR 917.

HESPEROCHLOA KINGII (S. Wats.) Rydb. [*Festuca kingii* Cassidy] Spike Fescue. North side of Holly Lake. JM 63-70.

HIEROCHLOE ODORATA (L.) Beauv. Sweetgrass. Infrequent in the Pacific Creek area and Wildlife Range. JFR 2254.

HORDEUM BRACHYANTHERUM Nevski. Meadow Barley. Common in the driest parts of the willow sedge area in the Wildlife Range. JFR 1535.

*HORDEUM JUBATUM L. Common in waste places. JFR 1504.

KOELERIA CRISTATA (L.) Pers. Junegrass. Common in the sagebrush flats. RJS 960, JFR 1410.

MELICA SPECTABILIS Scribn. Purple Oniongrass. Frequent in meadows of the Wildlife Range, and on the moraines of the valley floor. RJS 907, JFR 1343.

MUHLENBERGIA ANDINA (Nutt.) A. S. Hitchc. Foxtail Muhly. Common in sandy area near Pacific Creek. JFR 2536.

MUHLENBERGIA FILIFORMIS (Thurb.) Rydb. Frequent on sand in streambeds of the Wildlife Range. JFR 1577.

MUHLENBERGIA RACEMOSA (Michx.) BSP. Frequent in the meadows of the Wildlife Range. JFR 1004.

MUHLENBERGIA RICHARDSONIS (Trin.) Rydb. Frequent in the pothole area south of Jackson Lake. JFR 2722.

ORYZOPSIS ASPERIFOLIA Michx. Ricegrass. In Lodgepole-Pilgrim Creek. ETO 1523.

ORYZOPSIS EXIGUA Thurb. Frequent in vicinity of Holly Lake. JM 63-53.

ORYZOPSIS HYMENOIDES (Roem. & Schult.) Ricker. Big sagebrush community of the valley. D. R. Smith (no number).

PHALARIS ARUNDINACEA L. Canarygrass. Infrequent in wet areas of the Wildlife Range. JFR 2761.

PHLEUM ALPINUM L. Alpine Timothy. Frequent in the major canyons from 7,000 ft. to 10,000 ft. JM 62-51.

PHRAGMITES COMMUNIS Trin. Common Reed. Infrequent in water south of foot bridge, north end of String Lake. RJS 1082.

POA ALPINA L. Alpine Bluegrass. Owl Creek Canyon and Webb Canyon. AAB (no number).

POA AMPLA Merr. Berry Creek exclosure area. AAB (no number).

*POA ANNUA L. Frequent in the Wildlife Range. JFR 1060.

POA ARCTICA R. Br. Webb Canyon, 8,000 ft. AAB (no number).

*POA BULBOSA L. Frequent in disturbance sites at Colter Bay Maintenance Area. RJS 1550.

POA CANBYI (Scribn.) Piper. Common in aspen groves and meadows of the Wildlife Range. JFR 1342.

POA EPILIS Scribn. Common in woods, Holly Lake, 9,500 ft. JM 63-36.

POA FENDLERIANA (Steud.) Vasey. Frequent in the Elk Ranch and Amphitheater Lake. JFR 2321.

POA INCURVA Scribn. & Williams. Infrequent on cliffs overlooking Teton Glacier. JM 62-107.

POA INTERIOR Rydb. Frequent in the sagebrush flats. JFR 1407.

POA LEPTOCOMA Trin. Frequent in wet areas of the Wildlife Range. JFR 1064.

POA NERVOSA (Hook.) Vasey. Common in the forests of the Wildlife Range and Amphitheater Cirque. JFR 2249, LW 1035.

POA PALUSTRIS L. Frequent in the meadows of the Wildlife Range. JFR 1393.

POA PATTERSONII Vasey. Infrequent east end of Holly Lake. JM 63-35.

*POA PRATENSIS L. Frequent along the Snake River. RJS 943, JFR 918.

POA REFLEXA Vasey & Scribn. Webb Canyon near tree line. AAB (no number).

POA SANDBERGII Vasey. [*Poa secunda* of American authors, not Presl.] Webb Canyon near tree line. AAB (no number).

SITANION HYSTRIX (Nutt.) J. G. Smith. Squirreltail. Frequent in waste places. JFR 1420.

SPHENOPHOLIS OBTUSATA (Michx.) Scribn. Wedgegrass. Infrequent along the Snake River. JFR 2539.

STIPA COLUMBIANA Macoun. Needlegrass. Common in the meadows and forests of the Wildlife Range. JFR 939.

STIPA LETTERMANII Vasey. Common in the sagebrush flats. JFR 1402.

STIPA RICHARDSONII Link. Frequent in the lodgepole pine forest of the Wildlife Range. JFR 947.

STIPA VIRIDULA Trin. Frequent in Webb Canyon. AAB (no number).

TORREYOCHLOA FERNALDII (Hitchc.) Church. Infrequent 1½ miles south of Moose. B. Venrick (no number).

TORREYOCHLOA PAUCIFLORA (Presl) Church. [*Glyceria p.* Presl.] Frequent on margin of Pacific Creek bed. JFR 919.

TRISETUM SPICATUM (L.) Richt. Common in the coniferous forests of the valley and Amphitheater Lake. JFR 1048, JM 62-34.

TRISETUM WOLFII Vasey. Infrequent in the sagebrush of the Wildlife Range. JFR 1087.

HYDROCHARITACEAE

*ELODEA CANADENSIS Michx. Waterweed. Locally frequent at Two Ocean Lake outlet. D. Houston (no number).

IRIDACEAE

SISYRINCHIUM IDAHOENSE Bickn. Blue-Eyed Grass. Frequent two miles north of Moose on east bank of Snake River. RJS 537.

SISYRINCHIUM SARMENTOSUM Suksd. Locally frequent in wet meadow north of Cow Lake. RJS 1449.

JUNCACEAE

JUNCUS BALTICUS Willd. Rush. Locally common in wet areas of the Wildlife Range. JFR 1605.

JUNCUS BUFONIUS L. Common on moist sand in the Wildlife Range. JFR.

JUNCUS CONFUSUS Cov. Frequent in the sedge meadow of the Wildlife Range. JFR.

JUNCUS DRUMMONDII Meyer. Locally frequent around subalpine lakes and some peaks. RJS 1567, LCA 440.

JUNCUS ENSIFOLIUS Wikstr. Common in wet areas of the Wildlife Range and Willow Flats. JFR 1603, ETO 1264.

JUNCUS FILIFORMIS L. Rare in the sedge meadow of the Wildlife Range. JFR 1090.

JUNCUS LONGISTYLIS Torr. Common in wet areas of the Wildlife Range. JFR 1627.

JUNCUS MERTENSIANUS Bong. Stream bank near Lake Solitude, and Holly Lake. LW 1702, JM 63-83.

JUNCUS PARRYI Engelm. Frequent in the sedgegrass meadows of the Wildlife Range and up to 7,500 ft. of the slopes of Symmetry Spire. RJS 968.

JUNCUS SAXIMONTANUS A. Nels. Frequent along streambeds of the Wildlife Range. RJS 1217, JFR 897.

JUNCUS TRACYI Rydb. Frequent in main couloir on the east face of Symmetry Spire, 8,000 ft. RJS 967.

LUZULA GLABRATA (Hoppe) Desf. Woodrush. Common in Holly Lake area. FWP 11945, JM 63-91.

LUZULA SPICATA (L.) DC. Near summit of Table Mt., 10,900 ft. LCA 435, 527.

LUZULA WAHLENBERGII Rupr. Frequent, Timberline Lake and Amphitheater Lake. RJS 1153, 1595.

LEMNACEAE

LEMMA MINOR L. Duckweed. Locally common in small quiet ponds in the vicinity of Jackson Lake Dam. RJS 911, 1604.

LEMMA TRISULCA L. Infrequent on surfaces of quiet ponds in vicinity of Jackson Lake Dam. JFR 2543.

SPIRODELA POLYRHIZA (L.) Schleid. Great Duckweed. Moose Ponds —west of Jenny Lake. C. W. Lahser 508.

LILIACEAE

ALLIUM BREVISTYLUM S. Wats. Wild Onion. Frequent along Snake River below Jackson Lake Dam. RJS 535, LW 1211.

ALLIUM RUBRUM Osterhout. Locally common ¼ mile downstream from Jackson Lake Dam, south side. RJS 1507.

ALLIUM SCHOENOPRASUM L. Frequent along Snake River and into canyons up to 8,500 ft. RJS 972, LW 1227.

BRODIAEA DOUGLASII (Lindl.) S. Wats. Infrequent in the area of the Sawmill Ponds. RJS 510, LW 789.

CALOCHORTUS NUTTALLII Torr. Sego Lily. Infrequent on east side of valley on Gros Ventre Slide Road, also reported on Blacktail Butte. RJS.

CAMASSIA QUAMASH (Pursh) Greene. Blue Camas. Locally frequent in wet meadows of the valley north of Jackson Lake Dam. RJS 518, 841.

DISPORUM TRACHYCARPUM (S. Wats.) B. & H. Wartberry Fairy Bells. Frequent along the Snake River, and in the mouth of Death Canyon. RJS 739, 1005.

ERYTHRONIUM GRANDIFLORUM Pursh. Fawnlily. Common in North Fork of Cascade Canyon above 8,000 ft. RJS 1202.

FRITILLARIA ATROPURPUREA Nutt. Purplespot Fritillary. Infrequent on trails around valley lakes. RJS 622, LW 1137.

FRITILLARIA PUDICA (Pursh) Spreng. Common in the sagebrush flats. LW 1097.

LLOYDIA SEROTINA Reichb. Alplily. Infrequent at the head of Death Canyon, 9,600 ft. HEB 207.

SMILACINA RACEMOSA (L.) Desf. var. AMPLEXICAULIS (Nutt.) S. Wats. False Solomon Seal. Frequent around the shores of the valley lakes and along the Snake River. RJS 1198, LW 1120.

SMILACINA STELLATA (L.) Desf. Frequent around the shores of the valley lakes and along the Snake River. RJS 619.

STREPTOPUS AMPLEXIFOLIUS (L.) DC. Twisted Stalk. Frequent along stream, trail west shore of Jenny Lake, also John Graul Mine in Webb Canyon. RJS 882, 1464.

TOFIELDIA GLUTINOSA (Michx.) Pers. ssp. MONTANA C. L. Hitchc. Infrequent around Bradley and Leigh Lakes, also around some subalpine lakes above 9,000 ft. RJS 681, 1559, LW 1195.

VERATRUM ESCHSCHOLTZIANUM (R. & S.) Rydb. [*V. viride* of intermountain authors not Ait.] Locally frequent in wet meadow beside trail to Phelps Lake, ¾ of a mile above White Grass Patrol Cabin. RJS 869.

XEROPHYLLUM TENAX (Pursh) Nutt. Beargrass. Locally frequent in wet soil at the east end of Grassy Lake Dam near divide of Reclamation Road, 10 miles west of Flag Ranch, 6,900 ft. RJS 850. Rare in Waterfall Canyon-no specimen-only photograph seen.

ZIGADENUS ELEGANS Pursh. Death Camas. Infrequent on ledges around Amphitheater Lake. LW 1012.

ZIGADENUS PANICULATUS S. Wats. Frequent in the sagebrush flats and Elk Island in Jackson Lake. RJS 511, 1320.

ZIGADENUS VENENOSUS S. Wats. Locally frequent in major canyons above 9,000 ft. RJS 678, 1463.

POTAMOGETONACEAE

POTAMOGETON ALPINUS Balbis var. TENUIFOLIUS (Raf.) Ogden. Pondweed. Frequent in ponds of the Wildlife Range. JFR.

POTAMOGETON BERCHTOLDII Fieb. Frequent in beaver ponds of Wildlife Range. JFR 1521.

POTAMOGETON FILIFORMIS Pers. Common in ponds in the north end of the valley. JFR 1524, WGS 4269.

POTAMOGETON FOLIOSUS Raf. Submerged in Swan Lake. WGS 4070.

POTAMOGETON FRIESII Rupr. Frequent in Wildlife Range. JFR 1511.

POTAMOGETON GRAMINEUS L. Frequent in ponds of Wildlife Range. JFR 1497.

POTAMOGETON NATANS L. Swan Lake. WGS 4071.

POTAMOGETON RICHARDSONII (Benn.) Rydb. Common in ponds of the Wildlife Range and Swan Lake. RJS 709, WGS 3999.

POTAMOGETON ZOSTERIFORMIS Fern. Submerged in Swan Lake. WGS 4067.

ORCHIDACEAE

CALYPSO BULBOSA (L.) Oakes. Fairy Slipper Orchid. Infrequent in deep shade and local areas of decaying wood in the valley. RJS 698, 1538.

CORALLORHIZA MACULATA Raf. Coralroot. Frequent in morainal soil around the shores of the valley lakes. RJS 1019, WGS 4544.

CORALLORHIZA MERTENSIANA Bong. Frequent in lodgepole around valley lakes. RJS 1554, 1205.

CORALLORHIZA STRIATA Lindl. Rare on first switchback in the mouth of Death Canyon, 6,700 ft., also Bradley Lake Bridge. RJS 843, 1551.

CORALLORHIZA TRIFIDA Chat. Teton Glacier Trail. HVT 54378.

GOODYERA OBLONGIFOLIA Raf. Rattlesnake Plantain. Rare at south end of String Lake on the String Lake Trail and on second switchback above Hidden Falls Bridge. RJS 689, 961.

HABENARIA DILATATA (Pursh) Hook. Bog Orchid. Infrequent in wet areas on moraines and the major canyons up to 8,500 ft. RJS 995, 1208.

HABENARIA HYPERBOREA (L.) R. Br. Infrequent along Snake River near Biological Station. WGS 3922, ETO 1022.

HABENARIA OBTUSATA (Banks) Richards. Rare at the base of the north slope of Signal Mt. WGS 4100.

HABENARIA UNALASCENSIS (Spreng.) S. Wats. Locally frequent in shade of lodgepole on the east side of Jackson Lake. RJS 660, 1415.

LISTERA CONVALLARIOIDES (Sw.) Nutt. Rare on west shore of Jenny Lake. RJS 542, WGS 4224.

LISTERA CORDATA (L.) R. Br. Locally frequent near pond on Elk Island, Jackson Lake and Indian Paintbrush Canyon Trail. RJS 1509, 1515.

SPIRANTHES ROMANZOFFIANA Cham. & Schlecht. Ladies' Tresses. Frequent along the Snake River and ponds east of Colter Bay. RJS 672, 1529.

SPARGANIACEAE

SPARGANIUM ANGUSTIFOLIUM Michx. Burreed. Infrequent in beaver ponds along the Snake River and ponds near Colter Bay. RJS 714, 959, 1573.

TYPHACEAE

TYPHA LATIFOLIA L. Cattail. Locally common in wet areas of the Wildlife Range. JFR 1649.

STATISTICAL SUMMARY OF THE VASCULAR PLANTS OF GRAND TETON NATIONAL PARK[1]

	Indigenous			Naturalized Additional		
	Families	*Genera*	*Species*	*Families*	*Genera*	*Species*
Pteridophytes	7	15	19	0	0	0
Gymnosperms	2	5	9	0	0	0
Dicotyledons	56	211	489	5	34	60
Monocotyledons	10	60	177	1	2	12
Totals:	75	291	694	6	36	72

Grand Totals:

Families	81
Genera	327
Species	766

Largest Families (Native + Naturalized Species)

Compositae	96 + 19	Leguminosae	20 + 9
Gramineae	73 + 11	Ranunculaceae	27 + 0
Cyperaceae	43 + 0	Saxifragaceae	24 + 1
Cruciferae	29 + 9	Liliaceae	20 + 0
Scrophulariaceae	34 + 3	Salicaceae	20 + 0
Rosaceae	34 + 2		

Largest Genera (Native + Naturalized Species)

Carex	36 + 0	Ranunculus	11 + 0
Poa	14 + 3	Astragalus	10 + 0
Salix	16 + 0	Antennaria	10 + 0
Potentilla	14 + 0	Erigeron	10 + 0
Juncus	11 + 0	Senecio	10 + 0

[1]Based on table in: Thorne, R. F. 1967. A flora of Santa Catalina Island, California. Aliso 6: 1-77.

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CARYOPHYLLACEAE: ARENARIA CONGESTA. Sandwort.

COMPOSITAE: BALSAMORHIZA SAGITTATA. Balsamroot.

GENTIANACEAE: FRASERA SPECIOSA. Green gentian.

MALVACEAE: ILIAMNA RIVULARIS. Globemallow.

ONAGRACEAE: OENOTHERA CAESPITOSA. Evening primrose.

POLYGONACEAE: ERIOGONUM UMBELLATUM var. SUBALPINUM.
Eriogonum or wild buckwheat.

PORTULACACEAE: CLAYTONIA LANCEOLATA. Spring beauty.

PYROLACEAE: PYROLA ASARIFOLIA. Shinleaf.

RANUNCULACEAE: RANUNCULUS JOVIS. Buttercup.

UMBELLIFERAE: HERACLEUM LANATUM. Cowparsnip.

LILIACEAE: FRITILLARIA PUDICA. Yellow fritillary.

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CONTENTS

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A TREATMENT OF ABILDGAARDIA, BULBOSTYLIS AND FIMBRISTYLIS (CYPERACEAE) FOR NORTH AMERICA[1]

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Fimbristylis, Bulbostylis, and *Abildgaardia* of the Tribe Scirpeae (Cyperaceae) comprise approximately 300 species, primarily of warm temperate, tropical, and subtropical regions around the world. A clear majority are plants of full sunlight, humid climate and high hydroperiod soils, though many *Bulbostylis* are found on sandy substrates that are as a rule drier than those on which *Fimbristylis* succeeds. While the number of endemic species is considerable there are many species, particularly of *Fimbristylis,* that have become widespread as wetlands weeds because of their introduction either in ship's ballast or with rice into the rice growing areas of the world. It is difficult, in the case of such ubiquitous species, to ascertain their area of origin; however, in that the older rice cultivating regions of the globe are South Asian, it is reasonable to suppose that Southern Asia is at least one of the areas in which these species are native. However the case, their synonymy is impressive (Svenson, 1957, credited Clarke with stating that 400 synonyms exist for the "dichotoma" complex alone!); it is not unlikely that a world-wide revision of these three genera would do much to relieve a nomenclature already overburdened by those who feel bound to describe new species of weeds.

The most current treatment of North American *Abildgaardia, Bulbostylis,* and *Fimbristylis* is that of Svenson (1957), and it is both adequate and sensible. It was based primarily upon herbarium specimens, hence was probably intended to be quite conservative. Such factors as habitat, vegetative characteristics and cytology were not considered, emphasis essentially being placed upon spikelet and fruit features. These are still among the most reliable criteria for cyperaceous plants. However, since the time of that study, a good deal more evidence has come to light, both in regard to more specimens and additional criteria. The works of Kern (1955 et al.), Koyama (1961 et al.), and Gordon-Gray (1965) among others are instructive treatises regarding a new approach to a more comprehensive treatment of these plants.

My own attack has been based primarily on a field-herbarium study. However, cytological materials have been gathered from parts of the U. S. A. and Mexico; also specimens of most of the species have been successfully

[1]Manuscript received for publication 17 April 1968. (*Editor's note.*)

raised from seed in the greenhouse, giving me the opportunity to make prolonged observations of living plants. This kind of work was commenced in 1963 and now, after five years and many thousands of miles covered in the field, the compilative stage is reached with but slightly less trepidation on my part. While the number of taxa treated here is but slightly over 50, there are three major obstacles to a final, definitive, study. Firstly, there is the weedy character and circumglobal distribution of many of the species which adds greatly to the problem of resolving their nomenclature. Secondly, there is the problem of the fineness of the characters that sometimes delimit species within complexes. Thirdly there is the difficulty of deciding whether these species are in three genera, two genera, or actually make up but one genus. Adding further to the complexity is the fact that no one section either of *Fimbristylis* or *Bulbostylis* is itself confined to North America; therefore no one part of this particular work could itself be deemed complete. Hence, my chosen alternative is one of expedience. It is the purpose of this work hopefully to clarify circumscription of species, and to leave out most speculation as to problems of generic versus sectional rank for *Bulbostylis* and *Abildgaardia*. One is presently confronted with several nomenclatural alternatives, at a time when much field and experimental evidence yet remains to be gotten. The work of Tanaka (1939 et al.) is an indication that many Scirpoid genera *(Eleocharis, Scirpus, Fimbristylis, Bulbostylis)* and some genera of other tribes show a marked departure from the usual angiospermous mode of microsporogenesis. Koyama's (l.c.) work has shown the tremendous potential of studies made of floral and spikelet anatomy and morphology. Ultimately, the above sort of work, when combined with traditional morphological approaches, will lead to a better understanding of what constitutes generic characteristics in the Cyperaceae. Yet while the pilot work is hardly done the family is presently undergoing what seems to be a lot of nomenclatural upheaval. Perhaps wholesale combinations ought to be deferred until such time as the genera of Cyperaceae are better collected, hence better known at the species level. My own area of study is very well known compared to many equivalent areas of Asia or the New World and yet I am obliged in my treatment to add several new taxa. In other words, who is presently to know which species actually comprise the limits of cyperaceous genera as presently understood?

Some workers have treated *Bulbostylis* (a segregate in large part of the old, now obsolete and highly artificial genus *Isolepis* R. Br.) and *Abildgaardia* as sections of *Fimbristylis*. The former is comprised of tufted, wirey-leaved, eligulate plants, usually of sandy soils. The orifice of the leaf sheaths is, in these species, long-hairy. Spikelets are, as in *Fimbristylis,* from solitary to densely clustered or loosely cymose. Usually the style base persists as a small, button-like, tubercle, or fits cap-like over an apical projection of the akene body. All *Bulbostylis* have trifid, smooth styles and, usually, 3-angled akenes. *Abildgaardia* is, in the area of this treatment, comprised of but two species of bulbous-based, eligulate, perennials. The spikelets are essentially distichous, though sometimes individual spikelets have torque. The akenes are stipitate-obovoid, the surfaces warty; the styles are trifid and smooth. Thus it does appear that the differences distinguishing these two genera from *Fimbristylis* or from each other are few; in fact some species of *Fimbristylis* exhibit certain of the characteristics mentioned above. However, generic differences in Cyperaceae are often few at best. Some *Scirpus* and *Eleocharis (Heleocharis)* have a perianth, some do not. The showy white bracts of *Dichromena* are not present in all of its species; *Psilocarya* exhibits many characteristics of *Rhynchospora; Fuirena* species range from having well developed perianth of two cycles of segments of which three are bladed, to some examples having no perianth, and so forth. Number of florets per spikelet ranges so widely within the tribe as to further obscure generic limits as now understood. Carpel number, a character which often delimits families of angiosperms, ranges from two to three within many sedge genera.

Therefore my own treatment essentially has followed the conservative nomenclature employed by Svenson, Clarke and Kunth, and for the following reasons:

1. Many of those workers who would merge *Abildgaardia* and *Bulbostylis* with *Fimbristylis,* still recognize the first two categories as sections, hence acknowledge that these comprise biological units. Both groups, at least as treated for North America, are therefore recognizable whatever rank they carry. I treat them still as genera in order to present the least exercises in nomenclature.

2. If consistency of treatment of cyperaceous plants is to be sought and if a philosophy similar to that back of the merger of *Bulbostylis* and *Abildgaardia* is to be followed, so many other combinations ought to be made just for North American representatives (i.e. *Eleocharis, Dichromena, Kyllinga, Psilocarya, Websteria,* etc.) that very few of the genera today recognized would appear in treatments, and these would be immensely cumbersome in terms of the large numbers of species involved. By this sort of reasoning, no "generic level" difference might be found to distinguish *Eleocharis* from *Scirpus, Eriophorum* from *Scirpus, Fimbristylis* from *Scirpus,* etc., and we would have a return to something very like the original Linnaean sense of cyperaceous genera. I do not claim to know how advisable this would be, but do think that the problem ought to be posed. I feel that the employment of what have been called genera as sections of other genera (as is true in this case) which themselves are on shaky ground if consistency is the objective, is perhaps premature.

ACKNOWLEDGMENTS

The present work has involved the getting of over 13,000 duplicate specimens of *Abildgaardia, Bulbostylis* and *Fimbristylis;* these are being dis-

tributed at the present time.[2] However, the study could not possibly reach even this stage of completion without the help provided by curators and staffs of the following institutions in providing specimens and/or photographs of types (symbols for herbaria are those suggested by Lanjouw and Stafleu, 1964): ARIZ, University of Arizona, Tucson; B, Botanisches Museum, Berlin; BM, British Museum (Natural History), London; C, Botanical Museum and Herbarium, Copenhagen, Denmark; CHARL, the Charleston Museum, Charleston, S. C.; DS, the Dudley Herbarium, Stanford University, Stanford, California; ENCB, Escuela Nacional de Ciencias Biologicas, Instituto Politecnico Nacional, Mexico City, Mexico; FSU, the Herbarium, Department of Biological Sciences, Florida State University, Tallahassee; FPDB, the Herbarium, Department of Biology, Mayaguez, Puerto Rico; GH, the Gray Herbarium of Harvard University, Cambridge, Massachusetts; ILL, the Herbarium, Department of Botany, University of Illinois, Urbana; KANU, the Herbarium of the University of Kansas, Lawrence; LAF, the University of Southwestern Louisiana Herbarium, Lafayette; LL, the Lundell Herbarium, Texas Research Foundation, Renner; MICH, the Herbarium of the University of Michigan, Ann Arbor; MO, the Missouri Botanical Garden, St. Louis, Missouri; MSC, the Herbarium of Michigan State University, East Lansing; NCU, the Herbarium of the University of North Carolina, Chapel Hill; NEB, the University of Nebraska State Museum, Lincoln; NSC, the Herbarium, Department of Botany, North Carolina State University, Raleigh; NY, the New York Botanical Garden, New York, N.Y.; P. Museum National d' Histoire Naturelle, Laboratoire de Phanerogamie, Paris, France; RSA, the Rancho Santa Ana Botanic Garden, Claremont, California; SMU, the Herbarium, Southern Methodist University, Dallas, Texas; TENN, the Herbarium, Department of Botany, University of Tennessee, Knoxville; TEX, the University of Texas Herbarium, Austin; UC, the Herbarium, Department of Botany, the University of California, Berkeley; US, the U.S. National Museum, Smithsonian Institution, Washington, D. C.; VDB, Vanderbilt University Herbarium, Nashville, Tennessee. Several special collections made by Dr. Sidney McDaniel, Dr. D. Demaree, and Mr. F. H. Sargent have also been examined.

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[2] A complete set of my collections is, of course, at VDB. The largest duplicate sets (ranging in size from 600 to over 1,000) are at C, DS, FSU, GH, KANU, MICH, MISSA, MSC, NY, SMU, UC, US. These were sent out from 1968 to early 1969. Representative sets have been sent to B, BM, DUKE, FPDB, ILL, LAF, LL, MO, NCU, NSC, P, PH, RSA, TEX, WIS. A large set was sent to the Herbarium of the University of Missouri at Kansas City and to the Herbarium, Instituto Politécnico, Mexico City. Additional material has been distributed later, mostly incorporated into routine exchanges. Citations for all my collections together with those of others examined will ultimately be put into a master-list which will be made available to curators.

not only making available a large store of fine and recently collected specimens, but also for imparting to me a small part of his great knowledge of the flora of the southeastern United States; to Dr. A. Skovsted and to Dr. A. Lourteig of C and P respectively, who have provided me loans of critical type material without which my concept of many of the earlier names of *Fimbristylis* species would not have been possible; to Dr. J. Rzedowski, Instituto Politecnico, Mexico City, for his great help in directing me to critical collecting localities and thereby making my trips to Mexico far more productive than they otherwise might have been. Also, though there is no satisfactory way for me to communicate my thanks to countless good people from both north and south of the Mexican border, who provided friendly assistance along the way, these thanks are nonetheless heartfelt.

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MORPHOLOGY

Habit. Abildgaardia, Bulbostylis and *Fimbristylis* comprise both annual and perennial species. Perennation does not seem to be related to latitude; in other words, some species are not perennial in the southern part of their range, annual to the north. Material of annual species (i.e. *B. barbata, B. capillaris, F. autumnalis, F. miliacea, F. vahlii, F. annua, F. tomentosa)* grown in the greenhouse under fairly uniform temperature start to die back toward the end of summer or at the time of fruit maturation; these are true annuals. Perennial species (i.e. *B. ciliatifolia coarctata, B. juncoides, F. puberula, F. caroliniana, F. thermalis, F. argillicola,* etc.) also start to die back at about the time most of the fruit is mature and being shed; however these are at the same time developing overwintering buds or shoots or both. All species have an erect or ascending culm habit and leaves which tend to crowd toward the base of the culm.

Rootstock. The two species of *Abildgaardia* treated here perennate from clusters of bulbous-based culms, these developing as lateral offshoots. *Bulbostylis* species are strictly caespitose, with fibrous-diffuse root systems. Some species of *Fimbristylis* (e.g. *F. puberula, F. caroliniana, F. thermalis)* are rhizomatous. *F. caroliniana* may produce huge clones by systems of slender, elongate, shallow rhizomes. *F. puberula* var. *puberula* characteristically produces shorter, stouter rhizomes which are actually systems of coalesced bulbous plant bases. However, in the case of this latter species, character of the substratum and/or amount of ground water present may have some effect, for some *F. puberula* may produce crops of slender rhizomes in addition.

Most species of *Fimbristylis* are caespitose and arise from diffuse fibrous roots systems; bases of the perennials are often deepset and hard while those of the annuals are shallowly set. Perennials have the thickest roots.

Leaves. The leaves of *Abildgaardia* and *Bulbostylis* are usually arranged in spiral fashion toward the culm base. The leaves of *Fimbristylis* may be distichous (*F. autumnalis, F. miliacea,* etc.) or spirally arranged. The leaf bases in all three genera are characteristically clasping or actually form a sheath, the margins of which are quite thin, sometimes scarious. In some *Fimbristylis* a ligule of short, appressed, upwardly directed hairs is present. Neither *Abildgaardia* nor *Bulbostylis* produces a comparable structure. The apex of the leaf sheath in *Bulbostylis* is fimbriate or long-hairy in all North American species, this constituting a good generic character. Leaf blades in all three genera are of an elongate-linear type; in some species they are flat while in others they may be very inrolled. Vestiture of foliage may range from perfectly smooth, to scabrous or quite pubescent. Trichome characters are often useful in distinguishing species within species complexes.

Scapes. The scapes of *Abildgaardia, Bulbostylis* and *Fimbristylis* are usually rigid, erect or ascending, terete, angulate or somewhat flattened, and range from smooth to variously hairy. In such species as *B. setacea, B. pauciflora, B. funckii, F. complanata, F. autumnalis,* the morphology of the leaves and scape is too similar to escape notice. In these, the longest involucral bract often appears to be merely an extension of the scape; often an inflorescence will abort or no spikelets will form, and the scapes appear even more leaf-like.

Inflorescence. The basic type of inflorescence for all three genera is the spikelet. This is comprised of several to very many florets arranged in a spiral to subdistichous fashion on the axis, each subtended by a scale. In most *Fimbristylis* and *Bulbostylis*, the arrangement of the florets is in a distinct spiral; in *Abildgaardia* there is a tendency toward a distichous arrangement. Often the lowermost scales of a spikelet are barren, but the number of barren scales while low in all cases varies between species. The midribs of the lowermost fertile scales often are excurrent, these in the spikelet often grading above into scales with the midrib included and below into the involucral bracts which have prominent, leaflike blades. The spikelets themselves may be solitary on the scape (as is the case in *F. schoenoides, Abildgaardia ovata,* or *B. pubescens*) or arranged in simple or complex umbelliform arrangements of spikelets or cymules of spikelets. In species which normally have several spikelets, crowding or droughtiness may result in depauperate individuals which produce solitary spikelets. In most of the species which have branched inflorescences, the commonest arrangement is for the primary rays to arise around a central, sessile spikelet, the whole structure invested in one or more leaf-like involucral bracts. These primary rays are usually of varying length and may terminate in but a single spikelet, an involucrate cluster of three spikelets with the central one sessile, or themselves may be compound. The commonest number of spikelets within individual cymules is three. Great extremes exist within *Fimbristylis* and *Bulbostylis* ranging from considerable reduction of primary or primary and secondary rays to produce a densely glomerate, or head-like cluster (e.g. *B. warei, B. vestita, B. stenophylla, F. spathacea)* to a highly diffuse, highly branched system *(B. ciliatifolia* var. *coarctata, B. capillaris, B. juncoides* (extremes), *F. dichotoma, F. spadicea, F. complanata,* etc.).

Sequence of flowering on the plant is as to be expected in cymose arrangements; the central spikelets develop first, and there is progressive development outward. Sequence of flowering within the spikelet is acropetal; in each floret the gynoecium reaches anthesis before the androecium. The usual flowering pattern is for the florets of one or more of the close-set spirals of a spike to put forth stigmatic surfaces; then anthers from these same spirals will be exserted, but by this time the stigmatic areas have already turned brown; then stigmatic surfaces will protrude from the next set of spirals above, and so forth. The inflorescence is indeterminate, hence the total length of an older spikelet will show, from apex to base, a growing tip, a series of spirals of immature florets, some spirals either putting out stigmas or anthers, some spirals with fruit in various stages of development, and finally a basal portion of rachis from which the scales and akenes have fallen. In all cases the flowering pattern is for all florets of one or two (or more) spirals in a given spikelet to put forth anthers *or* stigmatic surfaces; it is never the case that both sexes are in anthesis at the same time in a given spikelet. Usually the entire plant is either receiving or sending pollen. Hence there appear to be few opportunities for pollen from one plant to reach stigmatic surfaces of that plant; out-crossing appears to be the rule.

Flowers. The flower of *Abildgaardia, Bulbostylis,* and *Fimbristylis* lacks a perianth. It is short-pedicellate, and this "joint" is itself subtended by a scale which conceals all but the exserted style tips and anthers. Stamen number varies somewhat within species, but is within the range of from one to three, uncommonly four. Annual species tend to have lower numbers, often only one, while the perennials tend to have three per flower. The anthers are short or long linear or oblong, basifixed, and in some species with the apices of the thecae plus elements of the connective prolonged into a narrowed and sterile apex. The two thecae on either side of the connective release their pollen at its maturity by means of a single lateral and longitudinal slit. The gynoecium is made up of two or three carpels; the three-carpellate types have, as a rule, trigonous fruit while the two-carpellate types produce lenticular or columnar fruit. In *Fimbristylis* the style is early trichomiferous.

Fruit. The fruit in all three genera is a trigonous, cylindrical or lenticular akene whose sculpturing is usually specific. In *Bulbostylis* the style base is usually persistent at the summit of the akene; in *Abildgaardia* and *Fimbristylis* it is deciduous. In *Abildgaardia,* the surface of the fruit is finely reticulate, the reticulum being made up of roughly isodiametric to horizontally oriented rectangular cells and in addition is usually coarsely verrucose; in *Bulbostylis* the pericarp is usually made up of rows of vertical, narrowly rectangular to almost linear cells, less commonly of isodiametric cells, the whole surface either rugose or papillose or both; in *Fimbristylis* the pericarp is usually reticulate, the reticule usually made up of horizontally oriented rectangular cells or of isodiametric cells, in either case appearing to be arranged in vertical rows, and sometimes verrucose as well.

CYTOLOGY

As has been commented on by Tanaka (1939, 1941), the mode of microsporogenesis in *Fimbristylis* and *Bulbostylis* is unusual. In my own observations of this phenomenon, the nucleus of the microspore mother cell meiotically divides, then divides mitotically in traditional fashion. However, cytokinesis does not take place. Sutures form in the mother cell wall, but no complete wall formation occurs. Instead, three of the tetrad of haploid nuclei retire to one end of the microsporocyte (at this stage the cell outline is obovoid) and lose both size and distinctness. At the same time the fourth nucleus again divides mitotically. Of these two products, one loses size and joins the other three reduced nuclei. The remaining, or fifth, nucleus is that which later will give rise to pollen tube and sperm. At the time of the third division, the wall of the microspore mother cell thickens and internal detail is gradually lost as the characteristic, pebbled, sculpturing of the exine takes place (see illustrations of the various stages).

In short, the entire process of microsporogenesis takes place within the microspore mother cell wall, which itself becomes the covering of the single pollen grain produced in the process. I have observed this in *Fimbristylis, Abildgaardia* and *Bulbostylis* and assume therefore that it is at least a widespread phenomenon in the three genera. I have seen it also in eight species of *Fuirena (F. pumila, F. squarrosa, F. simplex, F. longa, F. scirpoidea, F. breviseta, F. umbellata,* and one undetermined species); this will be reported on in a later paper. All of these genera are members of the Scirpeae. It is interesting that, in the case of such sedges, microsporogenesis is somewhat similar to megasporogenesis in some other plants.

CHROMOSOME COUNTS IN ABILDGAARDIA, BULBOSTYLIS, FIMBRISTYLIS

Several chromosome counts have been made of Fimbristyloid sedges prior to my own efforts. A check of the Chromosome Atlas (Darlington and Wylie, ed. 2, 1955, plus supplements) reveals the following:

1. *Abildgaardia monostachya* (equals *A. ovata),* 2N equals 20 (Sharma and Bal, 1956).
2. *Bulbostylis barbata,* N equals 5 (Tanaka, 1939).
3. *Bulbostylis capillaris* var. *trifida,* 2N equals 84 (Tanaka, 1937).
4. *Fimbristylis aestivalis,* 2N equals 10 (Sharma and Bal 1956); N equals

5 (Chuang et al, 1963).

5. *Fimbristylis autumnalis,* N equals 5, 2N equals 10 (Tanaka 1937).
6. *Fimbristylis complanata,* 2N equals 16 (Tanaka, 1939).
7. *Fimbristylis complanata,* N equals 5 (Sharma, 1962).
8. *Fimbristylis cymosa,* N equals 28, 2N equals 48 (Skottsberg, 1955).
9. *Fimbristylis dichotoma* (probably *F. tomentosa),* 2N equals 10 (Sharma and Bal, 1956).
10. *Fimbristylis dichotoma* (probably *F. tomentosa),* N equals 5 (Sharma, 1962).
11. *Fimbristylis diphylla* (probably *F. dichotoma),* 2N equals 20 (Sharma and Bal, 1956).
12. *Fimbristylis diphylloides* (equals *F. tristachya),* 2N equals 10 (Tanaka, 1939).
13. *Fimbristylis makinoana,* 2N equals 24 (Tanaka, 1939).
14. *Fimbristylis miliacea,* 2N equals 10 (Tanaka, 1939).
15. *Fimbristylis miliacea,* 2N equals 10 (Gadella and Klip., 1964).
16. *Fimbristylis miliacea,* N equals 5 (Chuang et al, 1963).
17. *Fimbristylis quinquangularis,* N equals 5 (Dnyansagar and Tiwari, 1956).
18. *Fimbristylis sericea,* 2N equals 44 (Tanaka, 1939).
19. *Fimbristylis, squarrosa,* 2N equals 20 (Tanaka, 1939).
20. *Fimbristylis subbispicata,* 2N equals 10 (Tanaka, 1939).

My technique for making aceto-carmine smears permanent has been that described by Beeks (1955), which involves Hoyer's Solution. The handling of root tips was based on the double-staining method of Snow (1963). I have had some difficulty with the Beeks technique, some material not holding up more than a few days and other material being still good after four years. Chromosome counts are summarized below:

Abildgaardia mexicana (N10); *A. ovata* (N10); *Bulbostylis barbata* (N5); *B. pubescens* (N5, 10); *B. funckii* (N10); *B. stenophylla* (N15); *B. hirta* (N15); *B. warei* (N15); *B. trilobata* (N25); *B. ciliatifolia* var. *coarctata* (N30); *B. junciformis* (N30); *B. vestita* (N30); *B. juncoides* (N60); *Fimbristylis autumnalis* (N5, 2N10); *F. complanta* (N5); *F. miliacea* (N5); *F. schoenoides* (N5); *F. tomentosa* (N5); *F. perpusilla* (N5); *F. vahlii* (N10); *F. thermalis* (N10); *F. spadicea* (N10); *F. pallidula* (N10); *F. castanea* (N10); *F. argillicola* (N10); *F. decipiens* (N10); *F. annua* (N15); *F. dichotoma* (N10, 15); *F. puberula* var. *interior* (N10); *F. puberula* var. *puberula* (N10, 20); *F. caroliniana* (N10, 20, 30); *F. spathacea* (N24).

A polyploid series from the base number of 5 appears to be the case in most of the North American examples; the only exception is *F. spathacea,* which appears to have arisen from another series whose base number could be either 6 or 8.

In *F. dichotoma, F. puberula* and *F. caroliniana* two or more chromosome complements exist within species. In the case of *F. dichotoma,* the haploid number of 10 appears to correlate in most cases with a denser inflorescence, but this external character difference breaks down in Mexico. In the case of *F. puberula* var. *puberula*, the haploid complement of 10 is far more frequent than 20. In the case of *F. caroliniana*, the haploid complement of 30 may be associated with a taller, more robust, exclusively coastal form; the count of 20 is morphologically intermediate in its external form to individuals whose complement is 10. These latter may be rhizomatous forms of *F. puberula* or actual hybrids between the two species. This remains to be determined; certainly at this stage of the study I am at a loss as how to annotate such examples.

A list of specimens which serve as vouchers for my work is below:

1. *Abildgaardia mexicana* (Palla) Kral. Anther smears: N equals 10. MEXICO. DISTRITO FEDERAL.: *Kral 27694;* MEXICO.: *Kral 25487.* MICHOACAN.: *Kral 25520; Kral 25569; Kral 25580; Kral 27685; Kral 27691.*
2. *Abildgaardia ovata* (Burm. f.) Kral. Anther smears: N equals 10. MEXICO. CHIAPAS.: *Kral 27767.* U.S.A. FLORIDA. MONROE CO.: *Kral 18128.*
3. *Bulbostylis barbata* (Rottb.) Clarke. anther smears: N equals 5. U.S.A. GEORGIA. BAKER CO.: *Kral 28602;* LIBERTY CO.: *Kral 18826.* SOUTH CAROLINA. BAMBERG CO.: *Kral 27155.*
4. *Bulbostylis ciliatifolia* (Ell.) Fern. var. *coarctata* (Ell.) Kral. Anther smears: N equals 30. U.S.A. FLORIDA. OKALOOSA CO.: *Kral 27691.* NORTH CAROLINA. BLADEN CO.: *Kral 27187.*
5. *Bulbostylis funckii* (Steud.) Clarke. Anther smears: N equals 10. MEXICO. JALISCO: *Kral 27643.*
6. *Bulbostylis hirta* (Thunb.) Svenson. Anther smears: N equals 15. MEXICO. NAYARIT: *Kral 27553; Kral 27540.*
7. *Bulbostylis junciformis* (HBK.) Lindm. Anther smears: N equals 30. MEXICO. OAXACA: *Kral 27778.* VERACRUZ: *Kral 27796.*
8. *Bulbostylis juncoides* (Vahl.) Kukenth. Anther smears: N equals 60. MEXICO. NAYARIT: *Kral 27560.* PUEBLA: *Kral 27696.* JALISCO: *Kral 27637.*
9. *Bulbostylis pubescens* (Presl.) Svenson. Anther smears; N equals 5. MEXICO. NAYARIT: *Kral 27504; Kral 27509.* OAXACA: *Kral 27739.* N equals 10. MEXICO. OAXACA: *Kral 27738.*
10. *Bulbostylis stenophylla* (Ell.) Clarke. Anther smears: N equals 15. U.S.A. FLORIDA. TAYLOR CO.: *Kral 23039;* WALTON CO.: *Kral 19372.* GEORGIA. LIBERTY CO.: *Kral 18828.* NORTH CAROLINA. PENDER CO.: *KRAL 22506.*
11. *Bulbostylis trilobata* Kral. Anther smears: N equals 25 MEXICO. OAXACA: *Kral 25329; Kral 27733.*
12. *Bulbostylis vestita* (Kunth) Clarke. Anther smears: N equals 30. MEXICO. OAXACA. *Kral 27783.*
13. *Bulbostylis warei* (Torr.) Clarke. Anther smears: N equals 15. U.S.A. FLORIDA. CLAY CO.: *Kral 22762;* OKALOOSA CO.: *Kral 17692; Kral*

23180; SANTA ROSA CO.: *Kral 23174;* ST. LUCIE CO.: *KRAL 22685;* WAKULLA CO.; *Kral 23021.* GEORGIA. BEN HILL CO.: *Kral 28751;* BULLOCH CO.: *Kral 22378;* TATNALL CO.: *Kral 22308;* WAYNE CO.: *Kral 22814;* WHEELER CO.: *Kral 22335.*

14. *Fimbristylis annua* (All.) R. and S. Anther smears: N equals 15. MEXICO. CHIAPAS: *Kral 27753.* JALISCO:Kral 27616; Kral 27634. OAXACA: *Kral 27741.* U.S.A. ALABAMA. CRENSHAW CO.: *Kral 22002.* GEORGIA. BULLOCH CO.: *Kral 22382;* CAMDEN CO.: *Kral 18630;* CHATHAM CO.: *Kral 18943.* LOUISIANA. BEAUREGARD PAR.: *Kral 20799.* PENNSYLVANIA. CHESTER CO.: *Kray 22601.* SOUTH CAROLINA. BERKELEY CO.: *Kral 19149.*
15. *Fimbristylis argillicola* Kral. Anther smears: N equals 10. MEXICO. DURANGO: *Kral 27447.* JALISCO: *Kral 27631.* MICHOACAN: *Kral 25509; Kral 25515; Kral 25521; Kral 27684.*
16. *Fimbristylis autumnalis* (L.) R. and S. Anther smears: N equals 5. GEORGIA. BAKER CO.: *Kral 27068.* LOUISIANA. BEAUREGARD PAR.: *Kral 20798.* Root tips: 2N equals 10. MISSISSIPPI. HANCOCK CO.: e. side Kiln, 5 Jul. 1963, *Kral.*
17. *Fimbristylis caroliniana* (Lam.) Fern Anther smears: N equals 30. MEXICO. TAMAULIPAS:*Kral 25012; Kral 27813.* VERACRUZ: *Kral 27806; Kral 27809.* U.S.A. ALABAMA. BALDWIN CO.: *Kral 23145.* DELAWARE. SUSSEX CO.: *Kral 22552.* FLORIDA. BAY CO.: *Kral 19285;* CHARLOTTE CO.: *Kral 22920;* LEVY CO.: *Kral 22944;* NASSAU CO.: *Kral 18614;* PASCO CO.: *Kral 22957;* ST.LUCIE CO.:*Kral 22868.* GEORGIA. GLYNN CO.: *Kral 18657.* NORTH CAROLINA. DARE CO.: *Kral 22531;* ONSLOW CO.: *Kral 22469.* SOUTH CAROLINA. GEORGETOWN CO.: *Kral 19016.* HORRY CO.: *Kral 19014.* TEXAS. KENEDY CO.: *Kral 27352.* VIRGINIA. ACCOMAC CO.: *Kral 22558.* Root tips: N equals 60. MISSISSIPPI. HARRISON CO.: *Kral 17559.* Anther smears: N equals 20. FLORIDA. BREVARD CO.:*Kral 18400;* LEE CO.: *Kral 18002;* OKEECHOBEE CO.: *Kral 22090.* GEORGIA. BAKER CO.: *Kral 20490.* Anther smears: N equals 10 (Possible influence of *F. puberula* here thus plants perhaps better treated as either *F. puberula* or hybrid; most of these examples look like rhizomatous *F. puberula* var. *puberula*). FLORIDA. CHARLOTTE CO.: *Kral 22920;* PASCO CO.: *Kral 22963;* ST LUCIE CO.: *Kral 18369; Kral 22861.*
18. *Fimbristylis castanea* (Michx.) Vahl. Anther smear: N equals 10. U.S.A. FLORIDA. BREVARD CO.: *Kral 18398;* GULF CO.: *Kral 19291;* MARION CO.: Glen Silver Springs, a *Godfrey* collection reared in greenhouse; NASSAU CO.: *Kral 18613;* VOLUSIA CO.: *Kral 18480.* GEORGIA. GLYNN Co.: *Kral 18656.* MISSISSIPPI. HARRISON CO.: *Kral 17560.* NORTH CAROLINA. BRUNSWICK CO.: *Kral 18985;* ONSLOW CO.: *Kral 22470;* SOUTH CAROLINA. BEAUFORT CO.: *Kral 18896; Kral 22686;* GEORGETOWN CO.: *Kral 19017.* TEXAS. GALVESTON CO.: *Kral 20806;* JEFFERSON CO.: *Kral 20814;* MATAGORDA CO.: *Kral 20108;* SAN PA-

TRICO CO.: *Kral 21159*. VIRGINIA. ACCOMAC CO.: *Kral 22559*. Root tips: 2N equals 20. FLORIDA. BAY CO.: *Kral 17768*. MISSISSIPPI. HARRISON CO.: *Kral 17560*.

19. *Fimbristylis complanata* (Retz.) Vahl. Anther smears: N equals 5. MEXICO. JALISCO: *Kral 27587*. NAYARIT: *Kral 27561*. PUEBLA: *Kral 27705*. VERACRUZ: *Kral 25456*.
20. *Fimbristylis decipiens* Kral. Anther smears: N equals 10. U.S.A. GEORGIA. COFFEE CO.: *Kral 22247-48;* WAYNE CO.: *Kral 22710*. LOUISIANA. EAST BATON ROUGE PAR.: *Kral 27346;* LIVINGSTON PAR.: *Kral 27852;* WASHINGTON PAR.: *Kral 19381*.
21. *Fimbristylis dichotoma* (L.) Vahl. Anther smears: N equals 15. FLORIDA. BREVARD CO.: *Kral 18386*. GEORGIA. WORTH CO.:*Kral 22120*. LOUISIANA. BEAUREGARD PAR.: *Kral 20801;* EAST BATON ROUGE PAR.: *Kral 27845;* LIVINGSTON PAR.: *Kral 27854*. Anther smears: N equals 10. MEXICO. OAXACA: *Kral 27785*. VERACRUZ: *Kral 27794*. U.S.A. ALABAMA. BALDWIN CO.: *Kral 23144*. FLORIDA. BAY CO.: *Kral 23202;* DUVAL CO.: *Kral 18594;* OSCEOLA CO.: *Kral 22820;* VOLUSIA CO.: *Kral 18452*. GEORGIA. COLQUITT CO.: *Kral 22090*. LOUISIANA. JEFFERSON DAVIS PAR.: *Kral 27832;* ST. TAMMANY PAR.: *Kral 23065*.
22. *Fimbristylis miliacea* (L.) Vahl. Anther smears: N equals 5. FLORIDA. LIBERTY CO.: *Kral 19320*. LOUISIANA. LINCOLN PAR.: *Kral 19396;* WASHINGTON PAR.: *Kral 19380*.
23. *Fimbristylis pallidula* Kral. Anther smears: N equals 10. MEXICO. OAXACA: *Kral 25318; Kral 27724*. SINALOA: *Kral 25681; Kral 27495; Kral 27500; Kral 27501*.
24. *Fimbristylis perpusilla* Harper. Anther smears: N equals 5 (*Godfrey 63204; Kral 15486*, from SEMINOLE CO., GEORGIA serve as vouchers from same locality).
25. *Fimbristylis puberula* (Michx.) Vahl var. *puberula*. Anther smears: N equals 10. ALABAMA. WASHINGTON CO.: *Kral 27471*. FLORIDA. BAY CO.: *Kral 17770;* BREVARD CO.: *Kral 18419;* ST. LUCIE CO.: *Kral 18329;* SARASOTA CO.: *Kral 17912;* TAYLOR CO.; *Kral 23041;* WALTON CO.: *Kral 19374*. GEORGIA. BAKER CO.: *Kral 20488; Kral 27066;* COLQUITT CO.: *Kral 22089*. LOUISIANA. BEAUREGARD PAR.: *Kral 20173;* LA SALLE PAR.: *Kral 20106;* RAPIDES PAR.: *Kral 20155;* VERNON PAR.: *Kral 16803*. TENNESSEE. COFFEE CO.: *Kral 26872*. Anther smears: N equals 20. GEORGIA. COFFEE CO.: *Kral 27107;* EVANS CO.: *Kral 27166*.
26. *Fimbristylis puberula* (Michx.) Vahl. var. *interior* (Britton) Kral. Anther smears: N equals 10. NEBRASKA. DAWSON CO.: *Kral 28923; HOWARD* CO.: *Kral 28872;* KEARNEY CO.: *Kral 28927;* SHERMAN CO.: *Kral 28963*.
27. *Fimbristylis schoenoides* (Retz.) Vahl. Anther smears: N equals 5. ALABAMA. BALDWIN CO.: *Kral 23142*. FLORIDA. DUVAL CO.: *Kral*

18593; LEE CO.: *Kral 22929;* WAKULLA CO.: *Kral 23025;* WALTON CO.: *Kral 19365;* GEORGIA. CAMDEN CO.: *Kral 18616;* WAYNE CO.: *Kral 19260.* Root tips: 2N equals 10. MISSISSIPPI. HANCOCK CO.: *Kral 17569.*

28. *Fimbristylis spadicea* (L.) Vahl. Anther smears: N equals 10. MEXICO. TAMAULIPAS. *Kral 24993;* VERACRUZ: *Kral 27805.*
29. *Fimbristylis spathacea* Roth. Anther smears: N equals 24. FLORIDA. MARTIN CO.: (from greenhouse plants grown from seed taken from n. of Stuart, Fla., during winter of 1963).
30. *Fimbristylis thermalis* S. Watson. Anther smears: N equals 10. MEXICO. COAHUILA: *Kral 25771.* U.S.A. CALIFORNIA. INYO CO.: *Kral 21784;* SAN BERNARDINO CO.: *Kral 21591.*
31. *Fimbristylis tomentosa* Vahl. Anther smears: N equals 5. ALABAMA. BALDWIN CO.: *Kral 23143.* GEORGIA. CHATHAM CO.: *Kral 18937;* COLQUITT CO.: *Kral 22091;* WAYNE CO.: *Kral 19259.* LOUISIANA. BEAUREGARD PAR.: *Kral 20802;* LAFAYETTE PAR.: *Kral 27838;* LIVINGSTON PAR.: *Kral 27853;* NATCHITOCHES PAR.: *Kral 20692;* LINCOLN PAR.: *Kral 19397;* WASHINGTON PAR.: *Kral 19382.* SOUTH CAROLINA. BERKELEY CO.: *Kral 19211.* Root tips: 2N equals 10. MISSISSIPPI. HANCOCK CO.: *Kral 17568;* STONE CO.: *Kral 17402.*
32. *Fimbristylis vahlii* (Lam.) Link. Anther smears: N equals 10. LOUISIANA. CLAIBORNE PAR.: *Kral 19431;* LINCOLN PAR.: *Kral 15910;* UNION PAR.: *Kral 23228.* TEXAS. WALKER CO.: *Kral 29018.*

TAXONOMIC TREATMENT

In the treatment which follows, keys and descriptions are based on material collected from within the area of study, namely North America. Generic limits are drawn only in the sense of North American species of these genera. Keys are based upon healthy, not depauperate, material. Dimensions of leaves are drawn from the fully expanded, longest leaves of a specimen. Dimensions of spikelets are drawn only from the scale-bearing portion of the spikelet (older spikelets often have a very large portion of rachis from which the scales have fallen, and this is not included in the measurement). Descriptions of fertile scales are based upon mature scales that subtend well developed akenes. Descriptions of akenes, particularly akene colours and surfaces, are drawn strictly from ripe akenes.

Species are numbered in a single continuous sequence for all three genera.

KEY TO FIMBRISTYLIS AND ALLIED GENERA

1. Tubercle of akene usually persistent; summit of leaf sheath long-ciliate or fimbriate; akene of most species trigonous; style three-branched, smooth save for papillosity of branches, its base usually 3-angled; surfaces of akene reticulate or cancellate or colliculate, often in addition transversely rugose; cells of surface usually very narrow and vertically ar-

ranged, or produced outward into papillae; tufted, filiform-leaved, annuals or perennials of moist to dry, usually sandy sites . . . *Bulbostylis*, p. 73

1. Tubercle of akene deciduous; summit of leaf sheath short-ciliate or entire; akene trigonous, obovoid, lenticular or columnar; style 2 or 3-branched, usually long-papillate or fimbriate, flattened or cylindrical, or 3-angled; surfaces of akene reticulate (sometimes very obscurely so), with the cells usually transversely elongate, isodiametric, sometimes raised as warts or concave as shallow pits; tufted or rhizomatous, usually linear-leaved, annuals or perennials of a variety of habitats.
   2. Spikelet usually flattened, the scales distichous, or subdistichous; base of style abruptly thickened, trigonous; akene obovoid, prominently stipitate, verrucose with numerous large, smooth, dome-like projections; bulbous-based, caespitose perennials, the spikelets usually either solitary or several in a single terminal cluster . . . I. *Abildgaardia*, p. 70
   2. Spikelet with scales spirally arranged, usually not keeled; style base flattened or dilated, sometimes thickened but usually not trigonous; akene trigonous or lenticular or columnar, reticulate or finely pitted and sometimes also verrucose, akene base not prominently stipitate; caespitose or rhizomatous annuals or perennials, the inflorescences various.
      . . . . . . III. *Fimbristylis*, p. 100

I. ABILDGAARDIA Vahl, Enum. 2: 296. 1805.

Perennial, smooth, the culms tufted, usually bulbous-based, spreading, leafy toward the base. Leaves narrowly linear to filiform, thickened, flat or involute, eligulate, the sheaths closed save at the summit. Spikelets ovate, usually somewhat flattened and subdistichous, either solitary and terminal on the scapes or few to several in a dense terminal cluster or rarely in a simple dichasium of three spikelets, in any case subtended by a single bract. Fertile scales in two rows or at least subdistichous, keeled, smoothish, deciduous, the lowermost fertile, the uppermost often subtending only male florets. Florets perfect or unisexual, produced on a short pedicel joint; perianth absent. Stamens, two or three, the anthers basifixed, narrowly oblong, the two thecae at maturity longitudinally and laterally dehiscing. Style three-branched, the unbranched portion smooth, three-angled, expanded at the base, the style base deciduous from the akene. Akene stipitate, obscurely trigonous to subglobose, apiculate, verrucose.

About 15 species of New and Old World tropics.

Type species: *A. monostachya (A. ovata).*

KEY TO NORTH AMERICAN ABILDGAARDIA

1. Spikelets reddish-brown, sometimes solitary at the apices of culms, more often sessile in small clusters at the apices of culms; plants of the Mexican high plateau, usually abundant on heavy soils of prairies or savannas
   . . . . . . 1. *A. mexicana* (Palla) Kral.
1. Spikelets pale, frequently solitary at the apices of culms or two or three

per culm, in which case scattered toward the culm tip; plants primarily of lower elevations in Mexico, in the southern tip of Florida (on limerock), and in various hibitats in the Caribbean Islands.
. . . . 2. *A. ovata* (Burm. f.) Kral.

1. ABILDGAARDIA **mexicana** (Palla) Kral, comb. nov.

Fimbristylis crassipes Boeckl., Linnaea 38: 392. 1874, not *F. crassipes* Boeckl., Flora 41: 602. 1858.

Fimbristylis mexicana Palla, Oest. Bot. Zeit. 58: 390-391. 1908.

Tufted perennial, the culms bulbous-based, usually spreading in a rosette fashion, and up to 4 dm. long, the outer leaves of a culm usually scape-like. Leaves usually half the length of the culms, the blades linear-filiform, seldom wider than 1 mm., smooth, flat, very firm, thickened, often somewhat involute, the backs prominently ribbed and with two ribs making a thickened-cartilaginous, ciliate-scabrid margin; sheaths broad, thick, clasping, pale tan to dark brown, sharply converging into the blade. Scape slender, about the width of the leaf blades, many-ribbed, subterete, smooth. Longest bract of the inflorescence shorter than the inflorescence, the margin of the blade similar to the leaves. Spikelets lance-ovoid, acute, ca. 1.0-1.5 cm. long, with few fertile scales, quite flat when young, rarely solitary, more usually in terminal clusters of from 2 to 5, at maturity quite thickened by the mature fruit. Fertile scales ovate, acute, smooth, subentire, a rich reddish-brown, curvate-keeled, subscarious save for a prominent greenish or tan midrib, this excurrent as a short, sometimes slightly reflexed mucro. Stamens 2 or 3, the anthers 2.0-2.3 mm. long. Style 3-branched, smooth, trigonous at the base. Akenes 2-3 mm. long, stipitate-obovoid, the apex apiculate or truncate, the surface pale brown to white, pebbled.

Moist to wet heavy dark clay earths of the grasslands of the Mexican high plateau in the states of Aguascalientes, Durango, Guanajuato, Guerrero, Distrito Federal, Jalisco, Mexico, Michoacan, Puebla, Queretaro, San Luis, Potosi, and Zacatecas.

Type locality: "Mexique . . . Santa Barbara pres Puebla, 25 Jun 1909, *G. Nicolas.*" Isotype at NY examined.

A. mexicana is very similar to *A. ovata,* differing from it only by its harsher leaf margins, the darker tones of its spikelets, and the tendency for the spikelets to form terminal clusters (*A. ovata* has straw coloured spikelets which are either solitary or few and separated along the axis, or rarely in terminal cymules of three, with the laterals pedicellate).

In Mexico, the only country in which both species occur, *A. mexicana* is found in one of the most beautiful regions of the world, the moist, cool grasslands of the Mexican high plateau, where its reddish-brown spikelets form part of a harmonious tapestry of grass, sedge, sunflower, *Eryngium, Cuphea* and *Lobelia.* Heavy grazing and consequent erosion have much reduced its numbers. *A. ovata* on the other hand appears to occupy only the lower elevations in Mexico and so far as I now know there are no instances of the two mingling on the same site.

As the statement of synonym indicates, Boeckler was first to describe the species but had himself published an earlier homonymn.

2. ABILDGAARDIA **ovata** (Burm. f.) Kral, comb. nov.
Carex ovata Burm. f., Fl. Ind. 194. 1768.
Cyperus monostachyos L., Mant. 180. 1771.
Abildgaardia monostachya (L.) Vahl, Enum. 2: 296. 1805.
Fimbristylis monostachya (L.) Hassk., Pl. Jav. Rar. 61. 1848.
Iriha monostachya (L.) O. Kuntze, Rev. Gen. Pl. 2: 751. 1891.
Fimbristylis ovata (Burm. f.) Kern, Blumea 15: 126. 1967.

Solitary or tufted, bulbous-based, perennial to 7 dm. tall (usually much lower and with culms often spreading in tradiate fashion), the outer leaves often scale-like. Leaves usually about 1/2 the length of well developed scapes, the blades seldom wider than 1 mm., linear-filiform, smooth, flat, very firm, often slightly involute, the backs prominently ribbed and with two ribs making an incrassate margin; sheath broad, sometimes thick, clasping, pale tan or brown, tapering abruptly to the blade. Scape slender (about the width of the leaves), many-ribbed, subterete, smooth. Lowest bract of the inflorescence with short sheath and blade, its blade margin often short-ciliate or scabrid, always shorter than the inflorescence. Spikelets lance-ovoid, acute, ca. 1.0-1.5 cm. long, quite flat when young, as a rule solitary at the tip of the scapes (rarely in a simple cyme of 3 spikelets) or 2 spikelets rather well separated toward the scape tip. Fertile scales ovate, acute, smooth, subentire, usually pale yellow-green or stramineous, curvate-keeled, subscarious save for a prominent greenish or darker coloured midrib of nerves, this excurrent as a short cusp. Stamens 1-3, the anthers 3-4 mm. long. Style 3-branched, smooth, trigonous at the base. Akenes stipitate-obovoid, ca. 2.5 to nearly 3.0 mm. long, sometimes obscurely trigonous but more usually subglobose above the stipe, the whole surface pebbly.

Savannas, primarily over calcareous rock, both Old and New World tropics. In North America found in southern Florida, the Caribbean Islands, and the coastal plain or lower mountain slopes of Mexico.

Type locality: Java (see Kern, l.c.).

This species interestingly combines a vast georgaphic range with a remarkably uniform morphology. In the United States (Florida) and Mexico it grows in humid savanna, and forms large tufts of bulbous-based plants. The flavescent spikelets are often solitary on the scapes, but may be in twos or threes. As a rule, if there is more than one spikelet borne on the scape these are arranged in a lineal fashion; rarely the system is a simple dichotomy of three spikelets, the central sessile. Fruit appears to develop only from the lower florets of a spike, and this might constitute a generic difference.

In Florida *A. ovata* appears confined to highly calcareous substrates, particularly to solution pockets in the Miami Oolite of the southern tip of the peninsula and of the keys. Interestingly enough, the only outlying locality for the species in the U. S. is on the "Orange Island" (Citrus County, *Kral 7890*) where it is occasional on savanna over outcrops of the Tampa limestone formation.

A. ovata forms a species pair with *A. mexicana,* a plant confined to the grasslands of the Mexican high plateau. In fruit, habit and foliage the two appear to be almost identical. However, the spikelets of *A. mexicana* are reddish, not flavescent, and are borne in clusters at the tip of the scape. The haploid chromosome complement of both species is 10.

II. BULBOSTYLIS, Kunth, Enum. Pl. 2: 205. 1837. (Sub *Isolepis,* R. Br, 1810.)

Nomen conservandum.

Neither *Bulbostylis* Steven, 1817, nor DC. 1836, nom. rejic.

Stenophyllus Raf., Neog. 4: 1825.

Oncostylis Mart.; Nees in Mart., Fl. Bras. 2^1: 80. 1842.

Perennial or annual, the culms solitary but usually in tufts, rigid or lax, usually wiry. Leaves filiform to narrowly linear, ascending to recurved, usually basal, usually scabrid, often pubescent, the sheaths long-ciliate or fimbriate apically. Spikelets lanceolate, oblong or ovoid in outline, terete to sometimes flattened or angled, solitary at the scape tips or in simple or compound umbelliform systems involving pedunculate spikelets or pedunculate cymules of spikelets, or in dense, head-like clusters, the whole inflorescence usually subtended by one or more leaf-like involucral bracts. Fertile scales glabrous or pubescent, subdistichous to more often spirally arranged, deciduous, all but the lowest (sometimes even the lowest) fertile. Florets perfect; perianth absent (the flower usually produced on a short pedicel point). Stamens one to three, the anthers oblong, basifixed, the two thecae at maturity longitudinally and laterally dehiscing, in some species the anther connective prolonged beyond the anthers into a subulate tip. Style 3-branched, the unbranched portion smooth, terete or three angled, the style branched papillate, the style base usually persisting on the akene. Akene trigonous, rarely plano-convex, often the akene face nearest the spikelet axis broader than the other two, subequal faces; surface of akene smoothish, cancellate or transversely rugose, usually made up of vertically oriented, broadly or narrowly rectangular cells, (rarely almost isodiametric cells), these either concave or produced outward into papillae.

At least 80 species, primarily on dry sandy situations in the warm-temperate or tropical regions of the world.

Type species: *B. capillaris* (L.) C. B. Clarke (by Code designation).

KEY TO BULBOSTYLIS OF NORTH AMERICA[3]

1. The plant with a stout, woody base, this invested by a stubble of old sheaths and old leaf bases (often the whole structure up to 3 or 4 cm. thick, usually blackened by fire); mature spikelets solitary at the culm tips, ca. 1 cm. long, pale; abundant in burned over grasslands, savannas,

[3] Species numbered 3-26.

pinelands of Cuba, Mexico (Oaxaca), Panama, and northern South America. . . . . 3. *B. paradoxa* (Spreng.) Lindm.

1. The plant not as above.
   2. Spikelets sessile, clustered in tight or open systems of fascicles or glomerules, or terminal and subcapitate, or paired and conjugate at culm tips, neither solitary nor in umbelliform cymes.
      3. Clusters of spikelets two to several per scape; Caribbean Islands, Mexico, and southward.
         4. Culms and foliage finely and copiously pubescent, texturally rough; scales of the spikelets uniformly puberulent; akene stramineous to dark brown, very delicately transversely rugose, the ridges comprised of vertically oriented cells; plants forming large, recurved-leaved, tufts. . . . . 4. *B. vestita* (Kunth) Clarke.
         4. Culms and foliage smooth; scales of spikelets not uniformly puberulent, often glabrous; ripe akene brown, white or waxy-gray, either with fine, honeycomb reticulation or pebbled with fine papillae, but definitely not rugose; plants in smaller tufts, usually taller, the culm bases often thickened, the sheaths a lustrous brown or cinnamon, the leaf blades usually ascending. . . . . 5. *B. junciformis* (H.B.K.) Lindm.
      3. Clusters of spikelets solitary at scape tips.
         5. The plants coarse, tall (usually not less than 2 dm.), tufted, perennial.
            6. Surfaces of akenes transversely rugose or smooth.
               7. Spikelets ovate, somewhat flattened, in dense, terminal, involucrate clusters, the lower margins of the involucral bracts fimbiate-pectinate, the akenes prominently 3-lobed, pale: plants of sandhills of the Coastal Plain of the southeastern U.S.A. . . . . 6. *B. warei* (Torr.) Clarke.
               7. Spikelets elongate usually linear-lanceolate or oblong in outline; margins of bracts not fimbriate; akenes not prominently 3-lobed; species from south of the U.S.A.
                  8. Surfaces of leaves and scapes pubescent with spreading hairs. . . . . 4. *B. vestita* (Kunth) Clarke.
                  8. Surfaces of leaves and scapes not as above.
                     9. Apex of scales of spikelet usually rounded or obtuse, sometimes acute, the scale margins pectinate-lacerate or fimbriate; akene dark brown or blackish, appearing smooth and lustrous; spikelets often crowded at plant base as well as being on culm tips; culm seemingly continuous with the primary bract of inflorescence, hence inflorescence appearing lateral; plants of beaches of Bahamas, Cuba, Hispaniola. . . . . 7. *B. floccosa* (Griseb.) Clarke.
                     9. Apex of scales acutish, the margins not pectinate-lacerate; akenes paler, transversely rugose or rugulose; spikelets not

crowded at plant base and inflorescence not appearing lateral; Caribbean Islands or Revillagigedo Island group, Mexico.

10. Culm bases usually bulbous-thickened; akene brownish or stramineous spikelets often proliferous; Caribbean Islands. . . . . 8. *B. subaphylla* Clarke.
10. Culm bases coarse, but not bulbous-thickened; akenes grayish; spikelets not proliferous: Revillagigedo Islands, Mexico. . . . . 9. *B. nesiotica* (Johnston) Fernald.

6. Surfaces of akenes papillate or finely reticulate, the cells widely rectangular or isodiametric. . . . . 5. *B. junciformis* (H.B.K.) Lindm.

5. The plants finer, lower (usually well under 2 dm. tall); setaceous-leaved annuals or perennials.

11. Spikelets usually numerous in an involucrate, subcapitate clusters; plants of the Coastal Plain of the southeastern United States (no. 11 also in Pinar del Rio, Cuba).

12. Akene usually not much longer than 0.5 mm., the surface finely reticulate, not transversely rugose; scales of the spikelet usually reddish-brown, lustrous, smoothish; involucral bracts either shorter than the inflorescence, or only one longer. . . . . *B. barbata* (Rottb.) Clarke.
12. Akene ca. 1 mm. long, the surface transversely rugose; scales of the spikelets usually greenish or dull pale brown, puberulent; several of the involucral bracts of a cluster exceeding the inflorescence by many times its length. . . . . 11. *B. stenophylla* (Ell.) Clarke.

11. Spikelets fewer (2 or 3, rarely 5) to a cluster; low plants of the Caribbean and the Revillagigedo Islands.

13. Scales of the spikelets stramineous or yellowish-green, glabrous; akene definitely 3-lobed, stipitate, the apex retuse; inflorescence appearing lateral; Caribbean. . . . . 12.*B. setacea* (Griseb.) Svenson.
13. Scales of the spikelets reddish-brown, puberulent; akene inconspicously trigonous or even plano-convex, broadly obovoid, the apex not retuse; spikelets appearing terminal; Revillagigedo Islands. . . . . 13. *B. sepiacea* Kral.

2. Spikelets solitary at culm tips and/or clustered at plant base *or* if two or more per cluster at least some pedicelled in some sort of open arrangement.

14. Spikelets solitary at culm tips and/or clustered at plant base.

15. Mature akene smooth, dark brown or blackish; robust plant with cylindrical spikelets. . . . . 7. *B. floccosa* (Griseb.) Clarke.

15. Mature akene pale, gray or brown, either cancellate or rugose; more slender, usually lower, plants.
  16. Akene with fine, longitudinal lines of vertically oriented, shallow cancellae or cells; Curacao and Haiti.
  . . . . 14. B. *curassavica* (Britt.) Kuekenth. & Ekman.
  16. Akene not as above, characteristically transversely rugose.
    17. Spikelet lanceolate, acuminate, in outline.
      18. Longest involucral bract appearing as an extension of the culm, barren, usually much longer than the spikelet, the spikelet thus appearing lateral; body of fertile scale stramineous or greenish save for darker coloured, often castaneous, midrib; slender lax plants; basal spikelets lacking; Caribbean.
      . . . . 15. B. *pauciflora* (Liebm.) Clarke.
      18. Longest involucral bract usually not appearing as an extension of the culm, often fertile; body of the fertile scale reddish; plants more compact, usually much lower, and with basal spikelets as well as terminal, the akenes of the basal spikelets much larger; southwestern U. S. A., Mexico, and southward through Central America into South America.
      . . . . 16. B. *funckii* (Steud.) Clarke.
    17. Spikelet ovate or oblong in outline, not acuainate.
      19. Most of the spikelets produced basally, hence much exceeded by leaves; very low annuals of the mountains of northern Mexico.
      . . . . 17. B. *schaffneri* (Boeck.) Clarke.
      19. Most of the spikelets produced at the tips of elongate culms, these exceeding the leaves; low or tall annuals or perennials.
        20. Fertile scales stramineous or pale brown; plants perennial, smoothish or at most with scabrous scape and leaf ridges. . . . . 12. B. *setacea* (Griseb.) Svenson.
        20. Fertile scales brownish or reddish-brown; plants annual, pubescent.
          21. Bract subtending spikelet longer than spikelet; fertile scales prominently keeled.
            22. Mature spikelet usually ca. 1 cm. long; akene usually between 1.5 and 2.0 mm. long; plant 1 dm. tall or taller.
            . . . . 18. B. *trilobata* Kral.
            22. Mature spikelet no longer than 0.7 cm.; akene not longer than 1.2 mm.; plants less than 1 dm. tall.
            . . . . 19. B. *arcuata* Kral.
          21. Bract subtending spikelet shorter than spikelet; fertile scales not prominently keeled.
          . . . . 20. B. *pubescens* (Presl.) Svenson.

14. Spikelets 2 to many at the culm tips, usually in unbellate cymes or paniculate cymes, at least some solitary on peduncles or distant along the scape toward the tip.
  23. Robust, tufted, the culm bases often bulbous, the scapes rigid, usually 1 mm. thick, subterete, the spikelets linear, in small, spreading, turbinate clusters, acute, in healthy material ca. 1 cm. long, the scales scarcely keeled; Caribbean.
  . . . . 8. *B. subaphylla* Clarke.
  23. More slender, or at least culm bases not bulbous, the spikelets ovoid or lanceolate-acuminate in outline, or, if *linear*, much less than 1 cm. long; fertile scales keeled, usually curvate.
    24. Spikelets and scales of spikelets lanceolate-acuminate; spikelets with very few florets, usually 2 or 3 fertile, 2 or 3 distant along a slender, angulate scape.
    . . . . 15. *B. pauciflora* (Liebm.) Clarke.
    24. Spikelets and scales of spikelets ovate; spikelets with several florets.
      25. Leaves and scapes noticeably spreading-pubescent or puberulent.
        26. Akene prominently 3-lobed, stipitate, coarsely transversely rugose, the lobes carinate and the surfaces of these ridges colliculate.
          27. Akene not longer than 1.2 mm.; plants less than 1 dm. tall. . . . . 19. *B. arcuata* Kral.
          27. Akene between 1.5 and 2.0 long; plants 1 dm. tall or taller. . . . . 18. *B. trilobata* Kral.
        26. Akene trigonous, but not prominently 3-lobed or stipitate, the surface transversely rugose and/or papillate.
          28. Tubercle early deciduous; ripe akene brownish, its surface transversely rugose, the cells vertically oriented, linear, and so inconspicuous as to give ridges a lustrous, finely-lined appearance; plants annual.
          . . . . 21. *B. hirta* (Thunb.) Svenson.
          28. Tubercle persistent; ripe akene grayish or brown, its surface transversely rugose but cells of ridges prominent, often raised as papillae; plants perennial.
          . . . . 22. *B. juncoides* (Vahl) Kuekenth.
      25. Scapes and leaves glabrous, or at most scabrid along ridges and margins.
        29. Ripe akenes gray or dark greenish-brown, waxy, papillose,
          30. Plants of the Coastal Plain of the southeastern U.S.A. and local in Cuba.
            31. Low annual, the inflorescence a simple to rarely compound umbel of few, lance-ovoid, spikelets; longest bract

of inflorescence seldom exceeding inflorescence; edges of leaves usually hispidulous.

. . . . 23. *B. ciliatifolia* (Ell.) Fern, var. *ciliatifolia.*

31. Tall perennial (usually of longleaf pine sandhills), the inflorescence usually of many, oblong or lance-linear spikelets and commonly compound; longest bract of inflorescence commonly longer than inflorescence; edges of leaves usually distinctly tuberculate-scabrid.

. . . . 23. *B. ciliatifolia* (Ell.) Fern, var. *coarctata* (Ell.) Kral.

30. Plants primarily montane, of the southwestern United States, Caribbean, Mexico and southward into South America; tufted perennials.

. . . . 22. *B. juncoides* (Vahl) Kuekenth.

29. Ripe akenes brownish or stramineous, papillose or rugose or both.

32. Akene prominently transversely rugose, the cells in transverse, undulating rows of vertical, narrowly rectangular, cells.

33. Akene stipitate-obovoid, often 3-lobed; 1.5-2.0 mm. long; perennial of Caribbean.

. . . . 12. *B. setacea* (Griseb.) Svenson.

33. Akene not prominently stipitate, ca. 1 mm. long; slender annual of various provinces in the U.S.A., less frequently in Mexico and Central America.

. . . . 24. *B. capillaris* (L.) Clarke.

32. Akene papillate, the papillae either evenly distributed or in fine, undulating, transverse lines.

34. Inflorescence open, in dense or open umbellate systems.

35. Akene 1.0-1.5 mm. long; spikelets reddish-brown to castaneous; plants perennial.

. . . . 22. *B. juncoides* (Vahl) Kuekenth.

35. Akene ca. 0.5 mm. long; spikelets pale brown; plants annual or short-lived perennials; papillae uniform over akene surface giving it a definite pebbled texture.

. . . . 25. *B. tenuifolia* (Rudge) Macbr.

4. Inflorescence dense, turbinate to subcapitate the spikelets linear or lance-ovoid in a contracted system of fascicles of sessile or short-stalked spikelets mixed with short-stalked cymules; longest involucral bract exceeding the inflorescence; surface of akene finely transcersely rugose, the ridges made up of rows of glistening oblong, vertical papillae; perennial of savannas, Martinique and Dominica.

. . . . 26. *B. antillana* (Britton) Fernald.

3. BULBOSTYLIS PARADOXA (Spreng.) Lindm., Bih, Sv. Vet.- Akad. Handl. 26 Afd. 3 No. 9: 17, 1900.

Schoenus spadiceus H.B.K., Nov. Gen. and Sp. 1: 227. 1816. Not *S. spadiceus* Vahl. 1805.

Schoenus paradoxus Spreng., Syst. 1: 190. 1825.

Isolepis paradoxa (Spreng.) Kunth, Enum. Pl. 2: 206. 1837.

Rhynchospora perrigida Boeck., Allg. Bot. Zeitschr. 2: 93. 1896.

Stenophyllus paradoxus (Spreng.) Standley, Contr. U. S. Nat. Herb. 18: 88. 1916.

Bulbostylis spadicea (H.B.K.) Kuekenth., Repert, Sp. Nov. 23: 197. 1926.

Perennial from a stout, sparingly branched caudex, this covered by a persistent stubble of old chaffy (or burned) leaf bases and up to 4 cm. thick, and producing thickened, fibrous roots, these cloaked in a dense mycorrhizal mat. Leaves often as long as the scapes, recurved, produced in large tufts from the apex of the caudex, the blades filiform, less than 0.5 mm. broad, thickened, flat to very involute, often semicircular in cross section, the backs rounded and inconspicuously nerved, sometimes with a scattering of antrorse, stout trichomes, the margins rounded or sharp, the upper surface with a deep, median, groove, this smooth or lined with stout-based, upward-pointing trichomes. Sheaths short, dark-brown, grooved, quite thick, with broad, cinnamon-brown, scarious margins, these densely long-fimbriate. Scapes rigid, erect, much thicker than the leaf blades, smooth, angulate, sometimes flexuous, conspicuously ridged and grooved toward the base, sometimes slightly flattened distally, Spikelets ellipsoidal or obovate, ca. 1 mm. long, solitary at the culm tips; lowest bracts of the spikelet long-attenuate, the tips aristate, equalling or slighly exceeding the spikelet. Fertile scales lanceolate, pale brown or stramineous or pale reddish-brown, the margin copiously fringed with long, crisped, trichomes, the midrib conspicuously raised, greenish, long-excurrant as an attenuate mucro. Stamens 3, anthers apiculate, 3.0-3.5 mm. long. Akene broadly trigonous-obovoid or short-pyriform, brown, ca. 1.5 mm. long, the angles rounded, smooth and paler, the flat to slightly convex, transversely rugulose. Tubercle depressed globose.

Sandy savannas and pinelands, Cuba, Mexico (Oaxaca), Panama, and northern South America.

Type locality: Caracas, Venezuela. Type not seen.

This species is very definitely a part of fire disclimax associations. Every flowering specimen I have examined shows a basal stubble of charred leaf remnants. Notes by collectors indicate that flowering is induced by burning. Some of the stubble-covered caudices of this species are several centimeters in length, while the leaf-bearing portion of the crown is relatively short. This is an indication that the plants must attain considerable age.

4. BULBOSTYLIS VESTITA (Kunth) Clarke in Urban, Symb. Ant. 2: 87. 1900.

Isolepis vestita Kunth Enum. Pl. 2: 210. 1837.
Oncostylis vestita (Kunth) Nees in Mart. Fl. Bras. 2[1]: 88. 1842.
Oncostylis hispida Liebm. Vidensk. Selsk. Skr. V. 2: 240. 1851.
Scirpus hirtus Griseb. Cat. Pl. Cub. 241. 1866.
Scirpus vestitus (Kunth) Reichenb. ex Boeck., Linnaea 36: 753. 1870.
Fimbristylis vestita (Kunth) Hemsl., Biol. Centr. Am. Bot. 3: 460. 1885.
Stenophyllus vestitus (Kunth) Britton, Bull. Torrey Club 43: 446. 1919.
Bulbostylis langsdorffiana Clarke in Urban, Symb. Ant. 2: 89. 1900. pro parte.

Perennial, in dense tufts, to 5 dm. (but usually smaller), the foliage and scapes spreading-hirsute, the culm bases thickened, brownish, usually invested in shreds of old leaf bases. Leaves up to 2/3 the length of the mature scapes, the blades linear-filiform, spreading-recurved, ca. 0.5 mm. wide, twisted, thickened, flat or somewhat involute, the backs with three, prominently raised ribs and with two more comprising a rounded and thickened margin; leaf sheaths hirsute with broad, scarious, bale-brown or cinnamon coloured margins, these sparsely fimbriate apically with pale, crisped hairs. Scapes rigid, angulate, wider than leaf blades, prominently ridged and grooved, the ridges spreading-hirsute. Spikes lance-ovoid, few-flowered, ca. 4-5 mm. long, subsessile in a solitary, subcapitate, bracteate cluster or in a simply branched system of few-spikeleted, turbinate clusters, one sessile and 1-6 on spreading or ascending branches; bracts of a cluster acicular to filiform, the longest often overtopping the cluster. Fertile scales ovate-lanceolate to ovate, acuminate or acute, curvate-keeled, reddish-brown, hirtellous, the midrib paler or greenish and at least on the lower scales prominently excurrent as a long, often somewhat reflexed mucro. Stamens 3, anthers apiculate, ca. 1. mm. long. Akenes trigonous-obovoid, ca. 1 mm. long, stramineous to pale brown or gray brown, the angles rounded and often paler, the interfaces finely transversely rugose and convex, of tiny, vertically oriented, often dark isodiametric or oblong, papillae. Tubercle depressed-conic or depressed globose.

Sandy savannas, fields, roadsides or clearings in oak-pine forest, Cuba, Puerto Rico, Haiti, Mexico (states of Oaxaca, Jalisco, Michoacan, Nayarit, Chiapas, Veracruz), British Honduras and in South America.

Type locality: Surinam. Type not seen by writer.

A clearly marked species because of its densely tufted, very hirsute foliage, its inflorescence of tight clusters of small reddish spikelets, and its finely papillate akenes. Often found mixed with *B. junciformis*, but easily distinguished even in the vegetative condition by its denser tufts of hairy leaves.

5. BULBOSTYLIS JUNCIFORMIS (H.B.K.) Lindm., Bih. Sv. Vet.-Akad. Handl. 26 Afd. 3 No. 9: 19. 1900.
Isolepis junciformis H.B.K., Nov. Gen. and Sp. 1: 222. 1816.
Scirpus junciformis (H.B.K.) Poir., in Lam., Encyc. Suppl 5: 105. 1817.
Scirpus humboldtii Spreng., Syst. 1: 1825.

Oncostylis junciformis var. *humboldtiana* Nees in Mart., Fl. Bras. 2[1]: 86. 1842.

Bulbostylis papillosa Kuekenth., Repert. Sp. Nov. 23: 198. 1926.

Fimbristylis papillosa (Kuekenth.) Alain, Bull. Torrey Club. 92: 290. 1965.

Perennial, the culms solitary or in small tufts, to 5 dm. tall, the culm bases often bulbous-thickened. Leaves smooth about 1/2 the length of the mature scapes, the blades linear, flattened or somewhat involute, thickened, sometimes 1 mm. or slightly more (-2) broad, the backs prominently 5 nerved, two nerves comprising the cartilaginous-thickened, antrorsely scabrid margin: sheaths brownish or cinnamon, hard, but with a broad, subscarious margin, this with long, pale fimbrieae apically. Scapes rigid, ascending, about the width of the leaf blades or slightly wider, angulate, prominently ridged-and-grooved, smooth. Spikelets lance-ovoid, acute, ca. 3-5 mm. long either subsessile in dense, subcapitate, involucral clusters or in a dense ascending fan-like system made up of several primary rays terminating in small glomerules, the whole inflorescence much longer than broad. Longest bract overtopping the inflorescence in the head-like type, but overtopped by the inflorescence in the elongate type. Fertile scales lance-ovate, curvate-keeled, few to a spikelet, dark chocolate brown to mahogany, smooth to papillose-puberulent, acute, the midrib conspicuous, pale brown to greenish, excurrent as a short, erect or slightly recurved mucro. Stamens 3, anthers ca. 1 mm. long, apiculate. Akene narrowly to broadly obovate, or oblong, obscurely trigonous, 0.8-1.2 mm. long, yellowish, brownish or gray, the surfaces honeycomb—reticulate or papillate, (imparting a finely "pebbled" look.) Tubercle persistant, compressed-globose.

Savannas, open woods and pinelands, usually on sandy soil, Cuba, Haiti, Santo Domingo, Jamaica, Mexico (Oaxaca, Chiapas, Veracruz, Tamaulipas, Jalisco), British Honduras, Panama and South America.

Type locality: Northeastern Venezuela. Type not seen by this writer.

Examination of a series of specimens identified variously as *Bulbostylis junciformis* and as *B. papillosa* reveals considerable intergradation of characteristics that are supposed to distinguish the two (i.e. akene length, relative papillosity of akene, indument of spikelets, inflorescence character, etc.). Therefore I have treated the entire range of forms as *B. junciformis*, the earliest available name for the complex. My illustration is of a plant from a savanna in the Isthmus of Tehuantepec near the city of Coatzacoalcos, Veracruz, Mexico (No. *27796*). On the low, rolling hills of this region, the whole spectrum of inflorescence and akene characteristics is to be found. This species in Mexico is often in association with *Abildgaardia ovata, Bulbostylis vestita, Bulbostylis tenuifolia, Bulbostylis pubescens.*

6. BULBOSTYLIS WAREI (Torr.) Clarke, Kew Bull. Add. Ser. 8: 26. 1908.

Isolepis warei Torr., Ann. Lyc. N.Y. 3: 354. 1836.

Stenophyllus warei (Torr.) Britton, Bull. Torrey Club 21: 30. 1894.

Perennial, in dense tufts, to 5 dm. tall. Leaves 1/4 to 1/2 the length of the culms, the blades narrowly linear, to 0.7 mm. wide, flat or slightly involute, thick, prominently 5-ribbed, smooth or rarely distantly and antrorsely scabrid along the blade margin, the sheaths brownish or reddish-brown, smooth or scabrid along the nerves and with a broad, scarious margin, this long-fimbriate apically. Scapes stiffly spreading or ascending, angulate, noticeably wider than the leaf blades, prominently ridged and grooved, smooth. Spikelets ovate, acute, 4-5 mm. long, somewhat flattened, in a dense, headlike, terminal, turbinate or hemisphaerical involucrate cluster. Longest bracts of the involucre with linear-filiform blades, usually exceeding the inflorescence, abruptly broadening toward the base where the margin is broad and prominently fimbriate-pectinate. Fertile scale ovate, acute, ciliate, somewhat keeled and with several nerves, pale brown to reddish-brown, smooth or minutely puberulent, the midrib greenish, included or slightly excurrent as a short mucro. Stamens 3, the anthers apiculate, ca. 3 mm. long. Akene broadly trigonous-obovoid, slightly more than 1 mm. broad, white or yellowish, usually 3-lobed, each lobe carinate and biconvex, the apex of the akene retuse, the interfaces coarsely and transversely rugose. Tubercle small, conic, surpassed by the projecting lobes of the akene.

Sandhills and dry sandy clearings in pine barrens, eastern North Carolina south to southern Florida and west along the coast to Escambia County, Florida.

Type locality: Tampa Bay, West Florida, *N. A. Ware.*

This species abounds in the longleaf pine-turkey oak sandhills and sand pine scrub of Florida, often in association with *B. ciliatifolia* var. *coarctata.* It is a weed on disturbed ground within the abovementioned vegetational types, but does not seem to invade other types of sandy areas, particularly roadsides, as do other *Bulbostylis* such as *B. barbata, B. stenophylla, B. capillaris,* and *B. ciliatifolia* var. *ciliatifolia.* It is a well marked species and the most robust of the U. S. species.

7. BULBOSTYLIS FLOCCOSA (Griseb.) Clarke in Urban, Symb. Ant. 2: 86. 1900.

Scirpus floccosus Griseb., Cat. Pl. Cub. 241. 1866.

Stenophyllus wilsoni Britton, Torreya 13: 215. 1913.

Bulbostylis haitiensis Kuekenth., Repert. Sp. Nov. 23: 199. 1926.

Bulbostylis wilsoni (Britton) Kuekenth.; Urban, Ark. Bot. 22A; 7. 1929.

Fimbristylis floccosa (Griseb.) Alain, Bull. Torrey Club 92: 290. 1965.

Perennial, tufted, 1-2 (-3) dm. tall, with hard culm bases often sheathed in persistent old leaf bases. Longer leaves 1/2 as long to nearly as long as the culms, the blades narrowly linear, spreading, thickened, with 5 low ribs, two lateral in a slightly flattened blade or the blade subterete, the surfaces smooth save for very short hairs in the narrow grooves between the ribs. Sheaths somewhat elongate, firm, a rich reddish-brown, smooth save for a prominently ciliate-fimbriate, apex. Scapes stiff, subterete, with usually several broad, low ribs, smooth save for copious, very short hairs in the grooves. Lowest involucral bract appearing as an extension of the scape, (hence the spikelets often appearing lateral), shorter to slightly longer than the inflorescence. Spikelets oblong or narrowly lanceolate in outline, 1.0-1.7 cm. long, acute, solitary or in small terminal clusters on the scapes and often in addition clustered at the plant base. Fertile scales spirally arranged, oblong to ovate, slightly keeled but more often rounded on the backs, pale brown to reddish-brown, acute to obtuse, smoothish to hirtellous, the margin ciliate-fimbriate, the hairs crisped, scarious save for a rigid, yellowish midrib which is slightly if at all excurrent. Stamens 3, anthers 2-3 mm. long. Akene obovate, obscurely trigonous, ca. 1 mm. long, very dark brown or almost black, smooth or minutely cancellate, the cancellae narrow, vertical. Tubercle depressed-globular.

A species of sandy beaches or sandy areas near the coast, from the Bahamas south through Cuba, and Hispaniola.

Type locality: Eastern Cuba, *C. Wright 3381.*

Robust enough to be similar to *B. nesiotica,* but differing from any other North American *Bulbostylis* in its blackish, smooth, akenes.

8. BULBOSTYLIS SUBAPHYLLA Clarke in Urban, Symb. Ant. 2: 86. 1900.

Stenophyllus subaphyllus (Clarke) Britton, Bull. Dep. Agr. Jamaica 5 (Suppl. 1): 12. 1907.

Bulbostylis alpestris Urban, Symb. Ant. 7: 168. 1912.

Bulbostylis tuerckheimii Urban, Symb. Ant. 7: 169. 1912.

Stenophyllus harrisii Britton, Torreya 20: 83. 1920.

Bulbostylis subaphylla var. *longiglumis* Kuekenth., Repert. Sp. Nov. 23: 198. 1926.

Bulbostylis subaphylla var. *rigida* Kuekenth., Repert. Sp. Nov. 23: 199. 1926.

Bulbostylis subefimbriata Kuekenth.; Urban, Ark. Bot. $22A^{17}$: 7. 1929.

Bulbostylis hispaniolica Kuekenth. & Ekman; Urban, Ark. Bot. $22A^{17}$: 6. 1929.

Fimbristylis hispaniolica (Kuekenth. & Ekman) Alain, Bull. Torrey Club. 92: 290. 1965.

Perennial, the culms bulbous-based, in small tufts, to 4 dm. tall. Longer leaves linear-filiform, nearly as long as the culms, fleshy, often semicircular in cross section or flat, or subinvolute, with several prominent, pale ribs, two marginal, the surface smooth save for scabrid marginal ribs; sheaths short, pale or reddish brown, hispidulous, converging more or less abruptly to the blade and long or short fimbriate apically with pale, crisped hairs. Scapes rather slender but still fairly rigid, smooth, many-ribbed, subterete or slightly flattened. Lowest involucral bract rigid, seemingly an extension of the scape, shorter than to exceeding the inflorescence. Spikelets oblong-lanceolate in outline, 0.7-1.5 cm. long, somewhat flattened, acute, reddish-brown, often proliferous, rarely solitary but more usually in open (some of the rays widely spreading) or contracted cymes or subcapitate clusters. Fertile scales narrowly ovate, acute, slightly curvate-keeled, hirtellous, reddish-brown, entire, ciliate, or short-fimbriate and with an inconspicuous, paler, midrib that is scarcely if at all excurrent. Stamens 3, the anthers apiculate, ca. 3 mm. long. Akenes trigonous-obovoid, pale brown or yellowish brown, finely rugulose, the cells vertical, very narrowly rectangular to almost linear. Tubercle depressed-conic.

Savannas, sandy areas, mountain slopes, eastern Cuba, Santo Domingo, Haiti, Jamaica.

Type locality: Cuba Oriental, *C. Wright 1533.*

This species is made up of a number of extremes in regard to inflorescence type, stature of plant, the pubescence of sheath apex. Intermediate forms are frequent.

9. BULBOSTYLIS NESIOTICA (I. M. Johnston) Fernald, Rhodora 40: 392. 1938.

Stenophyllus nesioticus I. M. Johnston, Univ. Calif. Publ. Bot. 7: 438. 1922.

Coarse tufted smoothish, rusty-based perennial to sometimes nearly 1 meter tall, (more usually 0.5 meter tall). Longer leaves linear, less than 1/2 the length of the mature scape, the blade smooth save for very short, pustular-based hairs on the margins, in cross section semicircular with 5 evident longitudinal veins, 3 dorsal and quite prominent and 2 marginal and somewhat less prominent; margins of leaf sheaths short, brownish, scarious, tapering gradually to the blade, long-hairy apically. Scapes subterete, stiff, multicarinate, evidently wider than the leaves. Spikes elliptic-oblong, acute, 0.5-1.0 cm. long (old ones with exposed rachis may be somewhat longer), rarely solitary, usually clustered at the scape tips. Lowest involucral bract stiff, straight, the blade similar to that of the foliage leaves, slightly shorter than, equalling, or (rarely) slightly exceeding the inflorescence. Bracts of the spikelets oblong-ovate, keeled, ciliate and/or lacerate, acute, brownish save for mid-veins and margin, the surface with fine appressed puberulence; nerves of a scale yellowish, seemingly 3, the central one on lower scales sometimes slightly excurrent. Stamens 3, including the exserted tip of the connective anthers ca. 2 mm. long. Akene broadly obovoid, trigonous, ca. 1.0-1.2 mm. long, pale gray, indistinctly transversely rugose, reticulate, sometimes with the central part of the "cells" raised; tubercle of the akene pale, hemisphaeric.

Rocky shores of Revillagigedo Islands, Mexico.

Type: MEXICO. REVILLAGIGEDO ISLANDS. San Benedicto Island, *A. W. Anthony 317.* Holotype at GH, isotypes at UC, NY.

10. BULBOSTYLIS BARBATA (Rottb.) Clarke in Hook. f. Fl. Brit. Ind. 6: 651. 1893.

Scirpus barbatus Rottb. Descr. Pl. Rar. 27. 1772.

Isolepis barbata (Rottb.) R. Br., Prodr. 222. 1810.

Scirpus dussii Boeckl., Beitr. Cyp. 2: 38. 1890.

Stenophyllus floridanus Britton; Nash, Bull. Torrey Club 22: 161. 1895.

Bulbostylis floridanus (Britton) Fernald, Rhodora 40: 392. 1938.

Annuals, tufted, to 3 dm. tall (seldom exceeding 2 dm.). Leaves 1/4-2/3 the length of the mature culms, the blades filiform, spreading to recurved, involute, with 5 prominent nerves, the marginal ones and sometimes the dorsals antrorsely hispidulous; sheaths greenish or tan, smooth, with wide scarious margins, these fimbriate apically. Scapes filiform, slightly wider than the leaf blades, angulate, smooth. Spikelets narrowly lance-ovoid to linear or oblong, 3-7 mm. long, in a terminal, often head-like, involucrate fascicle, rarely solitary or in 2's or 3's. Longest involucral bract setaceous, rarely exceeding the inflorescence. Fertile scales lance-ovate, curvate-keeled, acute, usually entire, a rich red or reddish-brown, rarely dull brown, smooth and lustrous, the midrib prominently raised, pale or greenish, excurrent as a short, usually spreading mucro. Stamens solitary, anther ca. 1 mm. long. Akene obovoid, trigonous, 0.5-0.6 mm. long, the angles often fairly sharp, pale brown, the faces flat or slightly concave, *finely* reticulate, the cells nearly isodiametric. Tubercle short-conic.

Moist to rather dry sands of roadbanks, fields, natural and artificial clearings in the Coastal Plain of the U. S. A. from eastern North Carolina south to southern Florida and west along the Gulf to southern Louisiana; Martinique; Guatemala. Old World tropics.

Type locality: Malabar (Koenig). Type not seen by writer.

B. barbata in North America is esentially a Coastal Plain weed, being a frequent invader of cultivated ground and common enough on sandy fields in late summer to form a reddish-brown carpet of inflorescences. It appears rapidly to be expanding its range in the southeastern United States.

11. BULBOSTYLIS STENOPHYLLA (Ell.) Clarke, Kew Bull. Add. Ser. 8: 26. 1908.

Scirpus stenophyllus Ell., Bot. S. C. and Ga. 1: 83. 1816.

Dichroma cespitosum Muhl., Descr. Gram. 14. 1817.

Dichromena caespitosa Spreng., Syst. 1: 202. 1825.

Stenophyllus cespitosus (Muhl.), Raf., Neog. 4. 1825.

Isolepis stenophylla (Ell.) Torr., Ann. Lyc. N.Y. 3: 353. 1836.

Stenophyllus stenophyllus (Ell.) Britton, Bull. Torrey Club 21: 30. 1894.

Fimbristylis stenophylla (Ell.) Alain, Bull. Torrey Club 92: 290. 1965.

Annual, densely tufted, to 2 dm. tall. Leaves 1/3-2/3 the length of the culms, the blades linear-filiform (0.5 mm. wide or less), flattened or involute, thick, the backs 5-nerved, the nerves prominent, antrorsely hispidulous: sheaths brownish or stramineous, prominently nerved, hispidulous, the margins broad, scarious, long-fimbriate apically, with crisped, pale hairs. Scapes rigid, ascending, erect, somewhat broader than the leaves or spreading, prominently angulate, the ribs antrorsely hispidulous. Spikelets oblong to lance-ovoid, acute, ca. 3-5 mm. long, in dense terminal, solitary, bracteate clusters, the longest bracts lanceolate-aristate, much exceeding the inflorescence. Fertile scales ovate, curvate-keeled, acute, hispidulous or puberulent, greenish to dull brown, with a prominently raised midrib, this excurrent as a conspicuous, recurved mucro. Stamens solitary, anthers ca. 0.5 mm. long. Akene broadly trigonous-obovoid, ca. 1 mm. long, rather sharply angled, pale or gray-brown, the faces flat or somewhat concave, finely rugose. Tubercle depressed-conic, persistent.

Sandy fields, roadsides, and clearings in pine flatwoods, Coastal Plain of the United States from eastern North Carolina south to southern Florida and west into northwestern Florida. Cuba.

Type locality: Around Beaufort, South Carolina, *Elliott*. Type at CHARL examined by writer.

In Georgia, South Carolina and Florida often mixed in populations with *B. barbata* and *B. ciliatifolia* var. *ciliatifolia* but quickly distinguished from either by its dense clusters of greenish spikelets and by its prominently elongate, setaceous-tipped, involucral bracts.

12. BULBOSTYLIS SETACEA (Griseb.) Svenson, Contr. Oc. Mus. Hist. Nat. Col. de la Salle 4: 10. 1946.

Abildgaardia setacea Griseb., Cat. Pl. Cub. 238. 1866.

Fimbristylis grisebachii Greenman; Combs, Trans. Acad. St. Louis 7: 474. 1897.

Fimbristylis cubensis Clarke, Ill. Cyp. pl. 43, f. 15-17. 1909.

Bulbostylis grisebachii (Greenman) Kuekenth., Repert. Sp. Nov. 23: 197. 1926.

Perennial, tufted, rarely to 3 dm. tall, the plant base often bulbous-thickened. Longer leaves 1/3 as long as the mature scapes to nearly as long, the blades filiform, with 4-5 prominent nerves, two marginal, the surfaces smoothish save for short, pustular-based hairs along the margins, less commonly on the veins below; sheaths short, with broad, pale-brown, scarious margins, the apices long-ciliate. scapes filiform, 4-5 carinate, smooth or with stout-based, short hairs along the ridges. Spikes pale brown or stramineous, lance-ovoid, 4-5 mm. long, solitary or in pairs (rarely three's) at the scape apex. Lowest involucral bract usually seeming an extension of the scape, often exceeding the spikelets, hence the spikelets usually appearing lateral. Fertile scales ovate to lanceolate, smoothish, keeled, tan or yellow-brown; nerves of the scales approximate, concentrated as a strong, greenish, midrib, this excurrent as a short erect mucro. Stamens 3, anthers ca. 1 mm. long. Akene pale brown, trigonous-obovoid, ca. 1.5-2.0 mm. long, 3-lobed, each lobe slightly carinate and tapering gradually to the akene base, the apex sharply retuse in outline, the surface between the ridges prominently and transversly rugose.

Rocky (usually limestone) pinelands and savannas, Cuba.

Type locality: Cuba. *C. Wright 1531; 3366*. Duplicates at NY examined.

13. BULBOSTYLIS **sepiacea** Kral, sp. nov.

Caespitosa subglabra humilis raro ad 2 dm. alta. Folia involuta filiformia scapos subteretes multicarinatos paulum latiores dimidium aequantia. Spiculae quasi terminales, glumis rufidulo-brunneis puberulis. Achaenia subtrigona vel plano-convexa, lato-obovoidea, apice non retusa.

Tufted, low smoothish plant, rarely to 2 dm. tall. Longer leaves filiform, about 1/2 the length of the mature scape, involute, the blades with 5 prominent longitudinal veins, two marginal and three dorsal, the surfaces smooth save for short, pustular-based hairs on the marginal nerves; sheaths short, the margins broad, scarious, pale-brown, tapering gradually into the blade and at this point long-fimbriate. Scapes subterete, multicarinate, slightly wider than the leaves. Spikes oblong or lance-ovoid, 5-7 mm. long (old ones with exposed rachis up to 1 cm.), solitary or in small clusters at the scape tips. Lowest involucral bract setaceous save for sheathing base, shorter than, equalling, or sometimes twice as long as the inflorescence. Fertile scales ovate, curvate-keeled, subentire, a rich reddish-brown save for the paler, nerves and the scarious margin, the surface appressed puberulent; nerves of the scale 5, approximate, not excurrent or but slightly so as a short cusp. Stamens 2 or 3, anthers ca. 1.0 mm. long, the anther connective prolonged. Akene obovate and obscurely trigonous (one face usually much wider), ca. 1 mm. long, yellowish, the surfaces finely rugose, the angles somewhat rounded and colliculate.

Crevices in rocky substrates, Revillagigedo Archipelago, Mexico.

Type locality: MEXICO. REVILLAGIGEDO ARCHIPELAGO. Socorro Island; crevices in bare rock, ridge at SE edge of plateau, sumit pleateau east of Mt. Everman, *R. Moran 5838*. Holotype at UC; isotype at RSA.

This plant, previously identified as *B. nesiotica* (I. M. Johnst.) Fernald, is not of the same species, in that *B. nesiotica* is much taller, much coarser, with broader, stiffer leaves and scapes (see description of that plant.).

14. BULBOSTYLIS CURASSAVICA (Britton) Kuekenth. & Ekman; Urban, Ark. Bot. 22A[17]: 6. 1929.

Bulbostylis floccosa var. B (?) *pumilio* Clarke in Urban, Symb. Ant. 5: 290. 1907.

Stenophyllus curassavica Britton, Bull. Torrey Club 43: 445. 1916.

Bulbostylis curassavica var. *pallescens* Kuekenth. & Ekman; Urban, Ark. Bot. 22A[17]: 6. 1929.

Fimbristylis curassavica (Britton) Alain, Bull. Torrey Club 92: 290. 1965.

Diminutive, tufted, annual rarely to 1 dm. usually 6-7 cm. tall. Leaves linear-filiform, spreading, 2/3 as long as or equalling the scapes, the blades linear-filiform, with 5 prominent pale ribs, two lateral and three dorsal, all hispidulous with ascending, short, stout-based hairs; the sheaths short, subscarious, tan, sparingly pubescent, the apices truncate, fimbriate. Scapes similar in width to the leaves, usually prominently 5-ribbed and hispidulous, in cross section therefore definitely grooved and angled. Spikelets ovoid, acute, ca. 5 mm. long, somewhat flattened, tan, solitary on the scapes and also often clustered at the plant base. Lowest involucral bract appearing as an extension of the culm, often many times longer than the spikelet, hence spikelet appearing lateral. Fertile scales subdistichously arranged, ovate, curvate-keeled, stramineous with red flecks, ciliate and subscarious save for a distinct, usually greenish, midrib, this excurrent as a short, erect mucro. Stamens 3, anthers ca. 0.7 mm. long. Agene obovoid, obscurely trigonous, ca. 1 mm. long, pale brown, lustrous, the surface foveate, with lines of vertically oriented, rectangular, shallow pits. Tubercle somewhat darker and depressed-globose.

Solution pockets in limerock, Curacao and Haiti.

Type locality: Curacao.

This species is similar to *B. schaffneri* of the Sierras of Mexico, but differs from it in being more pubescent, with flatter spikelets, the akenes of which are foveate rather than rugose.

15. BULBOSTYLIS PAUCIFLORA (Liebm.) Clarke, Kew Bull. Add. Ser. 8: 26. 1903.

Oncostylis pauciflora Liebm., Vidensk. Selsk. Skr. V. 2: 241. 1851.

Stenophyllus portoricensis Britton, Torreya 13: 216. 1913.

Bulbostylis ekmanii Kuekenth., Repert. Sp. Nov. 23: 197. 1926.

Bulbostylis portoricensis (Britton) Fernald, Rhodora 40: 392. 1938.

Fimbristylis portoricensis (Britton) Alain, Bull. Torrey Club 92: 290. 1965.

Perennial, tufted, smoothish, to 2 dm. tall, the plant bases often hard and somewhat thickened. Leaves 1/2 as long to slightly longer than the scapes, the blades filiform, usually 5-nerved but only 3 of these prominent, two forming the margin and one making a prominent mid-rib, thus the blade in cross section sometimes almost triangular; sheaths short, pale-brown, scarious, the thin margin tapering acutely to the blade, apically long-ciliate. Spikelets lance-ovoid, often narrowly so, few-flowered, ca. 0.5 cm. long, usually solitary on the scape, or two or three distant toward the scape tip. Lowest involucral bract setaceous, scabrous, seemingly an extension of the scape, usually longer than the spikelet. Fertile scales lanceolate, smoothish, scarious, prominently keeled, pale, save for a greenish to lustrous dark brown midrib of convergent nerves, this excurrent as a short cusp. Stamens 3, the anthers slightly longer than 1 mm. Akene obovoid, trigonous, ca. 1.5-1.7 mm. long, pale brown, one face (that toward axis of spikelet) wider, the surfaces prominently and transversely rugose; tubercle triangular, dark brown.

Rocky (limestone) savannas, Cuba, Puerto Rico, Haiti, St. Croix.

Type locality: St. Croix, West Indies.

Almost Rhynchospora-like in appearance, with its slender habit and its narrow, few-flowered, spikelets.

16. BULBOSTYLIS FUNCKII (Steud.) Clarke, Kew Bull. Add. Ser. 8: 26. 1908.

Isolepis funckii Steud., Syn. Cyp. 91. 1855.

Scirpus heterocarpus S. Wats., Proc. Am. Acad. 18: 171. 1883.

Stenophyllus funckii (Steud.) Britton, Bull. Torrey Club 21: 30. 1894.

Bulbostylis tenuispicata Barros, Anal. Mus. Argent. Ci. Nat. 41: 338. 1945.

Annual, tufted, to 1.5 dm. tall (usually much lower). Longer leaves spreading, from 1/2 as long to equalling the scape or rarely surpassing it, the blades linear-filiform, thickened, flat or somewhat involute, smooth, the backs prominently 3-ridged, the margins rounded, smooth or with distant, ascending, pustular-based short trichomes, the apex acuminate. Sheaths stramineous to reddish-brown, the margins broad, scarious, fringed apically with long, pale hairs. Scapes about the width of the leaf blades, angulate to somewhat flattened in cross-section, prominently, often sharply, ridged and channelled, the ridges often ascending-hispidulous distally. Spikelets of two sorts: terminal spikelets narrowly lance-ovoid or cylindrical, acuminate, 5-7 mm. long, solitary at the culm tips or appearing lateral to the lowest bract which appears as an extension of the culm, the fertile scales few, lanceolate, straight, prominently keeled, smooth, reddish-brown save for a prominently excurrent, greenish, midrib, the scale bases sometimes saccate and pushed out still further by the expanding akenes, the margins entire, lacerate or ciliate; basal spikelets sessile or subsessile, partly hidden by the foliage leaves or the foliage leaves themselves bearing florets in their axils, the fertile scales prominently curvate-saccate, forming a membranous covering over the ripe akenes. Stamens 2, anthers 0.5 mm. long. Akene broadly trigonous-obovoid, sometimes subglobose, those of the basal spikelets ca. 1.5 mm. long, those of the scapes usually slightly less than 1 mm. long; faces of the akene lustrous, slightly convex, finely and transversely rugose with rows of very fine, vertically oriented, lense-shaped, low, papillae. Tubercle conic to subglobose.

Sandy roadbanks, clearings in forest or savanna, lawns and fields, in the United States only in southern New Mexico and Arizona, in Mexico in the states of Chihuahua, Jalisco, Mexico, Michoacan, Nayarit, Oaxaca, Orizaba, San Luis Potosi, primarily in the high plateau, and southward into Central and South America.

Type locality: Venezuela. Type not seen.

Bulbostylis funckii is very weedy, being commonest on disturbed ground of overgrazed pastures or on roadsides. It is a common lawnweed in the city of Guadalajara. The species is unique in that it produces two sizes of akenes. It appears that the whole plant is morphologically a spikelet in that florets may develop in leaf axils. The basal akenes, which are often twice the size of those borne in the aerial spikelets, may develop cleistogamously; often they reach their full size without coming above the ground, looking for all the world like clusters of bulblets at the plant base. My attempts to germinate akenes of either sort has not as yet been successful.

17. BULBOSTYLIS SCHAFFNERI (Boeck.) Clarke, Kew Bull. Add. Ser. 8: 26. 1908.

Scirpus schaffneri Boeck., Bot. Jahrb. 7: 275. 1886.

Scirpus pringlei Britton, Bull. Torrey Club 15: 103. 1888.

Diminutive, tufted annual, at most to 6 or 7 cm. tall. Longer leaves often hiding spikelets, the blades filiform, flat to somewhat involute, spreading, with 5 prominent pale ribs, two marginal and three dorsal, smooth save for very short, stout trichomes along the ribs; sheaths short, pale, scarious, smooth save for a ciliate margin at the apex. Scapes short, ascending, with several sharp ribs, but often somewhat flattened and if so with short, stout-based hairs along the marginal ribs. Spikes ovoid, rather pale, about 5 mm. long, either solitary at scape tips or clustered at the plant base. Lowest involucral bract seemingly a continuation of the scape, the spikelets hence appearing lateral. Fertile scales lance-ovate, curvate-keeled, puberulent and ciliate, stramineous (sometimes with reddish flecks) and subscarious save for a thicker, greenish or yellowish, midrib, this excurrent beyond the tip of the scale as a long, spreading or slightly recurved, harsh-margined mucro. Stamens 3, the anthers very short. Akene yellowish or pale gray, trigonous-obovoid, ca. 1 mm. long, the edges prominent, paler and granular, the rest of the surface evenly and finely transversely rugose.

Sandy or gravelly clearings in pine or oak-pine, the Sierra Mts. of Mexico (Chihuahua and San Luis Potosi); also in southern New Mexico. So small a plant as to be easily overlooked, hence rare in collections.

Type locality: San Luis Potosi, *Schaffner*.

This diminutive species of the mountains of northern Mexico is one which tends to produce subsessile spikelets, these usually obscured by the tufts of leaves. As remarked upon by Svenson (1957) it is morphologically closest to the Caribbean *B. curassavica,* differing from it mainly in fruit character.

18. BULBOSTYLIS **trilobata** Kral, sp. nov.

Annua ad 3 dm. alta culmis solitariis vel in caespitibus parvis. Folia linearia scapos dimidium aequantia. Spiculae lanceo-ovoideae acute 1.0-1.3 cm. longae solitariae vel geminae vel ternae. Achaenia stipitato-obovoidea ca. 2 mm. longa prominenter triloba et tricarinata.

Annual, to 3 dm. tall, the culms solitary or in small tufts. Leaves linear, ascending, about 1/2 the length of the mature scapes, the blades flat or involute, ca. 0.5 mm. wide, with 5 prominent ridges, 3 dorsal and 2 forming a cartilaginous margin, the ridges hirsute with stiff spreading or ascending hairs, the sheaths also hirsute, with broad pale brown scarious margins, these long-ciliate at juncture with the blade. Scapes slightly wider than the leaf blades, straight, angulate, prominently ridged and grooved, the ridges hirsute with spreading hairs. Spikes lance ovoid, 1.0-1.3 cm. long, acute, solitary or in pairs or cymes of three, the rays of the inflorescence usually but slightly longer than the spikelets. Longest involucral bract either shorter than the inflorescence or exceeding it, the blade similar to the foliage leaf in vestiture. Fertile scales ovate, curvate-keeled, acute, and margin ciliate, the surface a pale reddish-brown, papillose-puberulent, the midrib prominent, greenish or greenish with a stramineous border, slightly if at all excurrent. Stamens 3, anthers ca. 1 mm. long. Akene stipitate-obovoid, ca. 2 mm. long, prominently 3-lobed and 3 carinate, pale brownish or greenish-brown, the faces coarsely and transversely rugose the carinae colliculate. Tubercle of akenes pyramidal.

Sandy areas of grass-sedge pockets in savannas, also on sandy roadbanks and fields, Mexico, (in the states of Chiapas, Oaxaca, Veracruz), Guatemala, Honduras.

Type: MEXICO OAXACA: 16.4 mi. w. Zanatepec along Mexico Highway

190 in moist sandy area of grass-sedge, *R. Kral and J. T. Murrell 27733.* Holotype at U.S.

This species most closely resembles *Bulbostylis pubescens* in its habit, its vesture, and in its fruit, but differs from that species in having prominently keeled spikelet scales, in often producing more than one spikelet on a scape, and in the more intricate sculpturing of its akene surfaces. I have not seen this new species save in association with *B. pubescens* and certainly they must be closely related. Populations of *B. pubescens* have haploid compliments of either 5 or 10 chromosomes; the two samples of *B. trilobata* thus far cytologically studied have a haploid complement of 25.

19. BULBOSTYLIS **arcuata** Kral, sp. nov.

Annua caespitosa ad 1.5 (-2.0) dm. alta. Folia longiora scapos 1/2-2/3 aequantia. Spiculae lanceo-ovoideae vel ovoideae 6-7 mm. longae solitariae vel geminatae. Achaenia obovata brevistipitata trigona 1.0-1.2 mm. longa.

Annual, tufted, to 1.5 (-2.0) dm. tall. Longer leaves 1/2 to 2/3 the length of the mature scape, the blades linear-filiform, spreading, ca. 0.2-0.3 mm. wide, involute, with 5 prominent veins, two marginal and three dorsal, the surface pubescent with spreading fine hairs; sheaths short, with broad pale scarious margins, pubescent, ciliate apically. Scapes spreading pubescent, linear-filiform, slightly twisted, prominently 5 ridged. Spikelets lance-ovoid or ovoid, 6-7 mm. long, solitary or rarely in two on a scape. Lowest involucral bract at least as long as the spikelet, sometimes twice as long or slightly more. Fertile scales lance-ovate, or ovate, puberulent, curvate-keeled, reddish-brown; midrib of scale of 5 approximate nerves, often greenish and excurrent as a spreading mucro. Stamens 3, anthers ca. 0.7 mm. long. Akene obovate, pale brown, short-stipitate, trigonous, ca. 1.0-1.2 mm. long, 3-lobed, each lobe carinate and convex-sided, the surfaces of the carinae pale and granular or colliculate, the faces transversely rugose, of rows of narrow, vertically oriented, cells.

Rocky or sandy grasslands, edges of temporary pools, sandy areas, Mexico from Baja California to Aguascalientes and Jalisco.

Type locality: MEXICO. JALISCO: depressions in grassland, on level summits 13 mi. w. Lagos de Moreno, abundant in Hilaria-Bouteloua turf, *R. McVaugh 17588.* Holotype at MICH.

20. BULBOSTYLIS PUBESCENS (Presl) Svenson, N. Am. Fl. 18, part 9, 543. 1957.

Abildgaardia pubescens Presl, Rel. Haenk. 1: 180. 1828.

Fimbristylis preslii Kunth, Enum. Pl. 2: 228. 1837.

Bulbostylis clavinux Clarke, Ill. Cyp. pl. 41, f. 1-3. 1909.

Annual, tufted, to 3.5 dm. tall. Leaves ascending, linear-filiform, from 1/3 to 1/3 the length of the mature culms, the blades involute with 5 prominently raised nerves, three dorsal and two marginal, the nerves pubescent with stiffly spreading hairs, the sheaths similarly pubescent, with broad, scarious, tan margins, these long-hairy apically. Scapes spreading or ascending, stiff, slightly broader than the leaf blades, angulate, prominently ridged and grooved, the ridges pubescent with spreading hairs or smooth. Spikes ellipsoidal to lance-ovoid, 0.5-1.0 cm. long, acute or blunt, solitary at the scape tip. Lowest involucral bract absent or acicular, shorter than the spikelet to sometimes slightly longer. Fertile scales ovate, slightly if at all keeled, very dark brown to reddish brown or flavescent, save for a greenish or stramineous midrib, acute or obtuse, the margin lacerate or ciliate, the surface finely papillose-puberulent, the midrib of the lower-most scales excurrent as a long mucro, those higher up merely mucronate. Stamens 3, the anthers 1.5-2.0 mm. long. Akene stipitate-obovoid, prominently three-lobed, ca. 1.5 mm. long, the lobes carinate, the interfaces concave, the surface of the interfaces either prominently transversely rugose or smoothish with a honeycomb reticulation, the carinae of the lobes either smooth or colliculate.

Sandy savannas, roadsides, and pastures, Mexico in the states of Mexico, Guerrero, Oaxaca, Chiapas, Nayarit, and Sinaloa, thence south into central America and northern South America (Colombia).

Type locality: Mexico and Luzon. Type not seen by this writer.

This species is a common weed in the savannas near the Mexican Pacific Coast, in an area extending from northern Chiapas into Nayarit. It is often abundant enough during the rainier periods of late summer to become an aspect dominant, the rich brown of its masses of spikelets being conspicuous even at a distance. Populations of it inland in Mexico tend to have lower stature, and to have much darker coloured spikelets. Most specimens I have examined have rugose akenes; however there are a few examples which lack this characteristic and so I have illustrated both types.

21. BULBOSTYLIS HIRTA (Thunb.) Svenson, Contr. Oc. Mus. Hist. Nat. Col. de la Salle 4: 11. 1946.

Cyperus hirtus Thunb., Phytogr. Bl. 6. 1803.

Scirpus hispidulus Vahl, Enum. 2: 276. 1805.

Isolepis exilis H.B.K. Nov. Gen & Sp. 1: 224. 1816.

Fimbristylis hispidula (Vahl) Kunth, Enum. Pl. 2: 227. 1837.

Scirpus chirigota C. Wright in Sauv., Anal. Acad. Ci. Habana 8: 81. 1871.

Fimbristylis hirta (Thunb.) Kuekenth., Repert. Sp. Nov. 23: 196. 1926. Not *F. hirta* R. & S., 1817.

Fimbristylis chirigota (C. Wright ex Sauv.) Alain, Bull. Torrey Club 92: 290. 1965.

Annual, solitary or in small tufts, to 3 dm. tall. Leaves narrowly linear, 1/4-1/2 the length of the mature scapes, the blades involute ca. 0.5 mm. wide with 5 prominent nerves, two marginal and three dorsal, the surface of the nerves spreading-pubescent or almost smooth: sheaths spreading-pubescent, with broad, scarious, brownish margins these with long, crisped, pale hairs apically. Spikelets lance-ovoid, acute, 5-6 mm. long, (2-) 3-5 (-6) in simple, open, umbellate cymes rays of the inflorescence spreading to ascending and seldom twice as long as the spikelets. Scapes angulate, slightly broader than the leaf blades, rigid, prominently ridged and grooved, the ridges spreading pubescent. Longest bract of the inflorescence acicular, hirsute, usually shorter than the inflorescence. Fertile scales ovate, acute, curvate-keeled, papillose-puberulent, entire of finely ciliete, a dark reddish-brown save for a stramineous or greenish, slightly excurrent midrib. Stamens 3, anthers ca. 1 mm. long. Akene trigonous-obovoid, ca. 1.2 mm. long and nearly as broad, 3-lobed, brown, the faces transversely rugose and finely etched with short vertical, linear cells, the whole surface with a "greasy" lustre. Tubercle short-conic, early deciduous.

Sandy fields, savannas, clearings, Africa, Madagascar, in the New World in Cuba, Venezuela, and in Mexico (Chiapas, Oaxaca, Veracruz, Nayarit).

Type locality: South Africa. Type not seen by this writer.

This species is perhaps closest to *B. trilobata,* in habit and general appearance, but is quite distinct in its greasy-looking, plumply trigonous akenes, and in the rich chestnut-brown color of its spikelet scales which is in sharp contrast to the prominent, paler or greenish, keeled, midrib. It is here reported as new for Mexico, (Kral nos. *25367, 25641, 27540, 27553, 27747, 27796B*) and is to be looked for in sandy situations throughout central America.

22. BULBOSTYLIS JUNCOIDES (Vahl) Kuckenth.; Osten, Anal. Mus. Hist. Nat. Montevideo II. 3: 187. 1931.

Oncostylis arenaria Nees in Mart. Fl. Bras. 2^1: 87. 1842.

Oncostylis tenuifolia var. *hirta* Liebm., Vidensk. Selsk. Skr. V. 2^1: 240. 1851.

Oncostylis tenuifolia var. *nana* Liebm., Vidensk. Selsk. Skr. V. 2: 240, 1851.

Scirpus lorentzii Boeck., Linnaea 38: 378. 1874.

Bulbostylis argentina Palla, Oesterr. Bot. Zeitschr. 57: 258. 1907.

Fimbristylis capillaris var. *pilosa* Britton, Bull. Torrey Club 15: 102. 1888.

Bulbostylis arenaria (Nees) Lindm., Bih. Sv. Vet.-Akad. Handl. 26 Afd. 3 No. 9: 19. 1900.

Bulbostylis fendleri Clarke, Kew Bull. Add. Ser. 8: 27. 1908.

Bulbostylis langsdorffiana Clarke in Urban, Symb. Ant. 2: 89. 1900.

Bulbostylis hirtella Clarke in Urban, Symb. Ant. 2: 166. 1900.

Fimbristylis savannarum Alain, Bull Torr. Club 92: 289. 1965.

Fimbristylis juncoides (Vahl) Alain, Bull. Torr. Club 92: 290. 1965.

Perennial, caespitose, to 4 dm. tall (usually lower), the culm bases often hard, fibrous, and bulbous-thickened. Leaves from 1/4 to 1/2 the length of the mature culms, the blades involute, less than 1 mm. broad, pale green, the backs with 5 prominent ribs, two making up a pale rounded margin, the ribs smooth, antrorsely hispidulous or scabrid; sheaths brownish or stramineous, smooth or puberulent, with broad scarious margins that are long-fimbriate apically. Scapes angulate, slightly wider than the leaf blades, rigidly spreading or ascending, prominently ridged and grooved, the ridges often with spreading hairs. Spikelets lance-ovoid, acute, 4-6 mm. long few to several in open or quite compact umbellate cymes, the cymes simple or with the primary rays themselves branched. Longest involucral bract with a filiform, leaf-like blade, this usually shorter than the inflorescence. Fertile scales ovate, prominently curvate-keeled, smooth or papillate-puberulent, usually a dark, rich reddish brown, the apex acute or rounded, the margin usually ciliate; midrib of scale raised, stramineous or pale green, included or excurrent as a short mucro. Stamens 3, anthers ca. 1 mm. long, blunt. Akene trigonous-obovoid, sometimes short stipitate, 1.0-1.5 mm. long, grayish or rarely yellowish brown or dark brown, the angles rounded and often paler, the faces transversely rugulose or even, but in either cases made up of fine, glassy-gray papillae. Tubercle persistent, subglobose.

Sands, clays or gravels of savannas, prairies, or fields, particularly at higher elevations, southwestern Texas, southern Arizona and New Mexico south through the mountains through Mexico into Argentina. Occasional in the coastal plain of Mexico and in the mountains of the Caribbean Islands.

Type locality: Montevideo, Uruguay.

Bulbostylis juncoides is perhaps the most highly variable species within the area of this treatment, and this is perhaps to be expected in light of the vast range and the large number of types of habitats occupied by the plants. It is perhaps the most abundant sedge on the heavy dark earth of the grasslands of the Mexican high plateau, here being often in association with *Fimbristylis argillicola* and *Abildgaardia mexicana*. In such situations, the species forms hard-based tufts of dozens of culms, these radiating out in a semidecumbent fashion. The inflorescence of this form is usually a simple, but often congested umbellate cyme of very dark brown spikelets, often none of the primary rays much longer than the spikelets. The lower habit and dense inflorescence may be a reflection of the higher, more exposed elevations at which these plants grow, but it is more likely genetic in that plants grown from seed in the Vanderbilt greenhouse retain these characteristics. Examples of my own collections of this form are as follows: see numbers *25114* (plants similar to this conform to the Uruguayan type material in their low habit, dense inflorescence, and smoothness); *25137* (foliage smooth); *25194* (weakly hirtellous); *25209* (foliage hirtellous); *25488* (foliage smooth); ish); *25501* (plants hirtellous); *25523* (plants hirtellous); *25556* (foliage smoothish; *25559* (plants slightly hirtellous); *25560* (plants hirtellous); *25584* (foliage hirtellous); *25589* (slightly hirtellous); *25735* (foliage hirtellous, the plants conforming with material at NY identified as "*Stenophyllus hirtellus* (R. & S.) Britton" or as "*Bulbostylis langsdorffiana* Clarke"); *27374* (plants smoothish); *27449* (foliage hirtellous); *27481* (foliage hirtellous); *27575* (foliage smoothish); *27608* (foliage smoothish); *27672* (foliage smoothish); *27686* (foliage hirtellous). Many of the above cited specimens are similar to examples of the variety *ampliceps* Kuekenthal (Osten, Anal. Mus. Hist. Nat. Montevideo II. 3: 188. 1831), and this is the entity found in the mountains of the southwestern United States. Often a single population will be a mixture of hairy and smooth individuals; akene characteristics also tend to vary somewhat within some populations.

A second, widely occurring, form is to be found in the oak or oak-pine forested slopes of the mountains of Mexico and Central America, primarily in the western cordillera. These are taller, usually with smoothish and longer foliage; the spikelets are longer, narrower, and of a paler, reddish-brown colour. The akenes are longer, often with the inward face much broader than the other two faces, dark gray or gray brown and with paler, usually yellowish, angles. Plants of this type grown from seed in the Vanderbilt greenhouse retain all of the abovementioned characteristics, and therefore appear to represent another genetic race. Examples from my own collections are as follows: *25299, 25618, 25537, 25623, 25651, 27539, 27560, 27613, 27644, 27718,* and *27721.* However, there are areas where this, the type common to clearings in oak-pine forest, comes into contact with the grassland form and because intermediate forms do exist it would seem advisable to designate all as entities of a highly variable species.

A third form is encountered in Cuba and in the lower elevations of Chiapas and Veracruz in Mexico. Examples of it have been identified as *B. arenaria.* However, it is so similar to *B. juncoides* in its spikelets, its perennial habit, and in the waxy, gray, rugose appearance of its ripe akenes, that it seems more appropriate to treat it also as *B. juncoides.* Examples of it from my own collections are the numbers *25336, 27745, 27749.*

23A. BULBOSTYLIS CILIATIFOLIA (Ell.) Fernald var. CILIATIFOLIA, Rhodora 40: 391. 1938.

Scirpus ciliatifolius Ell., Sk. Bot. S. C. & Ga. 1: 82. 1816.

Isolepis ciliatifolius (Ell.) Torr., Ann. Lyc. N. Y. 3: 352. 1836.

Stenophyllus ciliatifolius (Ell.) C. Mohr, Bull Torrey Club 24: 22. 1897. in part.

Stenophyllus capillaris A. *eu-capillaris* H. Pfeiffer, Bot. Arch. 6: 187. 1924.

Annual, in small to large tufts, to 3 dm. tall. Leaves 1/4-1/2 the length of the mature culms, the blades linear-filiform (less than 0.5 mm. wide), spreading, involute, prominently 5 ribbed, the lateral nerves comprising a thickened margin, all nerves with ascending, short, stout-based hairs, the sheaths similarly hairy with broad, scarious, stramineous margins, these fimbriate apically. Scapes angulate, slightly wider than the leaf blades, stiffly spreading or ascending, prominently ridged and grooved, either smooth or with a scattering of ascending, stout-based hairs. Spikelets narrowly ovoid, few flowered, 2-4 mm. long, usually few (3-9) in an open, umbellate cyme, rarely a compound systems, the primary rays of the inflorescense frequently 4 or 5 times the length of the spikelets and smooth or antrorsely scabrid. Lowest involucral bract acicular-setaceous, usually shorter than the inflorescence. Fertile scales broadly ovate, curvate-keeled, even cupuliform, dark reddish brown to dull brown, papillose-puberulent, ciliate, obtuse to acute, the midrib prominent, often bright green, slightly if at all excurrent. Stamens 2 or 3, the anthers ca. 0.8 mm. long, apiculate. Akene trigonous-obovoid, slightly less than 1 mm. long, grayish, the angles rounded, the interfaces pebbled with fine papillae, these either irregularly arranged or in fine lines, emparting a delicately rugulose appearance. Tubercle persistent, compressed-deltoid.

Moist to dry sands of exposed areas of savanna, old fields, roadbanks, pastures, or flatwoods clearings, southeastern Virginia south to southern Florida, west in the coastal plain into Texas. Cuba.

Type locality: Two miles from Beaufort, South Carolina, Elliott. Type at CHARL, examined by writer.

23B. BULBOSTYLIS CILIATIFOLIA (Ell.) Fern. var **coarctata** (Ell.) Kral, comb. nov.

Scirpus coarctatus Ell. Bot. S. C. & Ga. L 1: 83. 1816.

Isolepis coarctata (Ell.) Torr. Ann. Lyc. N. Y. 3: 352. 1836.

Fimbristylis capillaris var. *coarctata* (Ell.) Britton, Bull. Torrey Club 15: 102. 1888.

Stenophyllus coarctatus (Ell.) Britton in Small, Fl. SE. U. S. 189. 1903.

Stenophyllus carteri Britton in Small, Bull. N.Y. Bot. Gard. 3: 420. 1905.

Stenophyllus capillaris B. *coarctata* (Ell.) H. Pfeiffer, Bot. Arch. 6: 187. 1924.

Bulbostylis capillaris var. *coarctata* (Ell.) Machr., Field Mus. Publ. Bot. 11: 5. 1931.

Bulbostylis coarctata (Ell.) Fernald, Rhodora 40: 392. 1938.

Fimbristylis carteri (Britton) Alain, Bull. Torrey Club 92: 290. 1965.

Perennial (annual in the northern part of the range), in dense tufts, to 4 dm. tall. Leaves to 1/2 the length of the culms, the blades linear-filiform (0.5 mm. wide or less), flattened or involute, thickened, prominently 5 ribbed, the lateral nerves comprising a thickened margin, the surfaces smooth or the margin antrorsely scabrid, hispidulous, or distantly papillate, the sheaths tan, stramineous, or reddish brown, hard, lustrous, and with a broad pale, scarious margin, this long-fimbriate apically. Scapes stiffly ascending or spreading, angulate, prominently several ribbed, usually smooth. Spikelets lance-ovoid, oblong or narrowly ovoid, acute, few-flowered, 3-6 mm. long, usually many in a dense or open, ascending branched system of cymules: primary rays of the inflorescence either very short, giving whole inflorescence a fascicled appearance, or elongate with symules borne on branches several times the spikelet length and the inflorescence quite diffuse. Longest involucral bract setaceous, overtopping the inflorescence in the compact fascicled type, shorter or longer than the inflorescence in the diffuse type. Fertile scales ovate, curvate-keeled, pale brown to reddish brown, glabrous to hirtellous, entire or ciliate, acute, the midrib prominent, often greenish, usually excurrent as a short mucro. Stamens 2 or 3, the anthers ca. 1 mm. long, apiculate. Akene trigonous-obovoid, sometimes pyriform, grayish ca. 1 mm. long, the interfaces flat to somewhat convex, papillate. Tubercle persistent, compressed-globose.

Sandhills, particularly in the longleaf pine belt, southeastern Virginia to the tip of Florida, thence west in the Gulf Coastal Plain into Texas. Tennessee. Cuba.

Type locality: Beaufort, South Carolina. *Elliott.* Type at CHARL. examined. Most current workers consider *Bulbostylis ciliatifolia* and *B. coarctata* to be the same entity and it is true that an examination of any large series of specimens of this complex will reveal morphological intermediates. However, there is one extreme, that described by Elliott as *Scirpus coarctatus,* which frequents only the sandhills or at least dry sandy localities and which is a taller smoother plant with a denser inflorescence of more spikelets having longer involucral bracts, and which lives longer than one season. It is most commonly associated, in the heart of its range, with another sandhills *Bulbostylis, B. warei.* The other extreme is a much lower plant, more trichomiferous, with fewer spikelets in its inflorescence, with very short involucral bracts, and with a definitely annual habit. This latter extreme is more often found on moister sands, is often very weedy in old fields or in disturbed areas of pine flatwoods or at least moister sites in longleaf pine sandhills. It does not associate with *B. warei,* but is more often found with *B. barbata, B. stenophylla,* and *B. capillaris.* Although there are instances where it and the "coarctata" type intermingle on disturbed sandy sites, it is far weedier than the latter. In treating this complex I have found it impossible to consider both as the same entity, but at the same time cannot avoid realizing the morphological closeness of the two. My present alternative is to maintain both as varieties.

Good examples of *B. ciliatifolia* var. *ciliatifolia* from my own collections are as follows: *15216, 15542B, 18827, 19265, 22123, 25250, 22269, 22338, 22356, 22379, 22468, 27164, 28559, 28603, 28673* and *28684.*

Examples of *B. ciliatifolia* var. *coarctata* from my own sets show the two extremes, namely an open inflorescence similar to that of type variety, but more compound and with a longer involucral bract, and the other type with a much more congested inflorescence (usually turbinate in outline) with an involucral bract much exceeding the inflorescence in length. They are as follows: *15301* (open inflorescence), *25542a* (open inflorescence, here mixed with other variety), *15704* (open inflorescence), *17691* (closed inflorescense), *18258* (closed inflorescence), *18330* (closed inflorescence), *18388* (open inflorescence), *18981* (closed inflorescence), *19281* (open inflorescence), *19305* (open inflorescence), *19335* (closed inflorescence), *22080* (closed inflorescence), *22209* (closed inflorescence), *22336* (closed inflorescence), *22427* (open inflorescence), *22763* (open inflorescence), *22813* (closed inflorescence), *22828* (open inflorescence), *22835* (open inflorescence), *22850* (open inflorescence), *22876* (open inflorescence), *22883* (open inflorescence), *22967* (closed inflorescence), *23115* (open inflorescence), *23163* (open inflorescence), *23168* (open inflorescence), *23179* (closed inflorescence), *23175* (open inflorescence), *25876* (closed inflorescence), *27065* (closed inflorescence), *27101* (closed inflorescence), *27152* (closed inflorescence), *27187* (closed inflorescence), *27189* (closed inflorescence), *27256* (closed inflorescence), *28748* (open inflorescence). There is no geographic correlation to open versus closed habit of inflorescence.

24. BULBOSTYLIS CAPILLARIS (L.) Clarke in Hook. f., Fl. Brit. Ind. 6: 652 1893.

Scirpus capillaris L., Sp. Pl. 49. 1753.

Isolepis capillaris (L.) R. & S., Syst. Veg. 2: 118. 1817.

Scirpus brachyphyllus Link, Jahrb. Gewaschsk. 1^3: 78. 1820.

Isolepis brachyphylla (Link) Schultes in R. & S., Syst. Veg. Mant. 2: 64. 1824.

Scirpus muhlenbergii Spreng. Syst. 1: 207. 1825.

Fimbristylis capillaris (L.) A. Gray, Man. 530. 1848.

Isolepis radiciflora Steud., Syn. Cyp. 318. 1855.

Stenophyllus capillaris (L.) Britton, Bull. Torrey Club 21: 30. 1894.

Bulbostylis capillaris var. *crebra* Fernald, Rhodora 40: 395. 1938.

Bulbostylis capillaris var. *isopoda* Fernald, Rhodora 40: 395. 1938.

Annual, tufted, to 3 dm. tall. Leaves 1/4-1/3 the length of the mature scapes, spreading or ascending, pale green, the blades linear-filiform (ca. 0.5 mm. wide or less), smooth, involute, prominently 5-veined, two veins comprising the margin and upwardly scabrid or merely papillose of entire; sheaths glabrous with broad, tan margins, these fimbriate apically. Scapes capillary, about the width of the leaf blades or slightly wider, angulate, prominently ridged and grooved, the ridges occasionally upwardly hispidulous. Spikelets lance-ovoid or ovoid, acute, 3-5 mm. long, solitary or more usually 2 to 7 in open, umbel-like cymes with rays either quite short or several times the length of the spikelets (very occasionally the spikelets subsessile in subcapitate clusters). Lowest involucral bract acicular or linear, shorter than to exceeding the inflorescence. Fertile scales ovate, curvate-keeled, smooth or finely puberulent, the apex acute, rounded, or emarginate, the surface dark reddish-brown, the margin usually ciliate apically, the midrib prominent, usually a sharply contrasting pale green or straw coloured, and either included or excurrent as a short mucro. Stamens 2, anthers ca. 0.5 mm. long. Akene trigonous-obovoid, ca. 1 mm. long, flavescent to pale brown, the edges smoothish and rounded, the faces transversely rugose, of many rows of vertical, narrowly rectangular cells. Tubercle depressed-globose.

Sandy fields, grasslands, clearings and roadsides, often quite dry stites, especially abundant in areas of outcropping arenaceous rock, various provinces of North America, Maine to Florida, west into Texas and the lake states; scattered in the prairie provinces; in the mountainous areas of California, Oregon, New Mexico, Arizona and in contiguous areas of Mexico as well as in the state of Veracruz (*Kral 25069*). Rare in Cuba, central America. Local in southern Asia.

Type locality: Virginia, *Clayton*. Phototype from LINN examined.

Bulbostylis capillaris is perhaps the most widespread and weedy species of *Bulbostylis* in North America. It especially abounds on sandy highway shoulders or on the gravel and cinders of railroad right-of-way. In areas in which sandstone or granitic rock outcrops it is frequent in and about solution pockets. Of all U. S. Bulbostylis it is found the furtherest inland and north. In the Piedmont and in the inner Coastal Plain of the southeastern United States it may be found in sandy fields in association with *B. barbata, B. ciliatifolia,* and occasionally *B. stenophylla,* but does not intergrade with any of these. In inflorescence and general appearance it comes closest in appearance to *B. ciliatifolia* var. *ciliatifolia* but differs in the more reddish colour of its spikelets and in its akenes which are paler, finely rugose, rather than papillate. It is a very rapidly growing annual, often going from seedling to fruiting stage in a few weeks. Some workers have considered it conspecific with *B. juncoides,* a common sedge of similar habit of the mountains of Mexico and South America. However, that species is a hard-based perennial, usually with much darker coloured spikelets having gray-papillose akenes. Depauperate specimens of both are hard to distinguish, save by akene characteristics.

There are occasional examples of *B. capillaris* which produce basal fascicles of spikelets as well as terminal; these are most probably reactions to early drought.

25. BULBOSTYLIS TENUIFOLIA (Rudge) Macbr., Field Mus. Publ. Bot. 11: 5. 1931.

Scirpus tenuifolius Rudge, Pl. Guian. 18. 1805.

Isolepis bufonia H.B.K., Nov. Gen. & Sp. 1: 222. 1816.

Scirpus bufonius (H.B.K.) Poir. in Lam., Encyc. Suppl. 5: 105. 1817.

Oncostylis tenuifolia (Rudge) Nees in Mart., Fl. Bras. 2: 83. 1842.

Bulbostylis capillaris var. *tenuifolia* (Rudge) Clarke, Symb. Ant. 2: 89. 1900.

Fimbristylis bufonia (H.B.K.) Alain, Bull. Torrey Club 92: 291. 1965.

Annual or short lived perennial, in small tufts, rarely to 2 dm. tall. Longer leaves 1/2 to 2/3 the length of the mature scapes, the blades filiform, straight to somewhat twisted, prominently 5-ribbed, somewhat involute, two marginal, the surfaces smoothish or stout-ciliate toward the base; sheaths short, scarious-margined, pale-brown, tapering at acute angle to the blade proper, here long-ciliate. Scrpes straight, smooth, little if any wider than the leaves, prominently 5-ridged. Spikes lance-ovoid or ellipsoidal, acute, ca. 3.0 mm. long, long-pedunculate in simple or rarely in once-compound umbellate cymes, hence the inflorescence diffuse. Lowest involucral bract usually shorter or little longer than the basal spikelet, hence usually much shorter than the entire inflorescence, and often hardly in evidence. Fertile scales ovate or oblong, slightly curvate-keeled, smooth to hirtellous, a lustrous pale brown; evident nerves of the scales 3, approximate, forming a deeper brown or greenish midrib, this very slightly or not at all excurrent. Stamens solitary, anther ca. 1 mm. long. Akene broadly obovoid-trigonous, ca. 0.5 mm. long, yellowish or pale brown, the faces convex, low-papillate of finely colliculate.

Sandy wastelands, savannas, clearings in oak-pine or jungle scrub, northern South America, Central America, the Caribbean, Mexico.

Type locality: French Guiana. Type not seen.

A weed similar to *B. capillaris*, but more slender in habit and with smaller spikelets whose akenes are papillate rather than transversely rugose.

26. BULBOSTYLIS ANTILLANA (Britton) Fernald, Rhodora 40: 392. 1938.

Stenophyllus antillanus Britton, Bull. Torr. Bot. Club 43: 447. 1916.

Perennial, in dense tufts, to 3 dm. tall, the culm bases often bulbous or swollen and usually encased in persistent, chaffy old leaf bases. Longer leaves usually at least 1/2 as long as the mature scapes, the blades narrowly linear (less than 1 mm. broad), ascending, involute, the backs usually with 5 low ribs, the marginal ones with upwardly-pointing, stout-based, trichomes, the surfaces otherwise smooth. Sheaths somewhat elongate, pale brown or reddish-brown, the margin scarious, broad, and with a tuft of long, crisped hairs apically. Scapes smooth, about as broad as the leaves, ascending, conspicuously many-ribbed and channelled, subterete or somewhat flattened distally. Spikelets lance-ovoid or oblong, 5-6 mm. long, acute, very many in a dense, turbinate or hemisphaeric, glomerulate aggregation, the primary rays short, either terminating in a single spikelet or in cymules of 2 or 3 spikelets. Lowest involucral bract rigid, ascending, thickened, the blade setaceous, usually much exserted beyond the inflorescence. Fertile scales ovate, curvate-keeled, the sides a rich, reddish-brown, the midrib greenish, included or barely excurrent. Stamens 2, anthers ca. 0.8 mm. long. Akene broadly trigonous-obovoid, pale brown or stramineous, ca. 1 mm. long, the surfaces transversely rugulose with many fine undulating lines of low, glistening, contiguous, isodiametric or short-oblong papillae. Tubercle conical or depressed globose.

Dry sandy savannas, Martinique and Dominica.

Type locality: Grand Savanna, Dominica, *F. E. Lloyd 822* (NY).

This species most closely resembles *B. ciliatifolia*, differing in its bulbous culm bases, and in its more sharply trigonous akenes, the papillae of which are arranged in a more regular system of transverse ridges.

III. FIMBRISTYLIS Vahl, Enum. 2: 285. 1806.

Perennial or annual, the culms solitary or in tufts, or variously rhizomatous, rigid or lax, leafy toward the base. Leaves filiform to narrowly or broadly linear, glabrous to pubescent, flat or involute ligulate or eligulate, the sheaths closed or partly open at maturity of the leaf. Spikelets lanceolate, oblong, ovoid or round in outline, terete or somewhat flattened or angled, either solitary and terminal on the scapes or in simple or compound umbelliform systems involving pedunculate and sessile spikelets of cymules, the whole inflorescence as well as the cymules making it up often subtended by a leafy involucre. Fertile scales glabrous or variously pubescent, subdistichous to more often spirally arranged, deciduous, all but the lowermost fertile. Florets perfect; perianth absent (the flower produced on a short pedicel joint which usually disarticulates with the akene). Stamens one to three, the anthers oblong, basifixed, sometimes apiculate, the two thecae at maturity longitudinally and laterally dehiscing. Style two or three-branched, the unbranched portion flattened and fimbriate for at least a portion of its length, or (more rarely) subterete or angled, the style base either flattened or swollen but in any event not persistent at the summit of the akene. Akene lenticular or trigonous; surface of akene smoothish, cancellate, or warty, usually made up of isodiametric or horizontally arranged rectangular cells, these either concave or protuberant.

Over 200 described species, in a variety of habitats in warm temperate to tropical regions of the world.

Type species; *Fimbristylis dichotoma* (L.) Vahl.

KEY TO FIMBRISTYLIS OF NORTH AMERICA[4]

1. Style 3-branched.
   2. Akene trigonous, the surfaces smooth or warty; ligule of short hairs present.
      3. The plants perennial, usually rhizomatous. . . . . 27. *F. complanta* (Retz.) Link.
      3. The plants annual, caespitose. . . . . . . 28. *F. autumnalis* (L.) R. & S.
   2. Akene not trigonous or only obscurely so, obovoid, the surfaces usually warty; ligule wanting; plants annual.
      4. Spikelet usually broadly ovoid to subglobose, blunt; fertile scale rounded on the backs; leaf blades laterally flattened, the leaves of a culm flabellately spreading. . . . . 29. *F. miliacea* (L.) Vahl.
      4. Spikelet lance-ovoid, acute; fertile scales curvate-keeled; leaf blades dorsiventrally flattened. . . . . 30. *F. quinquangularis* (Vahl) Kunth.
1. Style 2-branched.
   5. Ligule of short hairs present (this characteristic is not noticeable in those entities which have broadly linear, flattened, leaf blades but is difficult to detect in those extremes which have very involute, narrow, leaf blades).
      6. A system of slender, pale or reddish, rhizomes present; robust perennials with tall, wand-like, culms.
         7. Outer surfaces of spikelet scales uniformly pubescent; spikelets elliptic-oblong, the apices of the bracts acutish, and with the midrib exserted as a prominent mucro; backs of leaf bases often pubescent; plants of marshy areas around mineral or hot springs

[4] Species numbered 27-49.

of the southwestern U.S.A. and northern Mexico.

. . . . 31. *F. thermalis* S. Watson.

7. Outer surfaces of spikelet scales glabrous or puberulent apically (hence spikelets usually more lustrous than in no. 5); spikelets ovoid to lance-ovoid, rarely oblong, the apices of the bracts rounded, with the midrib exserted, but not as prominently as above; backs of leaf bases seldom pubescent; plants of the midwestern U. S. A. or of the Atlantic and Gulf Coast of North America.

8. Fertile scales puberulent toward the tip; scapes usually flattened, often scabrous edged, distally; edges of leaves, especially toward the tip, scabrid; akene finely but definitely reticulate; upper edges of salt marshes, duneswales, or in sweet marsh inland near the coast, Atlantic and Gulf Coastal Plain from New Jersey to southern Mexico.

. . . . 32. *F. caroliniana* (Lam.) Fern.

8. Fertile scales usually smooth; scapes more slender, terete or broadly oval in cross section and smooth distally; edges of leaves usually not scabrid; akene smoothish or with longitudinal rows of shallow isodiametric pits; moist to wet sandy prairies, river sloughs, marshes and springy places, midwestern and western U. S. A.

. . . . 49b. *F. puberula* (Michx.) Vahl var. *interior* (Britton) Kral.

6. Rhizomes absent or, if present, thickened and made up of stout, contiguous, culm bases; perennial or annual species.

9. Spikelets pale (stramineous on herbarium specimens, pale reddish-brown on living specimens), usually solitary, sometimes in two's or three's on a culm; akenes appearing smooth under low (10-20x) magnification, under higher magnification showing longitudinal rows of shallow pits; usually low and spreading, always smooth, annuals of Asian origin but naturalized in the coastal regions of Georgia, Florida, Alabama, and Mississippi.

. . . . 33. *F. schoenoides* (Retz.) Vahl.

9. Spikelets darker, usually in open or congested umbellate cymes or panicles of cymes (depauperate examples with spikelets solitary at culm ends).

10. Face (one side) of akene smoothish or with many (15 or more) longitudinal rows of shallow pits or cells, thus finely striate.

11. Robust, smoothish perennials of brackish or coastal habitats such as beaches, edges of salt marsh, mangrove swamps; species of Caribbean and/or coasts of Mexico and Central America.

12. The plants usually densely caespitose, the leaf blades often poorly developed; spikelets ovoid, in a contracted cluster

of short-peduncled cymules at culm apex; akene pale, yellowish, very delicately and shallowly reticulate or smoothish; fertile scales densely appressed pale-hairy toward the apex; of wide distribution in the Caribbean, also on the coast of Yucatan and coasts of Central and South America. . . . . 34. *F. ferruginea* Vahl.

12. The plants in tufts of fewer culms, the culm bases fibrous, bulbous-thickened or grouped into short, knotty rhizomes, the leaf blades well developed, flat and broadly linear; spikelets lance-ovoid or ellipsoidal in a diffuse umbellate cyme or system of cymes; akene pale to dark brown, with many fine, but distinct, rows of pits or horizontally oriented cells; fertile scales lacking patches of hairs at the apices; local in the Bahamas and Cuban Keys. . . . . 35. *F. inaguensis* Britton.

11. Annual, the leaves and often the scape spreading-hairy; weed of the Atlantic and Gulf Coastal Plain of the United States. . . . . 36. *F. tomentosa* Vahl.

10. Face (one side) of akene more coarsely reticulate, usually with 12 or less longitudinal rows of horizontally oriented, rectangular cells.

13. Perennial with spreading, hard, pale-green leaves; akenes lacking warts. . . . . 37. *F. dichotoma* (L) Vahl.

13. Annual with spreading or ascending leaves; akenes with or without warts.

14. Sheaths densely spreading hairy; margins of leaf blades spreading-hairy, at least toward the base; leaves broadly linear, spreading subdistichous; primary rays of umbel stiffly spreading, the inflorescence often as wide as long or wider; edges of akene with at least a few low warts; weed of Atlantic and Gulf Coastal Plain, N. C. south to northern Florida, west into Texas. . . . . 38. *F. decipiens* Kral.

14. Sheaths, and leaves variable in pubescence; leaves narrowly linear, usually ascending; primary rays of umbel spreading or ascending but inflorescence usually longer than broad; akenes lacking warts or copiously warty; of general distribution throughout the eastern U. S. A., Caribbean Islands, Mexico and south into South America. . . . . 39. *F. annua* (All.) R. & S.

5. Ligule absent.

15. Low, often densely tufted, weedy annuals; leaf blades linear-filiform.

16. Base of style with long, reflexed hairs which cloak upper part of akene body; surface of akene smoothish; Old World and

Asian, in North America found only in Cuba (and once on ballast at Camden, N.J., Sept. 1865).

. . . . . . 40. *F. squarrosa* Vahl.

16. Base of style hairless or at least lacking long reflexed hairs: surface of akene reticulate.

17. Spikelets subsessile, in dense, head-like, involucrate clusters, several of the involucral bracts much longer than the inflorescence; akenes obovoid.

. . . . 41. *F. Vahlii* (Lam.) Link.

17. Spikelets in more open (umbellate) arrangement; akenes cylindrical, almost terete.

. . . . 42. *F. perpusilla* Harper.

15. Taller, more robust, wider-leaved, perennials.

18. Spikelets never as long as 5 mm., in dense, glomerulate, clusters of cymules, often giving the whole inflorescence a head-like appearance; tufted, hard-leaved, plants of brackish sandy situations, primarily along the coast (peninsular Florida, the Caribbean Islands, Mexico and southward).

. . . . 43. *F. spathacea* Roth.

18. Spikelets (by seeding time) never as short as 5 mm., usually closer to 1 cm. long, in more open inflorescences; the plants usually taller, with more slender, wand-like culms.

19. Akenes with warty protuberances on angles and faces.

20. Scales of spikelet a dark chocolate brown, in the fresh condition appearing almost blackish, outer surfaces of leaf bases smooth save along margins; plants of grasslands and brackish heavy soils of Mexican high plateau.

. . . . 44. *F. argillicola* Kral.

20. Scales of spikelet a reddish-brown or tan; outer surfaces of leaf bases pubescent, also old leaf bases persistent as shreds of long fibers; plants of reddish clay soils of open oak and oak-pine stands (usually frequently burned areas) Sierra Madre Oriental and Occidental, Mexico.

. . . . 45. *F. pentastachya* Boeck.

19. Akenes lacking warty protuberances.

21. Plants densely caespitose, common to brackish coastal habitats; bases of leaves hard, leathery, usually very dark brown or castaneous, often quite lustrous, deeply set in substrate.

22. Spikelets at seeding time a pale brown or pale reddish-tan; tufts of well-developed plants seldom a meter tall; west coast of Mexico.

. . . . 46. *F. pallidula* Kral.

22. Spikelets at seeding time a rich brown, reddish-brown or dark chestnut brown; taller plants of

brackish habitats on the east coast of Mexico (rarely along the western coast), or the Atlantic and Gulf Coastal Plains of the U. S. A., also found in the Caribbean Islands.

23. Spikelets arranged usually in a very compound, open system, the inflorescence at maturity therefore much longer than broad; spikelets oblong-linear or linear-lanceolate (prior to drying); longest bract of inflorescence longer than inflorescence (in most populations); brackish, usually coastal, marshes, the Caribbean Islands and the Atlantic coast of Mexico and south.
. . . . 47. *F. spadicea* (L.) Vahl.

23. Spikelets arranged usually in a denser inflorescence which is often not much longer than broad; spikelets broader, commonly ovate or broadly ellipsoidal; longest bract of inflorescence often overtopped by inflorescence or barely longer; brackish coastal marsh, Long Island south along the Atlantic coast and west along the Gulf coast to northern Mexico, tip of Yucatan peninsula; Cuba; the Bahamas.
. . . . . . .48. *F. castanea* (Michx.) Vahl.

21. Plants in small tufts or culms solitary, common to a variety of habitats in the U. S. A. (from sandy acid pineland savannas or oak barrens to heavy prairie earths) but not in brackish coastal marsh; bases of leaves thickened and hard or culm bases bulbous, but in any case more shallow-set in substrate; specimens either with stout, contracted rhizomes or with fasciculate clusters of narrow, orangish-brown, rhizomes.

24. Base of culms bulbous, often jointed together into a stout, knotty rhizome; old leaf bases often persisting as shreddy remnants; outer surface of fertile scales usually with some puberulence; savannas, prairies, grass-sedge bogs, oak or pine barrens, and upper edges of pineland ponds, U. S. A., the Atlantic and Gulf Coastal Plain westward into the High Plains.
. . . . 49a. *F. puberula* (Michx.) Vahl. var. *puberula*

24. Base of culms rarely bulbous, usually producing fascicles of slender, orangish, rhizomes; old leaf bases not persisting as shreddy remnants; outer surface of fertile scales seldom with any puberulence; moist, usually sandy areas of prairies and along prairie rivers, Nebraska, Kansas, and central Texas west into Colorado.

49B *F. puberula* (Michx.) Vahl var. *interior* (Britton) Kral.

27. FIMBRISTYLIS COMPLANATA (Retz.) Link, Hort. Berol. 1: 292. 1827.

Scirpus complanatus Retz., Obs. 5: 14. 1789.

Cyperus complanatus (Retz.) Willd., Sp. Pl. 1: 270. 1797.

Isolepis willdenowii R. & S., Syst. 2: 120. 1817.

Trichelostylis complanata (Retz.) Nees in Wight, Contr. Bot. India 103. 1834.

Trichelostylis rudgeana Nees in Mart. Fl. Bras. 2[1]: 79. 1842.

Fimbristylis obscura Fernald, Proc. Am. Acad. 36: 492. 1901.

Fimbristylis autumnalis (L.) R. & S. var. *complanata* (Retz.) Barros, Anal. Mus. Argent. Ci. Nat. 41: 334. 1945.

Perennial, either caespitose or (more commonly) rhizomatous, to 1 meter tall (usually about 2 to 4 dm. tall). Leaves ranging (often on the same plant) from 1/5 the length of the plant to the same length, the blades linear (up to 4mm. broad), stiffly ascending or spreading, flat, smooth, the backs with numerous, subequal, raised veins, the margins each with a prominent, pale, cartilaginous, ciliate-scabrid border; sheaths thicker, broader, sometimes sharply keeled, stramineous to pale brown, with a narrow to rather broad, scarious, tan to cinnamon, entire margin this usually joining the blade at an acute angle. Ligule present as a line of short, pale hairs. Scapes flat, similar to the leaves, sometimes twisted (in some coastal plants, or in plants competing with tall vegetation, the scapes may be narrower than the leaves, and somewhat angled or subterete in the cross section). Longest involucral bract with blade similar to that of the leaves, and seemingly a continuation of the scape, shorter than to much longer than the inflorescence. Spikelets linear-oblong to lanceolate in outline, usually 5 to 7 mm. long, dark brown, a rich reddish-brown, or tan, in a complex compound end to congested pedunculate system of cymes or cymules. Fertile scales ovate-lanceolate, to oblong, keeled (the keel sometimes ciliate-scabrid) entire, the midrib excurrent as a short mucro. Stamens usually 2 (rarely 3), the anthers 1.0-1.5 mm. long. Style 3-branched, much longer than the akene, trigonous at the base, subterete above toward the branches, utterly smooth. Akene trigonous-obovoid, apiculate, ca. 1 mm. long, pale brown, very finely striate-reticulate, the cells almost isodiametric to horizontally arranged, in numerous longitudinal rows, the surface also sometimes verrucose. Grasslands, savannas, grass-sedge bogs, or moist open disturbed grounds, throughout the Caribbean Islands and North America south of the United States. In both New and Old World topics.

Type locality: India (Type specimen not examined by this writer).

I have had field experience with this plant only in Mexico. There it is most abundant in the high plateau country on the heavy dark earths of grasslands or in moist soil pockets in the oak-pine belt. In the state of Durango it is occasional at elevations approaching 9,000 feet. However, it is also found in boggy situations in the coastal plain. As might be suspected, the plants of the lower elevations are taller and have narrower scapes which in some cases are hardly at all flattened. While some descriptions would indicate a strictly caespitose habit, the plants I have seen are all rhizomatous and tend to form large clones which actually locally may dominate the vegetation of low areas of grassland. In all it is a well marked species, readily distinguishable from *F. autumnalis*, the caespitose weedy annual with which it most often has been confused.

The surface of the akene of *F. complanata* is quite variable. In some populations it is almost smooth, in others evidently reticulate, in still others verrucose. However, all these seemingly extreme characteristics tend to blend together the more samples one inspects, and there seems to be little geographic correlation.

28. FIMBRISTYLIS AUTUMNALIS (L.) R & S., Syst. 2: 97. 1817.

Scirpus autumnalis L., Mant. 180. 1771.

Scirpus mucronulatus Michx., Fl. Bor.-Am. 1: 31. 1803.

Scirpus michauxii Pers., Syn. Pl. 1: 68. 1805.

Trichelostylis geminata Nees, Linnaea 9: 290. 1834.

Trichelostylis mucronulatus (Michx.) Torr., Ann. Lyc. N. Y. 3: 355. 1836.

Fimbristylis frankii Steud., Syn. Cyp. 111. 1855.

Frmbristylis frankii var. *brachyactis* Fernald, Rhodora 11: 180. 1909.

Fimbristylis autumnalis var. *mucronulata* (Michx.) Fernald, Rhodora 37: 398. 1935.

Caespitose annual, usually 0.5-2.0 dm. tall. Leaves glabrous, spreading, subdistichous, from half as long as the culms to equalling the culms, the blades linear, (to 4 mm. broad), flat, the backs with numerous, raised veins, the margin a pale, cartilaginous, ciliate-scabrid border. Sheaths broader, keeled, with a broad, scarious, tan, entire margin this joining the blade at an acute angle or truncate. Ligule present as a line of short, pale hairs. Scapes flat, similar to the leaf blades, the edges often harsh. Longest involucral bract with blade similar to that of the leaves, seemingly a continuation of the scape, shorter to longer than the inflorescence. Spikelets linear-oblong to lanceolate, usually 3-7 mm. long, a pale to dark brown, in an open to densely closed paniculate system of cymes, the primary rays usually ascending. Fertile scales ovate-lanceolate, usually keeled, entire, the midrib excurrent as a mucro. Stamens usually 2, rarely 1, 0.2-0.3 mm. long. Style 3-branched, much longer than the akene, trigonous at the base, subterete above toward the branches, utterly smooth. Akene trigonous-obovoid, apiculate, ca. 1 mm. long, pale brown, the surface smooth to quite verrucose.

Moist to wet sands, peats, silts or clays, primarily of disturbed, sunny ground, various provinces of eastern North America; the Caribbean Islands, Mexico, and Central America (here usually in low grounds near the coast). Old and New World tropics.

Type locality: Virginia (Clayton); phototype from LINN examined by writer.

This species has most been confused with *F. complanata* (Retz.) Link but differs primarily in its caespitose, annual habit and much shorter anthers (*F. complanata* is perennial, usually rhizomatous).

Many forms of *F. autumnalis* exist, some undoubtedly as habitat reactions. The sculpturing of the akene face is quite varied, in that this may range from utterly smooth to quite warty. The species also varies in regard to width of leaf blade and scape, openness of inflorescence, thickness and length of spikelet, number of spikelets, and total height of plant. Lower plants with shorter, stouter spikelets have been referred either to *F. geminata* Kunth or to *F. frankii* Steud. Examples of these tend to be mostly from the northern United States and southern Canada. Taller examples with narrower, longer spikelets and more open inflorescence were referred by Fernald to the variety *mucronulata* (Michx.) Fern. These latter are primarily from the southern United States or from the Coastal Plain. In Louisiana, where I have observed the greatest number of natural populations of the southern form, there are many small ponds with vacillating shorelines. Often, in October, along such shorelines may be seen stands of early and mid-summer weeks, these occupying higher, drying shores. Such plants are usually quite tall, with diffuse inflorescence (in short, good examples of *F. autumnalis* var. *mucronulata*), but are developing shorter, axullary shoots which terminate in denser inflorescences of stouter, shorter spikelets. More recent exposures of moist area along the same pond show younger plants which are often identical to the sort of plants found in the northern U. S. This has led me to think that perhaps shorter day length coupled with cooler temperatures may be the basis for most of the variation within the species. In fact, if the specimens be of young plants most late fall collections from the southern states bear striking resemblance to summer collections made in the northeastern United States or southern Canada. (See *Kral* specimens *23234, 23250, 19413, 23226, 23253,* and *Godfrey 63203*).

29. FIMBRISTYLIS MILIACEA (L.) Vahl, Enum. 2: 287. 1805.

Scirpus miliaceus L., Syst. Nat. ed. 10. 868. 1759.

Scirpus bengalensis Pers., Syn. 1: 68. 1805.

Fimbristylis littoralis Gaud. in treyc., vol. Bot. 413. 1826.

Isolepis miliacea (L.) Presl, Rel. Haenk. 1: 188. 1828.

Trichelostylis miliacea (L.) Nees in Wight, Contr. Bot. India 104. 1845.

Caespitose annual to 5 dm. tall (rarely to 1m.). Leaves equitant, distichous, from 1/2 the length of the plant to nearly as long, rigid, smooth, flabellately spreading, tapering evenly from broad, clasping sheaths into the blade, thence continuing to taper into a slender tip, the veins numerous, raised, and evenly spaced, the margin of the blade narrow, pale, cartilaginous, antrorsely ciliate-scabrid, the margin of the sheath somewhat broader, scarious, entire: sheaths keeled, often bladeless. Ligule not evident. Scapes slender, but rigid, flattened or somewhat angled in the cross section toward the base, more flattened distally, but often with a double margin along each edge. Spikelets subglobose, ovoid or short cylindrical, 2-4 mm. long, on flattened scabrous pedicels in a compound loose to congested system of cymes. Longest involucral bract usually shorter than the inflorescence. Fertile scales ovate, pale to (usually) dark brown, smooth, the apex obtuse, rounded, or emarginate, the margin entire, the midrib paler by contrast, or greenish, rarely excurrent. Stamens 1 or 2, anthers less than 1 mm. long. Style 3-branched, the unbranched portion not much longer than the akene, subterete below, more flattened and fimbriate above toward the branches. Akene obovoid, usually narrowly so, apiculate, ca. 1 mm. long, pale brown, reticulate, the cells narrowly rectangular, horizontally oriented in 4-6 rows on a face, the longitudinal ribs usually more prominent and usually verrucose.

Sandy peat, peat-muck, and silt of open areas such as savannas, pond, lake or river shores, cultivated areas (particularly rice fields), in the U. S. from N. C. south in the coastal plain into peninsular Florida, west in the Gulf into Texas. Throughout the Caribbean Islands, Mexico, Central America.

Type locality: India (phototype from LINN examined by writer).

This species is very similar to *F. quinquangularis* (Vahl.) Kunth, which has been collected from North America only in Puerto Rico. Examples of both species are, at LINN. It had been the opinion of Blake (1954) that, in that an inscription does appear on the specimen known as *F. quinquangularis* by prior authors, that plant would have to serve as the type. Such being the case, the nearest available name for what previously had been called *E. miliacea* by authors would be *E. littoralis* Gaudichaud (Freyc. Voy. Bot. 413. 1826.). However, it is the opinion of Kern (1954) that there is no proof which of the two specimens may actually have been used by Linnaeus in drawing up the original description. Therefore Kern's solution has been to consider the two sheets as syntypes; accordingly he has selected the second to serve as a lectotype in order to avoid legally "an undesirable change of names for two well known plants." The alternative chosen by Kern is here adopted.

It is easy to see how Linnaeus could have placed both species under one name in that both are annual herbs of similar foliage, habit and fruit. However, they do differ consistently in shape and coloration of spikelet, *F. miliacea* having a subglobose to short-oblong, blunt spikelet and *F. quinquangularis* having a lance-ovoid, acute spikelet.

If a species of *Fimbristylis* could be called attractive, this one comes closest. The history of introduction of this weed into the U. S. A. probably parallels that of rice, in that it is a common species of the rice growing countries of the Orient. In fact, in areas of the U. S. where rice is presently being grown (i.e. Arkansas, Louisiana, and southern Texas) it is often the commonest sedge of late summer.

30. FIMBRISTYLIS QUINQUANGULARIS (Vahl) Kunth, Enum. Pl. 2: 229. 1837.

Scirpus quinquangularis Vahl, Kunth, Enum, 2: 279. 1805.

Trichelostylis quinquangularis (Vahl) Nees in Wight, Contrib. 104. 1834.

Caespitose annual to 5 dm. tall (rarely taller). Leaves equitant, ascending, from scale like and quite short to nearly as long as the culms, rather firm, tapering rather evenly from broad, clasping, wide-margined sheaths into the blade, thence tapering gradually to the tip, the veins numerous but inconspicuous save for the two marginal and one central, the blade margin itself antrorsely scabrid, the sheath margin scarious, entire; Ligule not evident. Scapes slender, about the width of the leaves or slightly narrower, deeply angulate (with 3 or 4 sharp, flattened ridges), smooth. Longest involucral bract shorter than the inflorescence. Spikelets lance-ovoid, 2-3 mm. long, acute, in a diffuse paniculate system of cymes, the primary rays elongate hence the whole inflorescence usually longer than wide. Fertile scales ovate, acute to acuminate, curvate-keeled, a rich, lustrous reddish-brown, glabrous, entire, the midrib conspicuously elevated and pointed beyond the scale as a slightly recurved mucro. Stamens 1 or 2, anthers ca. 0.5 mm. long. Style 3-branched, slightly longer than the akene, the unbranched portion about the length of the branches, three-angled in the cross section, and delicately fimbriate from at least the midpoint to the branches. Akene obovoid or pyriform, ca. 1 mm. long, obscurely trigonous or subterete, pale, apiculate, reticulate with the cells horizontally oriented in 4-6 vertical rows on a face, the longitudinal ribs usually more prominent and also usually verrucose.

Sandy swamps, roadsides, and fields, Puerto Rico. A common wetland weed of the southern Orient, probably recently introduced in Puerto Rico.

Type locality: Presumably southern India. Type at C, not examined by this writer.

For the discussion of the synonymy of the species, and the nomenclatural problem that involves it and *F. miliacea*, see discussion under *F. miliacea*. *F. quinquangularis* is evidently very closely related to *F. miliacea*, but differs in having narrower, acute, more reddish spikelets and leaf blades which have dorsiventral rather than lateral flattening.

I am obliged to Professor Gonzalez-Mas, of the University of Puerto Rico, Mayaguez, for specimens of the Puerto Rican record and which I had erroneously identified earlier as *F. complanata*. These specimens are as follows: PUERTO RICO. Mayaguez. College campus, Mayaguez, *A. Gonzalez-Mas 2198, 2132;* Mayaguez Miradero Road, *A. Gonzalez-Mas 880;* Carolina, 65th Infantry Road, Banks of Rio Grande de Loiza, *A. Gonzalez-Mas 1230.*

31. FIMBRISTYLIS THERMALIS S. Wats., Bot. King's Expl. 360. 1871.

Rhizomatous perennial, the plants solitary or in small tufts, from 0.5-1.5 meters tall. Leaves, 1/3-1/2 the length of the scapes, the blades linear, 1-3 mm. (-4) mm. broad, flat to somewhat involute, smooth or with some pubescence toward the sheath and apex on the lower surface, veins numerous and prominent on the lower surface, the marginal vein or veins pale, cartilaginous, ciliate-scabrid. Sheath of the scape much broader, clasping, indurate, usually with some pubescence, stramineous to dull brown, with a broad and scarious margin, this usually entire and converging to the blade at an acute angle. Ligule of short pale hairs present; upper surface of the blade just above the ligule usually puberulent. Spikelets oblong-cylindric to lance-ovoid, 1.0-2.0 cm. long, a pale, dull prown, one to many in a closed to quite open paniculate system of cymes. Longest bract of the inflorescence shorter than the inflorescence. Scapes rather rigid, about the width of the leaves, glabrous, many-ridged, subterete below, progressively flattening toward the inflorescence, the edges of the flattened portion scabrous. Fertile scales ovate, subentire, a pale dull brown, the backs uniformly puberulent, the midrib by contrast paler, and exserted as a prominent cusp. Stamens 3, the anthers about 2 mm. long. Style branches 2, the style flattened and fimbriate from the base to above the point of branching. Akene lenticular-obovoid, about 1.5 mm. long, a dark lustrous brown, finely reticulate, the individual foveae horizontally rectangular, arranged in numerous, vertical lines. Joint of akene short, persistent on fruit.

Type locality: U. S. A. CALIFORNIA. SAN BERNARDINO CO.: vicinity San Bernardino, *S. B. Parish 3667*. Holotype at GH. This locality is probably Arrowhead Hot Springs, from which I have collected a series of specimens later to be distributed as topotypes (*Kral 21591*).

Wet, highly mineralized, usually sandy substrates, of marshes and banks of hot springs, or at least in desert provinces, southern California, Nevada, Utah, and Arizona, and south to the states of Baja California and Coahula in Mexico.

F. thermalis has perhaps the most unique habitat of all the species treated here. It abounds on the hot sandy banks of hot springs or in the highly mineralized sands of marshes in desert country where the temperatures of the ground become quite high. The substrate in which it roots is often hot enough to be uncomfortable to the touch and, as one follows a stream away from the hot springs which are its source it is noticed that *F. thermalis* is gradually replaced by other sedges along the banks. Taken out of context of habitat it could easily be mistaken for the robust, Gulf Coastal *Fimbristylis caroliniana*. However it differs markedly from that species by its much more pubescent, prominently mucronate, spikelet scales, and in its usually pubescent leaf sheaths. While coastal forms of *F. caroliniana* have a haploid complement of 30 chromosomes, *F. thermalis* has but 10.

The species geographically nearest *F. thermalis* is *F. puberula* in that its variety "interior" is of the high plains of the western United States. It is not unreasonable to suppose that *F. thermalis* arose long ago from *F. puberula* at a time when a moister climate permitted a continuum of sedge habitats to exist across North America. With subsequent drying out of large areas of the West populations of this rhizomatous sedge became isolated and have adapted to the unique niche they now occupy. In fact, the only consistent differences distinguishing *F. thermalis* from *F. puberula* var. *interior* are quantitative, *F. thermalis* being more pubescent (particularly on the backs of the spikelet scales) and a far more robust plant.

I have visited a locality in Coahuila where *F. thermalis* is extremely abundant on seepage areas in the vicinity of Cuatro Cienegas. In that locality it grows amongst an odd admixture of brackish soil plants such as *Cladium jamaicense, Distichlis spicata, Anemopsis californica, Sabatia stellaris* and *Samolus ebracteatus*. It is an area strange beyond description, the hot winds blowing from the surrounding Coahuilan desert and over these patches of rich marsh flora. The seepage itself is so filled with minerals that they precipitate in places as an actual crystalline crust, the upper portion of which literally bakes in the glaring sun.

I have been able to raise good crops of this species from fruit collected from both California and Mexico, so that it would seem that it is not dependent upon a heated soil medium save in nature.

32. FIMBRISTYLIS CAROLINIANA (Lam.) Fern., Rhodora 42: 246. 1960.

Scirpus carolinianus Lam., Ill. 1: 142. 1791.

Fimbristylis harperi Britton in Small, Fl. Miami 29. 1913.

Rhizomatous perennial, to 1.5 (-2) meters tall, the clums solitary or in small tufts, the bases rather shallowly set in the substrate. Leaves subdistichous, usually spreading, about half as long as the scapes, the blades firm, linear, 2-5 (17) mm. wide, the surface smooth or in some cases pubescent near the ligule on the upper face, the backs with several raised nerves, the margin pale, hyaline, scabrid. Leaf sheath broader, clasping, firm, a pale, to dark brown, glabrous to sparsely pubescent, with a wide stramineous, tan or reddish-brown scarious margin, this gradually or abruptly passing into the blade, and often ciliate at this point. Ligule of appressed hairs, usually complete. Scapes about the width of the leaf blade, glabrous, many ribbed, subterete toward the base, usually flattened toward the apex, in which case the edges scabrid. Longest bract of the involucre much shorter than the inflorescence to but slightly exceeding it, the back glabrous to puberulent, the margin harsh. Spikelets ellipsoidal, lance ovoid, or oblong, 0.5-1.5 cm. long, blunt to acute, a pale dull brown to reddish brown, few to many in a compound umbellate system of cymes, the edges of the peduncles scabrid. Fertile bracts ovate, glabrous or puberulent on the backs toward the apex, the margin entire, the surface marked by a thick, usually paler area of midrib, this sometimes excurrent as a short mucro. Stamens 3, the apex of the flattened filaments narrowed, the anthers about 3 mm. long. Style 2-branched, flat, fimbriate from near the base to slightly beyond the point of branching. Akene lenticular-obovoid, ca. 1 mm. long, a pale to deep brown, often lustrous, finely reticulate, the reticule being made up of several fine rows of foveae or horizontally oriented rectangular cells. Pedicel joint very short, usually persistent.

Brackish, alkaline or mildly acid sands or sandy peats of beaches, duneswales, lakeshores, roadside ditches, more rarely savannas or flatwoods, coastal plain, New Jersey south into the Florida Keys and west along the Gulf to the state of Tabasco, Mexico; Cuba.

Type locality: "e Carolinia. *D. Fraser.*" Holotype at Herbarium Lamark, P. Phototype examined.

F. caroliniana is one of the more robust species. It graces those portions of the Atlantic and Gulf Coastal Plain where extensive deposits of sand develop along the coast. It is abundant where salt marsh grades into circumneutral marsh, where moisture accumulates in interdune swales, or even in mildly acid marshy situations inland. Occasionally it is in association with *F. castanea,* a true brackish marsh species, but this is usually along an ecotone. It may easily be distinguished from that species by its rhizomatous, rather than caespitose, habit, by its flattened rather than rounded upper culms, by its broader, blunter leaves and by its paler spikelets.

While *F. castanea* may enroach on its habitat from the seaward side, *F. puberula* may do the same from the landward side. This is particularly the case in the state of Florida, where much of the land is either undergoing mechanical disturbance (which would tend to mix habitat types) or is recently emergent. I was once of the opinion that these two species were easily distinguished on the basis of rhizome character alone, that *F. caroliniana* invariably produces long, slender rhizomes while those of *F. puberula* are a jointed together complex of thick-bulbous, knotty, culm bases. However, some *F. puberula* have at seasons of the year long slender rhizomes in addition. Examples of this are to be found in the flat country along the St. Johns River in peninsular Florida, also in broad marsh between the Indian River and the present coast. Therefore other, supplemental characteristics must be found to distinguish *F. caroliniana* from *F. puberula.* These consist of a noticeably broader, usually spreading, leaves, a stouter and usually flattened upper scape, together with a discernible (with hand lens) usually complete ligule of hairs. Plants which exhibit such characteristics have haploid chromosome complements of either 20 or 30; the 30's are invariably the most robust plants and these are most often found in closest proximity to the present seacoast. See further discussion under *F. puberula* Michx.

33. FIMBRISTYLIS SCHOENOIDES (Retz.) Vahl, Enum. 2: 289. 1805.

Scirpus schoenoides Retz., Obs. 5: 14. 1789.

Fimbristylis inconstans Steud., Syn. Cyp. 107. 1855, fide Clarke.

Caespitose annual 1.0-3.5 (-4.0) dm. tall. Leaves 1/3-2/3 the length of the culms, the blades linear, about 1 mm. wide, smooth, flat or somewhat involute, pale green, spreading to ascending, the backs with a few prominent raised nerves, the margin evident as a narrow, thickned, distantly ciliate-scabrid border. Leaf sheath broader, firmer, with a wide, usually tan or reddish-brown, scarious entire margin, this rounded or subtruncate at junction with blade. Ligule present as line of short hairs. Scapes rather rigid, slightly narrower than the leaves, many-ribbed and subterete toward the base, becoming somewhat flattened (oval in cross section) near the inflorescence. Spikelets ovoid, 5-8 mm. long, flavescent, acute to blunt tipped, often solitary, sometimes in twos and sessile and distant on a scape rarely in threes and laterals peduncled. Lowest bract from shorter than the subtending spikelet to much longer, the blade similar to that of the leaves. Fertile bracts broadly ovate, entire, the whole surface uniformly flavescent, the midrib indistinct save as a short mucro, the nerves apparent as paler lines. Stamens 3, the anthers about 1 mm. long. Style 2-branched, thickened at its base, otherwise flat, fimbriate from about its mid-point to the point of branching. Akene lenticular-obovoid or obpyriform, nearly 2 mm. long, nearly white to pale brown, finely reticulate, the individual depressions usually almost isodiametric, and arranged in numerous vertical lines, giving a "honeycomb" appearance to the surface. Joint of akene (pedicel) up to 1/5 the length of the fruit, usually persistent on akene.

Moist sandy clearings, savannas, roadsides, ditchbanks, flatwoods clearings, particularly on recently disturbed ground, Coastal Plain of the United States from eastern Georgia south to the tip of Florida, west along the Gulf into Mississippi. An introduction from tropical Asia.

Type locality: India ("F. schoenoides. Cyperus monostachyos junior, ex India orientali, Koenig"). At C. Specimen examined by this writer.

Fimbristylis schoenoides, with its pale, often solitary, spikelets, and its very finely reticulate akenes, is so distinct from other species in the range of this treatment that further comment is unneccessary. It is weedy enough to be looked for in disturbed pine flatwoods situations north into the Carolinas and west into eastern Texas. No specimens of it have been found from Mexico. In Asia it is similar (see plate 33a) to *F. polytrichoides* (Retz.) Vahl (see plate 33b) and to *F. tristachya* R. Br. (see plate 33c) both of which may have similar habit and spikelet characteristics. It differs from the former mainly by having several nerves on its fertile bracts; it differs from the latter mainly by having a shorter style. In that only this character plus anther length distinguish *F. schoenoides* from *F. tristachya*, it is possible that they are the same species. Both have the same chromosome complement, namely N equalling 5.

34. FIMBRISTYLIS FERRUGINEA (L.) Vahl, Enum. 2: 291. 1805.

Scirpus ferrugineus L., Sp. Pl. 50. 1753.

Scirpus debilis Lam., Ill. 1: 141. 1791, fide Vahl, Enum. 2: 292. 1805. Not *S. debilis* Pursh, 1814.

Scirpus ferrugineus var. *debilis* (Lam.) Poir. in Lam., Encyc. 6: 780. 1804.

Fimbristylis sublateralis Steud., Syn. Cyp. 114. 1855.

Fimbristylis ferruginea var. *compacta* Kuekenth., Repert. Sp. Nov. 23: 196. 1926.

Tufted perennial to 7 dm. tall, the outer leaves of a tuft often abbreviated, scale-like. Leaves seldom half as long as the fully developed scapes, sometimes bladeless or very short-bladed, the blades narrowly linear (up to 2 mm. broad), flat to involute, smoothish, the backs prominently ribbed, two of these forming an incrassate, pale margin, this ciliate with ascending, pale, stout-based hairs; sheaths broad, smooth, with a wide, tan or reddish-brown, subscarious margin that forms an acute angle (or is subtruncate) and ciliate apically. Ligule present as a horizontal line of short pale hairs. Scapes rather rigid, noticeably wider than the leaf blades, many-ribbed, subterete toward the base, often somewhat flattened toward the inflorescence. Spikelets dull reddish-brown, broadly to narrowly ovoid, 0.8-1.0 cm. long, acute to blunt, rarely solitary, usually in a dense, usually simple cyme or even a subcapitate cluster (peduncles of spikelets rarely longer than 2 cm. in North American examples). Longest involucral bract similar to leaves but shorter, usually shorter than the inflorescence or equalling it, sometimes up to twice as long. Fertile bracts ovate, pale reddish-brown, save for greenish or gray-green longitudinal mid-zone, the apex acute to obtuse, the margin entire or ciliate apically, the surface smoothish save toward the apex where pale, appressed short hairs concentrate; midrib of scale inconspicuous, the individual veins comprising it indistinct, but exserted as a short cusp. Stamens 3, the anthers short (less than 2 mm. long). Style 2-branched, flattened, the edges fimbriate from base to point of branching. Akene lenticular-obovoid, *finely* reticulate, the individual cells subisodiametric and in distinct longitudinal lines (less often of lines **of** narrow, horizontal rectangles). Base of akene jointed to spikelet by means of a short joint which usually breaks off with the fruit. Chromosomes N equals 10.

Type locality: Jamaica ("in Jamaicae paludibus maritimis.")

In North America found mostly in the Caribbean Islands always close to the sea or in brackish localities inland; also found in Yucatan peninsula. Of world-wide distribution in the tropics.

This species is distinguished from other brackish-habitat *Fimbristylis* by its short leaf blades, its rather plump, usually aggregated spikelets, its finely reticulated akenes, and by close-set, copious, pale pubescence of the apices of its fertile scales.

35. FIMBRISTYLIS INAGUENSIS Britton, Torreya 13: 216. 1913.

Perennial, the culms solitary or in small tufts, to 6 dm. tall, from a knotty rhizome comprised of old, bulbous, culm bases, the old leaf bases persisting as fibrous shreds. Leaves from 1/3 to 2/3 the length of the culms, spreading, often distichous, the blades linear, to 4 mm. broad, flat or rarely somewhat involute, smooth or sometimes puberulent inside in the zone of the sheaths, rigid, the backs inconspicuously nerved, the marginal nerves often prominent as a cartilaginous band, entire to antrorsely ciliate-scabrid; sheaths clasping, the backs hard, a pale to deep brown, often puberulent, the margin broad, scarious, tan or reddish-brown, puberulent and also ciliate distally. Ligule usually present as a zone of ascending, pale, stout hairs. Scapes rigid, flattened distally, subterete below. Longest involucral bract shorter than to somewhat longer than the inflorescence, rigid, the blade flat and antrorsely ciliate-scabrid, the sheath puberulent. Spikelets lance-ovoid or cylindrical, at maturity ca. 1 cm. long, acute, reddish brown, from few to several in an open or compact, simple or compound umbellate cyme, the primary branches or rays ascending. Fertile scales oblong or ovate, smooth, the apex acute to obtuse, the margin entire or sometimes ciliate, the backs rounded: nerves of the bract low, inconspicuous, included or sometimes slightly exserted as a weak, short mucro. Stamens 3, the anthers ca. 2 mm. long. Style 2-branched, flattened, the edges fimbriate from about the mid-point to the area of branching. Akene lenticular-obovoid, 1.0-1.5 mm. long, tumid, finely reticulate, a pale to deep brown, the individual almost isodiametric cells arranged in many fine longitudinal lines.

Sandy beaches and clearings, the Bahamas, also in the Cuban Cays.

Type locality: Inagua, *Nash* and *Taylor 1019*. Holotype at NY.

This entity most resembles *F. caroliniana* in that it is of very robust habit, has stiff, flattened scapes, and has spreading, flattened, broadly-linear bluntish leaf blades. However, it lacks the slender rhizomes of that species, being more similar to *F. puberula* in having a system of bulbous culm bases jointed together into a stout, knotty rhizome.

36. FIMBRISTYLIS TOMENTOSA Vahl, Enum. 2: 290. 1805.

Fimbristylis diphylla var. *pluristriata* Clarke in Hook. f., Fl. Brit. Ind. 6: 637. 1893.

Fimbristylis podocarpa Nees in Wright, Contrib. 98. 1843.

Fimbristylis annua forma *tomentosa* (Vahl) Ohwi, Jour. Jap. Bot. 14: 578. 1938.

Caespitose annual to 7.5 dm. tall. Leaves from half as long to nearly the length of the mature culms, the blades linear 2-4 (-5) mm. broad, usually flat but sometimes slightly involute, spreading to ascending, the surfaces pubescent, the backs with several prominent raised nerves, the margin evident as a pale, cartilaginous narrow border which is ciliate-scabrid. Leaf sheath broad, usually tomentose, with a wide, brownish, subscarious margin, this long-ciliate and truncate above at juncture with blade. Ligule present as horizontal line of short pale hairs. Scapes rather rigid, subterete basally, usually flattened or oval in cross section just below inflorescence, smooth or variously pubescent. Spikelets at maturity a rich reddish-brown, lance-ovoid, 4-6 mm. long, acute, usually many in a rather dense paniculate system of cymes, the primary branches of which are usually ascending, pubescent (spikelets solitary in depauperate specimens). Longest involucral bract exceeding inflorescence, leaflike in its vestiture, always with a prominently hairy sheath. Fertile bracts ovate, at maturity glabrous, reddish-brown, save for a paler, often greenish, area of midrib, this usually exserted as a short cusp (backs of the midrib of lowermost scales often with some hairs). Anthers 2, 0.7-1.0 mm. long. Style 2-branched, flattened, the edges fimbriate from near the base to the base of the branches. Akene obovoid, slightly apiculate, including the pedicel 1.7-2.0 mm. long, lenticular, finely foveate (pitted), the pits arranged in many vertical rows, sometimes slightly umbonate, at maturity a dark to pale brown save for the pale margin; pedicel joint persistent, up to 0.5 mm. long.

Moist to wet sands, silts or clays of disturbed habitats such as pond or river banks, roadside ditches, canals, or agricultural grounds, coastal plain from North Carolina south to northern Florida and west into Texas.

Type: Holotype at C (" ex India orient"); examined by author.

F. tomentosa is fast becoming one of the commonest weeds of ricefields in Louisiana, Texas and Arkansas; it is also not uncommon in former rice-growing areas of Georgia and the Carolinas. However, for all its present abundance, it is rare in U. S. herbaria, an indication that it may be a comparatively recent introduction. What few specimens have been collected have usually been identified either as *F. dichotoma* or as *F. annua*. However, it differs from both in finely pitted-striate character of its akenes, in its consistently hairier and wider leaves, and in the distinctly "rusty" coloration of its mature spikelets. It is an annual throughout its range and has the lowest haploid chromosome complement of the complex (N equals 5).

In the rice country of southern Louisiana it may be so abundant in late summer as to form dense stands wherever there are moist roadside ditches, or canals.

37. FIMBRISTYLIS DICHOTOMA (L.) Vahl, Enum. 2: 287. 1805.

Scirpus dichotomus L., Sp. Pl. 50. 1753.

Scirpus diphyllus Retz., Obs. 5: 15. 1789.

Fimbristylis glaucum Vahl, Enum. 2: 288. 1805.

Fimbristylis laxum Vahl, Enum. 2: 292. 1805. in part.

Fimbristylis brizoides Nees & Meyen; Nees in Mart., Fl. Bras. 2^1: 74. 1842.

Fimbristylis polymorpha Boeck., Linnaea 37: 14. 1871.

Fimbristylis annua var. *diphylla* (Retz.) Kuekenth., Repert. Sp. Nov. 23: 196. 1926.

Fimbristylis Annua f. *brizoides* (Nees & Meyen) Kuekenth., Repert, Sp. Nov. 23: 196. 1926.

Fimbristylis diphylla ssp. *diffusa* Ward, Castanea 33: 127. 1968.

Tufted perennial to 5 or even 8 dm. tall. Leaves from half as long to nearly the length of the culms, the blades linear, 2-5 mm. broad, flat to somewhat involute, often glaucous and spreading, usually smoothish or rarely the lower surface pubescent, the backs with several prominent raised nerves, the margin evident as a pale, cartilaginous border which is ciliate-scabrid; sheaths broad, usually appressed pubescent, with a wide, tan or reddish-brown, subscarious margin that is ciliate and subtruncate apically. Ligule present as a horizontal line of short hairs. Scapes rigid, subterete basally, usually flattened or oval in cross section just below the inflorescence (the edges of a flattened scape usually scabrid). Longest involucral bract usually longer than the inflorescence, the blade similar to a leaf blade, the sheathing base sometimes pubescent and ciliate. Spikelets drab, brownish or reddish brown, usually lance-ovoid or oblong, 4-8 mm. long, acute, in a open of dense, simple to compound unbellate system of cymes (spikelets solitary in depauperate specimens). Fertile bracts broadly oblong or ovate, the apex acute to obtuse, the margin entire; the surface smooth, a pale to dark brown save for a paler, often greenish midrib; midrib terminating at the scale apex or excurrent as a short cusy. Anthers 1 or 2, about 1 mm. long. Style 2-branched, flattened, the edges fimbriate toward the point of branching. Akene lenticular-obovoid, sometimes fairly tumid, about 1 mm. long or slightly longer, apiculate, white to brownish, striate-reticulate, the cells rectangular, shallowly concave, horizontally arranged in (5-) 10 to 12 longitudinal rows/.side, the longitudinal ribs more conspicuous than the horizontal.

On a variety of substrates so long as they are moist and sunny; savannas, roadsides, fields, grasslands, etc. in warm temperate to tropical climates of both hemispheres. Fast becoming a weed of moist, open, sandy soils throughout the lower Coastal Plain of the southeastern United States.

Type locality: India (type material consists of specimens some of which have open, some congested, inflorescence.)

As has been stated by C. E. C. Fisher (Kew Bull. 1935: 149-150) *F. dichotoma* is based on *Scirpus dichotomus* Linn. Sp. Pl. 50 (1753). This same plant was described by Linnaeus in his Fl. Zeyl. 16, which description was in turn based on both Hermann (Zeyl. 26) and Plukenet (Alm. 179, t. 119, f.3). Both of these latter citations are represented by type specimens at BM. Material from my own collections has been compared and matches with the types (thanks for the comparison are due to Prof. John Lewis of the British Museum). The species has been confused with both *F. annua* (All.) R. & S. and with *F. bisumbellata* (Forsk.) Bubani. Many authors maintain that *F. annua* is a part of the *F. dichotoma* complex; however, *F. annua* is invariably annual while *F. dichotoma* is (at least in the New World) a perennial species. Another annual plant of the Old World with smaller akenes and spikelets but with a habit similar to that of *F. dichotoma* was also often misidentified as that species; thanks again to Fisher (l.c.) this mistake has been ironed out, the correct name for the plant in this case being *F. bisumbellata* (Forsk) Bubani (for an illustration of the species, see plate 37B).

Actually, any large set of New World specimens of *F. dichotoma* and *F. annua* will show extremes that are most difficult to place. As a rule the former species in addition to being perennial, is a smoother plant, usually with broader, stiffer foliage, and almost always with no tubercles on the ribs of the akene. As a rule specimens of the latter species, in addition to being annual, are either hairy or narrower-leaved, have softer foliage, and very often have tubercles on the ribs of the akene.

Two forms of *F. dichotoma* are prevalent in North and Central America. Vegetatively both are quite similar, having distichous, usually spreading, hard leaves, these as a rule broader than those of *F. annua*. Save for the sheaths and margins of the leaves and involucral bracts, the foliage is usually smooth, very often glaucous. The scapes are rather rigid and terminate usually in an inflorescence of numerous, lance-ovoid small spikelets, which when young often have greenish tints but which age to various shades of brown. The main difference between the two sorts of *F. dichotoma* lies in the relative denseness of the inflorescence. In one (see Kral numbers *25372, 27785, 27794,* from Mexico and *25915, 25953, 25912a, 22921, 22090, 25831, 25883* from the U. S. A.; see also plate 37) the total inflorescence is made up of several, long-rayed, dense clusters of cymules. In the other (see Kral numbers *17841, 18270, 18452, 18386, 18594, 22769, 22777, 25232, 25912b, 27375, 27554, 27845,* etc. from Mexico and the U. S. A.) the inflorescence is an open system of cymules. In the coastal plains of Mexico and the U. S. A. both often occur in the same locality; in the highlands of Mexico only the latter type is found. This difference in inflorescence is correlated with a difference in chromosome number, the haploid complement of plants with the closed inflorescence being 10, that of plants with an open inflorescence 15. There are pubescent examples of both, but these are far less frequent than the smooth (see Kral numbers *25615, 27562* of Mexico, and *27832* from Louisiana, U. S. A.) I have taken fruit from spikelets of both forms; these develop into plants consistently true to type. However, in that there are several specimens from Mexico and Central America which have intermediate sorts of inflorescence, it is difficult to know how to annotate the material. For convenience sake I have therefore annotated all of the forms as *F. dichotoma*, with hopes of investigating this sort of dimorphism in more detail.

38. FIMBRISTYLIS **decipiens** Kral, sp. nov.

Annua caespitosa ad 3 dm. alta foliis scapos dimidium aequantibus. Vaginae dense pilosae; laminae basin versus (vel ultra) patenti-pilosae, lato-lineares, patentes, subdistichae. Inflorescentia saepe isodiametrica vel latior, ramis primariis umbellatis rigido-patentibus. Achaenia marginibus pauciverrucosis.

Caespitose decumbent annual to about 3 dm. tall, the scapes spreading or ascending. Leaves about 1/2 as long as the mature culms, the blades linear, pale green, averaging about 2 mm. wide, the upper and lower surfaces smoothish, or with erect, long trichomes along the veins beneath, the backs with several prominent raised nerves, the margins thickened, pale-cartilaginous, with approximate to scattered, long horizontal trichomes toward the blade base, these grading ino a scabrid margin distally; sheaths closed, with a broad, scarious, tan margin, this spreading-pilose also ciliate apically. Ligule present as a line of short, pale, appressed hairs. Scapes fairly rigid, multicostate, terete below, sometimes slightly flattened distally, the ridges sometimes with scattered, horizontally spreading hairs. Longest involucral bract, longer than the inflorescence, similar to leaves in width and indument of blade, the expanded sheath spreading pilose. Spikelets ellipsoidal to lance-ovoid, 5-6 mm. long, acute, stramineous to brownish, few to several in an open system of spreading, usually 1-3-spikeleted, cymules, the inflorescence usually about as broad as or broader than long. Fertile bracts broadly oblong to ovate, the apex acute to acuminate or obtuse, the margin entire and scarious, paler, the surface smooth, tan or tinted with brown, the midveins inconspicuous and pale, or the midnerve itself green;

midvein usually excurrent as a short mucro. Anthers 1 or 2, about 0.8 mm. long. Style 2-branched, flattened, the edges usually fimbriate only from about the midpoint to the base of the style branches. Akene broadly lenticular-obovoid, about 1 mm. long, pale brown or greenish-brown, the 2 edges somewhat thickened and paler, the surface ridged-reticulate, the cells rectangular and horizontally oriented in 8-11 vertical lines to a side, with the longitudinal edges more prominent than the transverse; edges of the akene usually with a few isolated papillae toward the distal end.

A weed of moist sandy roadbanks, fields, and disturbed, open usually piney woods, in the coastal plain from eastern North Carolina south to northern Florida and west into eastern Texas.

Type locality: U. S. A. MISSISSIPPI. FORREST CO.: Interstate 56 crossing of Leaf River, n. of Hattiesburg, *R. Kral 27858*. Holotype at US.

F. decipiens appears to represent an intermediate morphology between *F. dichotoma* and *F. annua*. It is so evidently a weed, and is so often in association with other weedy and introduced *Fimbristylis* (i.e. *F. miliacea, F. tomentosa*) that I have long worried over how to treat it. Undoubtedly a search through Old World collections would result in turning up examples. It is possible that I have annotated South American or Central American specimens of it as *F. annua,* for it is extremely difficult for me to distinguish my own processed collections of *F. decipiens* from *F. annua*.
Yet, though photographs or herbarium specimens of this plant would be difficult to distinguish from those of *F. annua* or *F. dichotoma,* it is quite a different matter in the field when one sees mixed populations of the three. It may be distinguished from *F. annua* by its harder, broader and more spreading, leaves, its more rigid scapes, and by the almost umbonate appearance of the akene. It may be quickly distinguished from *F. dichotoma* on the basis of its usually fewer-flowered and broader inflorescence, the primary rays of which are spreading, often reflexed, and by the different character of pubescence of its leaf and sheath margins. While tubercles do form on the akene, they are usually larger and fewer than those forming on verrucose examples of *F. annua,* and they are only to be found distally along the swollen edges of the fruit. Rosettes of this entity are hardly distinguishable from those of *F. dichotoma* save for the very pilose membranous sheath margins. Yet, in spite of the hard character of the leaves and plant bases, and the seemingly perennial appearance of the mature plants, *F. decipiens* lives for but one year.

Chromosome counts of *F. decipiens* have thus far shown haploid complements of but 10. This distinguishes it on a cytological basis from *F. annua* which has 15, and from examples of *F. dichotoma* that have a diffuse inflorescence which also have 15. A form of *F. dichotoma* having 10 haploid chromosomes is distinguishable morphologically even in the herbarium in that its inflorescence is made up of dense fascicles of cymules, while that of *F. decipiens* is more open, usually with less spikelets.

39. FIMBRISTYLIS ANNUA (All.) R. & S., Syst. 2: 95. 1817.
Scirpus annuus All., Fl. Ped. 2: 277. 1785.
Fimbristylis serratulum Vahl, Enum. 2: 285. 1805.
Fimbristylis hirtellum Vahl, Enum. 2: 286. 1805.
Fimbristylis laxum Vahl, Enum. 2: 292. 1805.
Scirpus baldwinianus Schultes in R. & S., Syst. Veg. Mant. 2: 85. 1824.
Scirpus sulcatus Ell., Bot. S. C. & Ga. 1: 86. 1816. Not *S. sulcatus* Petit-Thouars, 1811.
Scirpus elliottii Spreng., Syst. 4^2: 28. 1827.
Fimbristylis verrucosa Presl, Rel. Haenk. 1: 190. 1828.
Fimbristylis baldwiniana Torr., Ann. Lyc. N. Y. 3: 344. 1836.
Scirpus depauperatus Muhl.; Kunth, Enum. Pl. 2: 233., as syn 1837.
Fimbristylis alamosana Fernald, Proc. Am. Acad, 36: 491. 1901.
Fimbristylis holwayana Fernald, Proc. Am. Acad. 36: 492. 1901.
Fimbristylis darlingtoniana Pennell, Bartonia 15: 30. 1933.
Fimbristylis dichotoma f. *annua* (All.) Ohwi, Jour. Jap. Bot. 14: 477. 1938.
Fimbristylis diphylla var. *tomentosa* Barros, Anal. Mus. Argent. Ci. Nat. 41: 328. 1945.
Fimbristylis arenicola Wiggins, Contr. Dudley Herb. 4: 15. 1950.

Caespitos, decumbent, ascending or erect, annual, to 5 dm. tall (usually much lower). Leaves from half as long to nearly the length of the mature culms, the blades usually narrowly linear glabrous to tomentose, 1-2 (-4) mm. wide, the backs with several prominent raised nerves, the margin often pale, cartilaginous, usually ciliate-scabrid; sheaths broad, smooth or pubescent, with a wide, subscarious margin, this smooth or pubescent, pale brown, and toward its apex ciliate and truncate or acute. Lingule present as a horizontal line of short hairs. Scapes lax to rigid, ascending or erect, subterete basally, flattened or subterete above at junture with inflorescence. Longest involucral bract similar to leaves in its width and indument, shorter or longer than the inflorescence, the sheathing base smooth or hirsute. Spikelets lance-ovoid or oblong, 3-8 mm. long, acute, greenish, tan, brown, to a dark reddish-brown, in a few to many spikeleted on simple or compound umbellate systems of cymes (spikelets solitary in depauperate specimens). Fertile bracts broadly oblong to ovate, the apex acute to obtuse, the margin entire, the surface smooth, the midrib paler, seldom excurrent. Anthers one or rarely two, about 1 mm. long. Style 2-branched, flattened, the edges fimbriate from the base to the branches, or entire basally. Akene lenticular obovoid or obovoid and quite tumid, about 1 mm. long, apiculate white to brownish, often iridescent, striate-reticulate, the cells rectangular, shallowly concave, horizontally arranged in from 5 to 12 longitudinal rows per side, the longitudinal ribs more conspicuous than the horizontal. Surface of akene often verrucose, the warts forming either along the longitudinal ribs or over entire cells.

On a variety of moist sunny substrates; savannas, roadsides, grasslands, disturbed or cultivated areas, etc. in temperate to tropical climates of both hemispheres.

Type locality: Italy (Piedmont). Holotype at TO has been examined. It is a temptation to follow the lead of several other cyperologists and to treat this entity as part of *F. dichotoma*, especially in that it is difficult (if not impossible) to distinguish betweeen herbarium specimens of extremes of both. However, as the name Allioni selected indicates, this is strictly an annual plant; characteristically it is smaller or at least more slender in habit. *F. dichotoma* is a perennial, usually coarser, plant.

A very large number of forms of the species are to be found, many of which have been designated species or varieties of other species, particularly *F. dichotoma*. In my experience the commonest forms are as follows: (1) a relatively tall, ascending-leaved, pubescent, reddish-brown spikeleted form with reticulate, non-verrucose akenes (see Kral numbers *7932, 15288, 18724, 27839, 21062, 22061, 22938, 25473, 25793, 25805b, 25819a* (see illustration 39b), *25821, 27744, 27808, 27817, 27820*); (2) a lower, usually smoothish, spreading-leaved, pale-spikeleted plant with reticulate-warty akenes (see numbers *25325, 25330, 25393, 25463, 25667, 25670, 25673, 27505, 27726* illustrated as 39a); (3) a fairly tall, usually smoothish, ascending-leaved, chestnut-brown spikeleted plant with reticulate smooth *or* warty akenes (see numbers *25522, 25600, 25630, 27616, 27627, 27641, 27680, 27753);* (4) a low, usually smoothish, ascending or spreading-leaved, reddish brown spikeleted plant with reticulate, smooth-or-warty akenes (see numbers *13780, 13942, 18633, 22002, 22062, 22193, 22374, 22436, 22601, 22684, 22697, 24593, 25965, 25977A, 27157, 27850, 27857*). The first form most often has been identified as *F. laxa* Vahl, or *F. hirtellum* Vahl, or erroneously as *F. tomentosa* Vahl: it is a common weed in central and South America, also the Orient. The second form has been identified most often as *F. baldwiniana* Torr., but, collections of it from southwestern United States and from Mexico (where it is locally abundant) have also been identified as *F. alamosana* Fernald. The third form was named *F. holuayana* by Fernald (l.c) and is not uncommon in the foothills of the Sierras of Mexico and Central America. The fourth form is widespread in the New World tropics, in the eastern United States and in southern Europe with isolated examples in the Orient; it is this form which is the type of *F. annua*, but which in the United States has long been called *F. baldwiniana*. An extreme of it, from the serpentine barrens of Pennsylvania and Delaware (Virginia?) was named *F. darlingtoniana* by Pennell.

Morphological intermediates between the above-mentioned forms do occur, and when they do, such may constitute very large, seemingly pure, populations. Fruit characters, so often reliable in distinguishing *Fimbristylis* species, are in such cases not constant enough to be useful and are indeed a reason for my treatment of all of the above sorts as one species. All forms are also held together by an annual habit, together with what is so far found to be a consistent chromosome complement, namely, N equalling 15.

The original area occupied by the species is open to conjecture. It would appear that the greatest diversity of forms is in Austral Asia, and that at least some of the forms have been introduced to North America by way of rice culture. However the form which includes the Allioni type actually behaves like a native over a good bit of its range in the United States. It is to be found in such habitats as granite or limestone outcrops (i.e. the outcrops of Alabama, Georgia) wet areas of clearing in original forest, edges of brackish marshes, etc. as well as in weedy situations. It is easy to see how such authors as Fernald, Pennell, etc., would have considered it native. These workers made much of the verrucose character of the fruit; however, specimens of European, Asian, and South American *F. annua*, sometimes show development of some warts and therefore it is not the most reliable of characters. Such a feature often varies rather widely *within* otherwise fairly uniform populations.

40. FIMBRISTYLIS SQUARROSA Vahl, Enum. 2: 289. 1805.
Isolepis hirta H.B.K., Nov. Gen. & Sp. 1: 224. 1816.
Fimbristylis hirta (H.B.K.) R. & S., Syst. Veg. 2: 99. 1817.
Pogonostylis squarrosus (Vahl) Bertol., Fl. Ital. 1: 313. 1834.
Fimbristylis comata Nees in Wight, Contr. Bot. India 102. 1834.

Annual, caespitose, to 4 dm. tall. Leaves 1/2 as long to nearly as long as the culms, the blades linear filiform, flat, the backs rather prominently and evenly nerved, the lower surface and margin often hirtellous; sheaths soft, hirtellous or puberulent, the margins broad, scarious, pale, entire or ciliate toward the apex. Scapes slender, erect, about the width of the leaves, subterete, prominently ridged-and-grooved, smooth. Spikelets ellipsoidal or oblong, acute, 4-5 mm. long, few to many in open, umbellate or paniculate cymes, usually the inflorescence with some ascending primary rays, these several times the length of a spikelet, and either terminating in a single spikelet or in a cymule of two or three spikelets, hence the inflorescence usually longer than broad. Longest involucral bract linear-lanceolate, long-attenuate or setaceous, slightly shorter to somewhat longer than the inflorescence. Fertile scales ovate, brown or greenish brown, the backs rounded or slightly keeled, the margins entire, the surface smooth or with a scattering of short ascending hairs; midrib of fertile scale raised, usually deep green, well exserted beyond the scale as an attenuate, recurved, mucro. Stamens solitary, the anther ca. 0.5 mm. long. Akene lenticular-obovoid, slightly less than 1 mm. long, pale brown, smooth or reticulate. Style somewhat longer than the akene, 2-branched, flattened, retrorsely long-fimbriate at the base to form a fringe over the summit of the akene, smooth toward the mid-point, then sparsely fimbriate above toward the style branches.

A weed in tropical, humid situations, very common in the Old World and in tropical Asia, seemingly rare in North America having been collected only from Cuba, (C. Wright) and once on ballast at Camden, N.J. (C. F. Parker).

Type locality: South America. The type specimen, obligingly sent from C, shows good material of one plant plus a top from another. There is no problem in identification but the caption on the specimen is sketchy: "Fimbristylis squarrosum e collect Amer. Loefl. dedit Ortega."

According to Koyama (1961), this small sedge is but a variant of *Fimbristylis aestivalis* (Retzius) Vahl. Both are diminutive, eligulate, and have similar akenes, inflorescence, and spikelet shapes. However, *F. aestivalis* is smoother, and lacks the elongate-recurved midrib character of bract, also the recurved fimbriate character of style base that is so distinctive in *F. squarrosa*. I feel that these constitute specific rather than varietal differences, hence am retaining the previous nomenclature. Only experimentation with the two entities can decide the matter. For purposes of comparison I have drawn typical examples of both (see plates 40a, 40b).

41. FIMBRISTYLIS VAHLII (Lam.) Link, Hort. Berol. 1: 287. 1827.

Scirpus vahlii Lam., Ill. 1: 139. 1791.

Isolepis vahlii (Lam.) H.B.K., Gen. & Sp. 1: 221. 1816.

Fimbristylis congesta Torr., Ann. Lyc. N. Y. 3: 345. 1836.

Fimbristylis vincentii Steud., Syn. Cyp. 109. 1855.

Scirpus apus A. Gray, Proc. Am. Acad. 10: 78. 1874.

Fimbristylis apus (A. Gray) S. Wats., Bot. Calif. 2: 224. 1880.

Caespitose low annual, the culms to 1.5 dm. tall (usually much lower). Leaves 1/3 as long as the scape to equalling or exceeding it, the blades linear-filiform, spreading recurved less than 1 mm. broad, somewhat involute, the backs with several prominent, raised veins often with small, stiff, ascending hairs, the margin somewhat thickened and similarly hairy. Leaf sheath broad, stramineous or pale brown, usually smooth or with a scattering of small hairs, the margin scarious, entire, passing gradually into the blade. Ligule absent. Scapes stiffly ascending, wiry, slightly broader than the leaves, glabrous, many-ribbed, subterete. Spikelets lance-ovoid, linear-ellipsoidal or oblong, 0.5-1.0 cm. long, usually acute, pale greenish-brown, 3-8 in a dense terminal cluster, this subtended by several leaf-like involucral bracts, these always exceeding the inflorescence and usually at least the length of the basal leaves. Fertile bracts ovate-lanceolate or oblong-lanceolate, glabrous, stramineous or pale green, the midrib conspicuous, dark green, and pointed beyond the scale as a short, erect or slightly recurved, mucro. Stamen 1, the anther less than 0.5 mm. long. Style 2-branched, much longer than the akene, subterete, the base swollen, the surface smooth, or papillate from about the midpoint to the point of branching. Akene obovoid, tumid, 0.5-0.7 mm. long pale, sometimes slightly iridescent, reticulate, the individual rectangular cells arranged horizontally in 5-7 vertical rows on a side.

Fine sands, silts or clays, usually alluvial or shoreline situations, often on areas of disturbed bottomland, South Carolina south to northern Florida, west to Texas; scattered localities in inland states (Kentucky, Illinois, Missouri, Arkansas, Oklahoma and Kansas); in the western United States, California and Arizona; Mexico and into Central America beyond the range of this study.

Type: "Habitat in America meridionali, nec in Hispania" (Vahl, Enum. 2: 263). Not seen by writer.

Fimbristylis vahlii together with the extremely rare *F. perpusilla* Harper, comprise the two most diminutive species of the genus in North America. It is very much a weed, being most often found on fine textured, often alluvial, soil such as would be recently exposed by receding water. In Texas and Louisiana it is most often seen around farm ponds, artificial lakes, backwaters of rivers and streams, or borrow pits. It is most often in association with such *Fimbristylis* as *F. autumnalis, F. miliacea* and *F. annua,* but is found further west in the United States than any of these although its occurrence in the western United States is sporadic. Fruiting plants may develop from seed in a few weeks time, an indication that this is a species extremely efficient in getting the most out of the sort of temporary habitat it occupies.

42. FIMBRISTYLIS PERPUSILLA Harper in Small, Fl. SE. U. S. 188. 1903.

Solitary or tufted, low glabrous annual, the culms to 8 cm. tall (usually lower). Leaves from 1/3 the length of the scape to equalling or exceeding it, the blades linear-filiform, less than 1 mm. broad, spreading involute, the backs with 3, prominently raised veins, the margin composed of similar, ciliate-scabrid, veins; sheath much broader, with an entire, broad, scarious margin, this converging with the blade at an acute angle. Ligule absent. Scapes stiffly ascending, wiry, slightly broader than the leaf blades, many-ribbed, flattened to subterete. Spikelets ovoid to subglobose, 2-4 mm. long, greenish-brown, blunt, in a simple to compound panicle of cymules this subtended by several, leaflike involucral bracts, the longest exceeding the inflorescence. Fertile bracts lanceolate or oblong, thin and stramineous, save for a prominent, broad, greenish midrib, this exserted as an elongate ascending to somewhat recurved cusp. Stamens 1, the anthers 0.2 mm. long. Style 2-branched, about the length of the akene or slightly longer, subterete, the base not swollen, the surface smooth. Akene oblong, slightly curvate, terete, 0.4-0.6 mm. long, pale brown with some iridescent tints, finely reticulate, the reticule made up of about 12 vertical rows of many narrowly rectangular slightly concave horizontal cells, the longitudinal lines more prominent than the horizontal.

Alluvium of borders of pineland ponds, Sumter and Seminole counties Georgia.

Type: U. S. A. GEORGIA. SUMTER CO.: prostrate on muddy bottom of exsiccated pine barren pond near Leslie, *R. M. Harper 1729.* Holotype at NY, examined by writer.

Taxonomically, this species could be confused in northern America only with *F. vahlii,* but differs from it in its more open inflorescence and in its narrower, banana-shaped, fruit. It bears a striking resemblance to the Asian *F. dipsacea,* differing from it only in its more ascending-tipped fertile scales and in the lack of bladder-like projections of pericarp (see figure 42B). One can see from a comparison of specimens of the two that they are undoubtedly very closely related, if not conspecific. From the standpoint of plant geography this may be a more interesting consideration than if indeed *F. perpusilla* is a distinct species. *F. perpusilla* is also similar in its fruit to *F. stauntoni* Debeaux and Franchet ex Debeaux (see figure 42C) but differs from that species in its lower stature, fewer and much shorter style branches, and in its lack of a ligule.

As might be inferred from the statement of range given above, *F. perpusilla* is the rarest North American *Fimbristylis*, being known only from two localities in Georgia. It is quite diminutive, hence has probably been often overlooked by collectors. My own encounter with it was purely accidental. Whilst looking for *Xyris* in southwestern Georgia I came across a virtual "fuzz" of small sedge carpeting the drying margins of a small pineland pond (Georgia. Seminole Co.: 1.5 mi. e. Donaldsonville; sandy clay of cypress-pond pine flatwoods; mucky pond margin, (12 Aug. 1962, *R. Kral 15486*). It is so unlike any other North American *Fimbristylis* in appearance that I did not even record it as such in my field notes. On returning to the herbarium at F. S. U. I discovered the odd "banana" shaped akenes that could only be the fruit of *F. perpusilla*. According to Small (1933) the plant had been known only from the type locality. Harper, discoverer and namer of the species, had also described it as carpeting a pineland pond bank. This was in 1903, and as I understand it subsequent visits to the same habitat in later years were all unproductive. Dr. Godfrey returned to the Seminole County locality a year later to find but a few plants; my own visits during following years have been to no avail.

It is noteworthy that *F. perpusilla* can develop in such numbers on a particular year, yet virtually disappear the next. It would seem that the sporadic appearance of this species must have to be based on an inherent capacity for long periods of dormancy. Conditions for its germination must involve first a fine textured substratum such as would be exposed by retreating silty water, and secondly that this neither be dried out nor on the other hand covered by advancing water during the time of establishment of the seedlings. In the Coastal Plain, which has frequent summer rains, these conditions are seldom met.

43. FIMBRISTYLIS SPATHACEA Roth, Nov. Pl. Sp. 24. 1821.

Scirpus glomeratus Retz., Obs. 4: 11. 1786. Not *S. glomeratus* L. 1753.

Scirpus obtusifolius Vahl, Enum, 2: 275. 1805.

Fimbristylis obtusifolia (Vahl) Kunth, Enum. Pl. 2: 240. 1837.

Fimbristylis sintenisii Boeck., Bot. Jahrb. 7: 276. 1886.

Fimbristylis glomerata (Retz.) Urban, Symb. Ant. 2: 166. 1900. Not *F. glomerata* Nees, 1834.

Fimbristylis melanospora Fernald, Proc. Am. Acad. 36: 491. 1901.

Solitary or tufted, hard-based, glabrous perennial to 5 (rarely 7) dm. tall with stiffly spreading leaves and rigidly erect or ascending culms, the culms bases sheathed by dark, stiff, remnants of old leaf bases. Leaves firm, thick, about half as long as the scapes or even shorter, the blades linear, 1-4 mm. broad, spreading or recurved, flat to somewhat involute, gray-green, the nerves of the back raised, often one particularly prominent and giving a double-edged appearance to one margin, the margin itself distantly scabrid; sheaths rigid, broad, thick, clasping, pale-green but aging to dark brown, with a broad, thin, usually entire margin this abruptly converging to the blade. Ligule absent. Scapes stiff, usually erect, subterete, the ridges several and fairly prominent. Longest involucral bract shorter than the inflorescence. Spikelets ovoid, 2-3 mm. long, acute to blunt, greenish, brown, or yellow-brown, very many in a dense, often hemisphaerical, usually head-like, sometimes open aggregation of subsessile to pedunculate cymules. Fertile scales ovate, slightly keeled, entire, obtuse to emarginate, stramineous to brown save for a broad scarious margin and a thicker, usually paler, zone of midrib, this not excurrent. Stamens usually 1, anthers ca. 0.3 mm. long. Style 2-branched, (the branches longer than the base) somewhat 2-edged, not fimbriate. Akene about 1 mm. long, obovoid, usually tumid, rarely obscurely angled in cross section, the surface pale brown, brown or very dark brown (almost blackish), cancellate or distinctly or indistinctly reticulate, and in addition often verrucose. Pedicel joint not persisting on akene.

Moist to rather dry, brackish sands or estuarine deposits, coastal dunes, beaches, edges of brackish marshes, in the United States only in peninsular Florida and the Keys, in North America throughout the Caribbean and along both the Atlantic and Pacific shores of the continent from northern Mexico south. Found in both Old and New World tropics.

Type locality: India. Type not examined by this writer.

This species, with its thick, rigidly spreading rosette of leaves, its thick stiff scapes terminating in dense clusters of small spikelets the scales of which have broad, scarious margins, is so unlike any other North American species that no great problem in identification exists. However, *F. spathacea* is treated by Koyama (1964) as *F. cymosa* R. Br., a plant of the Pacific island and Australasia. However, that plant was described by Robert Brown as having 3 style branches, and the akenes of specimens of *F. cymosa* I have examined (admittedly few) show at least an obscurely trigonous design (see plate 43b). While in Cyperaceae the number of style branches is not a generic character it still constitutes an important specific character.

F. spathacea appears to be a rather recent introduction into the United States. There is no mention of it in Small's Manual; some of the first collections of it from the U. S. were made by Killip in the 1930's, these from very southern Florida. However, now that it is here, it appears quickly to be occupying alkaline situations along beaches and road shoulders in peninsular Florida. Its spread further north may be controlled by temperature in that the plants have their heaviest flowering and fruiting during the winter months. This may be just as well, for in the greenhouse it is a full fledged, very aggressive weed.

44. FIMBRISTYLIS **argillicola** Kral, sp. nov.

Perennis caespitosa usque 1 m. alta, culmis basi bulbosis cum foliis exterioribus squamiformibus. Folia propria plantam 1/3-2/3 aequantia, laminis anguste linearibus (ad 1 mm. latis) laevibus (marginibus ciliato-scabridis exceptis). Spiculae lanceol-ovoideae vel ellipsoideae castaleae vel brunneae (vivo atratae). Achaenia lenticulari-obovoidea vel obpyriformia ca. 1.5 mm. longa.

Caespitose perennial, erect or ascending at most to 1 meter tall, the bases of the culms bulbous, the outer leaves of a clump scale-like. Leaves 1/3-2/3 the length of the plant, the blades narrowly linear (rarely exceeding 1 mm.), involute, smoothish, pale green, the nerves of the lower surface numerous and raised, the margin pale, thickened, upwardly ciliate-scabrid, at least toward the base and apex; sheathing portion of the leaf broad, smooth, stramineous to dark brown, thickened, but with a pale brown scarious margin, this entire, its apex passing into the blade at an acute angle. Ligule of hairs absent. Scapes slender, little wider than leaves, multicostate, smooth, subterete below, somewhat flattened toward the apex. Longest bract of the involucre shorter than the inflorescence, the blade similar in character to that of leaves. Spikelets lance-ovoid, or ellipsoidal, 0.7-1.2 cm. long, (1-) 3-5 (-7), all but the central one in an open umbellate system of ascending peduncles, castaneous to dull brown. Fertile bracts broadly ovate, entire smooth, or with a few short hairs apically around the midrib, the midrib itself paler, either pale green or stramineous, this usually exserted as a short cusp. Stamens usually 2, rarely 3, the anthers 1.5-2.0 mm. long, apiculate, the filaments broad and flattened, but narrowing apically at point of attachment with anthers. Style 2-branched, flattened, fimbriate from at least its midpoint to the point of branching. Akene lenticular-obovoid, or obpyriform about 1.5 mm. long, a pale to deep brown, rather finely scalariform-foveate or reticulate, the individual cells horizontally rectangular, arranged in numerous, vertical lines; surface of akene usually verrucose. Joint of akene short, usually persistent on fruit.

Type: MEXICO. MICHOACAN. Just west of Puente Rio de Turundeo, w. of Tuxpan on heavy wet soil of boggy swale in relict prairie by highway 15, *R. Kral 25509*. Holotype at MICH.

Moist to rather dry, often somewhat brackish, heavy soils of original grasslands, Mexico, in the states of Guerrero, Mexico, D. F., Jalisco, Michoacan, Durango, Zacatecas, Aguascalientes, Puebla, Guanajuato. Particularly abundant in the lake country of Jalisco.

This species has often been identified as *F. pentastachya* Boeck. the type locality of which is in the state of Vera Cruz, a state in which this plant does not seem to occur. It differs from *F. pentastachya* by its smoother foliage, its darker coloured spikelets, and in the character of its old leaf bases which is not fibrous-shreddy. *F. pentastachya* has much paler, reddish brown spikelets, and is well marked by the fibrous character of its old leaf bases. While *F. pentastachya* is a plant of savanna development in oak or oak-pine forest, *F. agrillicola* is definitely a plant of native grassland. The former is a plant of rather loose textured soils, while the latter grows on heavy black gumbo-type clay.

The best growth of *F. argillicola* is on alkaline soils. In the lake country around Guadalajara it is frequent in association with brackish soil plants. In the greenhouse it responds best to fine-texture, alkaline or circumneutral, potting medium. Flowering plants may be grown from seed in a few months. As is the case with *Abildgaardia*, the seedlings quickly develop numbers of close-set and bulbous-based lateral offshoots. Flowering scapes usually do not form until rosettes of such offshoots are well developed.

45. FIMBRISTYLIS PENTASTACHYA Boeck., Flora 40: 36. 1857.

Perennial to 1 meter tall, the culms bulbous-based, solitary or in small tufts, usually also with bases invested in a fibrous ramentum of old leaf bases. Leaves 1/2-3/4 the length of the mature scapes, spreading-recurved, lax, the blades linear, flat to somewhat involute, with several prominent ribs on the backs and two marginal ribs, the margins ciliate, particularly toward the apex and base of the blade, with pale, stout and rather long, ascending or upwardly appressed, trichomes, the upper and lower surfaces similarly pubescent toward the base of the blade; sheaths broad at the base, the old sheaths becoming fibrous, a deep reddish-brown, the margins subscarious, pubescent on the backs, and tapering gradually or abruptly to the blade, here copiously pubescent with pale, crisped trichomes. Ligule not evident. Scapes about the width of the leaf blades, rather lax, subterete and multicarinate below, many-ribbed and somewhat flattened distally, smooth. Longest bract of the inflorescence similar in texture and indument to leaves, somewhat shorter than to longer than the inflorescence. Mature spikes ovoid to ellipsoidal, acute, ca. 1 cm. long, 3-7 (usually 5), all but the central ones pedunculate in open simple umbell-like cymes, the individual peduncles ascending, to 4 cm. long. Fertile scales ovate, smooth, reddish-brown save for a paler, scarious edge and a paler or sometimes greenish midrib, rounded or obtusely angled, the margin entire or ciliate apically. Midrib of 5, often conspicuous, close-set nerves, this exserted as a short mucro on the lower scales, otherwise included. Stamens 3, anthers about 3 mm. long. Styles 2-branched, the edges fimbriate above the mid-point and to the bases of the style branches. Akene lenticular-obovoid, 1.5-2.0 mm. long, brown, rather flat to somewhat tumid, the surface reticulate, the cells broadly or narrowly rectangular, horizontal, in several longitudinal lines, the surface irregularly dotted with pale, dome-like or irregularly shaped warts.

Red, sandy-clay soils of pine or oak-pine savannas, lower elevations in both the Sierra Madre Oriental and Occidental of Mexico in the states of Guerrero, Jalisco, Michoacan, Oaxaca, Veracruz.

Type locality: Veracruz, Mexico ("ex hb. Schultzii Bip."). The identification of *F. pentastachya* has to be based upon the type description rendered by O. Boeckeler (1860) in that the actual specimen (or specimens) was destroyed by fire during the Second World War. Therefore I designate the following specimen as neotype: MEXICO. VERACRUZ. Zacuapan and vicinity, *C. A. Purpus 2405;* at US.

This *Fimbristylis* is not infrequent in the Mexican mountains, particularly in burned-over areas or savanna formations. It appears to be closest to *F. puberula* (Michx.) Vahl, but has very different fruit which is obpyriform, usually tumid, and which is papillose-tuberculate, a feature not known for that wide-spread United States species. I have as yet been unable to get living material into the United States and have seen the plants only in the vegetative condition.

The name *F. pentastachya* has been applied to another species of the Mexican high plateau; this latter grows only in the grasslands, often in fairly brackish situations, and is distinguished by its smoother foliage, its very dark (sometimes almost blackish) spikelets, and its tendency to form large tufts of bulbous-based culms. This latter species has been assigned the name *F. argillicola,* after the heavy clay earths of its habitat.

46. FIMBRISTYLIS **pallidula** Kral, sp. nov.

Perennis dense caespitosa usque 1 m. alta (plerumque humilior). Glumae fertiles lato-ovatae integrae glabrae flavescentes ad pallido-brunneae juxta costam pallidiores. Achaenia lenticulari-obovoidea ca. 1.5 mm. longa pallido-brunnea.

Densely caespitose, glabrous, perennial to 1 meter tall (usually lower), the culm bases invested by long, castaneous, leaf bases, the plant base deeply set in the substrate. Leaves from 1/3 the length of the scapes to nearly equalling them, gray-green, the blades linear, about 1 mm. broad fleshy, involute, the backs not prominently nerved, the margins somewhat thickened and ciliate-scabrid at least toward the sheath and tip; sheaths broad, glabrous, aging to dark brown, with a scarious, often broad margin, this rounded or forming an acute angle with the blade, its margin usually ciliate at this point. Ligule absent or incomplete. Scape slender, somewhat broader than the leaf blades rather rigid, somewhat channelled, subterete throughout, or slightly compressed upwardly toward the inflorescence. Spikelets ellipsoidal or lance-ovoid, a pale brown, 5-8 mm. long, acute, few to many on ascending, flattened branches, in a compound panicle of cymules. Longest bract of the involucre somewhat shorter than to much exceeding the inflorescence, the blade somewhat flatter than that of the leaves. Fertile scales broadly ovate, entire, glabrous, flavescent to pale brown, the region of the midrib even paler, the midrib exserted as a short cusp. Stamens 3, the anthers ca. 2 mm. long. Style 2-branched, flattened from the base to the point of branching, the edges conspicuously fimbriate from about mid-style to point of branching. Akene lenticular-obovoid to obpyriform, about 1.5 mm. long, pale brown, foveate, the cells almost isodiametric or horizontally rectangular, usually arranged in many fine, vertical lines separated by conspicuous longitudinal ridges. Akene joint (pedicel) short, persistent.

Edges of salt marshes or brackish situations slightly inland, the Pacific coast of Mexico in the states of Sinaloa, Jalisco, Oaxaca, Chiipas.

Type: MEXICO. OAXACA. garbage dump of Salina Cruz, *R. Kral 25312*. Holotype at MICH.

This species is in the same complex as *F. castanea* and *F. spadicea*. It too is densely caespitose, with slender, hard, narrow leaf blades whose bases are usually castaneous; like those species, it also frequents brackish habitats. However, it is a consistently lower plant with consistently smaller, paler spikelets. The pale character of the foliage is also in contrast. I know of no instances of *F. castanea* along the Pacific coast of Mexico, nor are there many examples of *F. spadicea* from that coast line. The chromosome complement of the three is the same, namely N equalling 10.

47. FIMBRISTYLIS SPADICEA (L.) Vahl, Enum. 2: 294. 1805.

Scirpus spadiceus L, Sp. Pl. 51. 1753.

Scirpus domingensis Pers., Syn. Pl. 1: 67. 1805.

Fimbristylis speciosa Rhode: Spreng., Pug. 1: 5. 1813.

Fimbristylis spadicea f. *domingensis* (Pers.) Kuekenth., Repert. Sp. Nov. 23: 196. 1926.

Densely caespitose perennial, often to 2m. tall, the bases castaneous, deep-set in substratum, the outer leaves of a tuft often persistent as scales. Leaves 1/3 to 2/3 the length of the plant, the blades usually very narrowly linear (rarely to 2 mm.) ascending involute, (at least toward base), smoothish, thick, the marginal nerves ciliate-scabrid with stout-based hairs. Sheathing portion of the leaf broad, smooth, a deep and lustrous brown, and with a paler brown or reddish-brown, thin margin, which is entire save for the truncate-ciliate apex. Ligule of hairs absent or incomplete (usually there is a sharp change in colour on the upper surface at the level of the collar). Scapes slender, wand-like, as wide as the blades or somewhat wider, terete toward the base of the plant, subterete or oval in the cross section just below the inflorescence. Spikelets narrowly elliptical, lance-ovoid, or oblong, about 1-1.5 cm. long (in older spikelets much longer lengths are attained, but that part of the rachis bearing scales remains of about the same length) castaneous to pale reddish brown, in an open or somewhat contracted paniculate system of cymes. Longest bract of the involucre with a flat blade sometimes equalling the inflorescence but very often exceeding it. Fertile bracts broadly ovate, smooth, castaneous, brown or reddish-brown save for the pale areas along the midrib, the apex obtuse, the margin pale, entire and sub-scarious; veins of the mid-portion of the scale hardly distinguishable from the other veins, but excurrent as a short mucro. Stamens 2 or 3, the anthers about 2 mm. long. Style 2-branched, flattened, fimbriate from the base to the point of branching. Akene lenticular-obovoid, or obpyriform 1.5-2.0 mm. long, a pale to deep brown, scalariform-foveate or reticulate, the individual depressions almost isodiametric or horizontally rectangular, usually arranged in fine, vertical lines. Base of akene jointed to spikelet by means of a short joint, this usually breaking off with the fruit.

Type locality: Jamaica "In Jamaicae fluviis." Based on figure in Sloane, Hist. Jam. pl. 76.

In North America confined to the coastal marshes of the Caribbean Islands and Mexico. A common salt-marsh sedge along the Atlantic in both Central and South America.

I treat this species as distinct from *F. castanea* (Michx.) Vahl in that it usually has narrower spikelets in more diffuse inflorescence together with a more robust habit. Admittedly the two entities are quite similar in many respects and it is therefore a strong temptation to treat them as conspecific. However, my mind was changed as a result of a trip to Mexico via the gulf coast of Texas. The plants of the Texas coast are not much different than those of the coasts of the other Gulf and Atlantic states. In the state of Tamaulipas, Mexico, plants of vastly different appearance are to be seen along the coast in similar habitat to that occupied by *F. castanea* in the U. S. These are, on the average, much taller, with a more reddish quality to the living spikelets and with much narrower (often smaller) spikelets in much larger and more diffuse inflorescences. This sort of plant is continuous along the Atlantic coast of Mexico until one reaches the Yucatan peninsula, where (at the tip of Yucatan) stands of the "castanea" type again appear. Both types cohabit coastal areas of the Bahamas and of Cuba. I am faced with the sort of situation that is clear in the field, yet hard to demonstrate on the basis of herbarium specimens. As Svenson has stated, all the "spadicea" complex have very similar akenes (this complex includes taxa here treated as *F. caroliniana, F. puberula, F. castanea, F. inaguensis, F. thermalis* in addition to *F. spadicea*).

48. FIMBRISTYLIS CASTANEA (Michx.) Vahl, Enum. 2: 292. 1805.
Scirpus castaneus Michx., Fl. Bor.-Am. 1: 31. 1803.
Fimbristylis cylindricum Vahl, Enum. 2: 293. 1805.
Fimbristylis spadicea (L.) Vahl var. *castanea* (Michx.) A Gray, Man. ed. 5. 566. 1867.

Densely caespitose perennial to 1.5 (-2.0) m. tall, the bases of the plant castaneous, deep set in substratum, the outer leaves of a tuft and the older leaves persistent as imbricated scales. Leaves from 1/3 the length of the culms to nearly as long, the blades usually very narrowly linear (rarely to 2 or 3 mm. broad), ascending, thick (often semicircular in cross section), most frequently involute, smooth, particularly toward the base, the nerves on the back numerous and indistinct, but the marginal nerve or nerves ciliate scabrid with ascending, stout-based, hairs, sheathing portion of the leaf broad, (broadening gradually toward the base) a pale brown, dark brown or very deep lustrous reddish-brown, thick and rigid, the margin broad, thin or even scarious, entire save for the truncate or rounded, ciliate apex. Ligule of hairs either absent or incomplete, but a colour change evident on the upper surface of the leaf at the collar. Scapes slender, wandlike, as wide as the blades or somewhat wider, many-ribbed, terete toward the base of the plant, subterete, oval, or elliptical in the cross section upwardly. Longest bract of the involucre usually shorter than the inflorescence or about the length of the inflorescence (rarely longer), the blade somewhat flattened, ciliate-scabrid. Spikelets usually ovoid or lance-ovoid, very rarely cylindrical, 0.5-1.0 cm. long, rarely longer, the mature ones usually pale to dark brown, dull, in a dense to open ascending or spreading umbellate compound system of cymes. Fertile bracts broadly ovate, smooth, brown, usually dull, the margin entire or becoming erose with age, the apex rounded; veins of the mid-portion of the scale obscure, or visible as faint pale lines, these, converging apically to form a short mucro. Stamens 2 or 3, the anthers about 2 mm. long. Style 2-branched, flattened, fimbriate from the base to the point of branching. Akene lenticular-obovoid or obpyriform, 1.5-2.0 mm. long, reddish-brown or dark brown, often lustrous, scalariform-foveate or reticulate, the individual cells almost isodiametric or horizontally rectangular, usually arranged in numerous, fine, vertical rows.

Type locality: "Florida." (Herbarium Richard, at P).

Moist sands or muck of coastal marshes, duneswales, or estuary banks (rarely alkaline situations inland), Long Island south along the Atlantic coast into the Florida Keys, and along the Gulf Coast south and west into Mexico (Tamaulipas); Yucatan peninsula; the Bahamas; Cuba.

Fimbristylis castanea is invariably found in brackish marsh and, save in the state of Florida, seems never to be found far from the existing seacoast. Along the Atlantic coast in the southeastern and Gulf United States it may be found in proximity to two other perennial species, *F. caroliniana* and *F. puberula*. It may be distinguished from both by being caespitose rather than rhizomatous (*F. caroliniana* produces slender rhizomes while *F. puberula* produces thick, knotty rhizomes or more rarely slender rhizomes in addition). It is also to be distinguished on the basis of habitat, being a true denizen of brackish marsh, while *F. caroliniana* is usually in drier or less alkaline situations and F. puberula in turn frequents more acid habitats inland. Occasionally, where there has been much mechanical disturbance of coastal areas where the habitats of all three are contiguous, one may find all three growing together on the freshly disturbed surface.

F. castanea and *F. spadicea* overlap in the Bahamas, Cuba and parts of Mexico. However, as fine as the differences are which (in my opinion) distinguish the two, these differences appear to hold (see discussion under *F. spadicea*).

49A. FIMBRISTYLIS PUBERULA (Michx.) Vahl var. PUBERULA, Enum. 2: 292. 1805.

Scirpus puberulus Michx., Fl. Bor. Am. 1: 31. 1803.

Isolepis drummondii Torr. & Hook.: Torr., Ann. Lyc. N. Y. 3: 350. 1836.

Fimbristylis drummondii (Torr. & Hook) Boeck., Flora 41: 603. 1836.

Fimbristylis anomala Boeck., Flora 43: 242. 1860.

Fimbristylis multistriata Boeck., Flora 43: 1860.

Fimbristylis spadicea (L.) Vahl var. *puberula* (Michx.) Chapm., Fl. S. US. 522. 1860.

Fimbristylis puberula var. *drummondii* (Torr. & Hook.) Ward, Castanea 33: 132. 1968.

Perennial, the culms solitary or in small tufts, to 1 m. tall, the culm bases often hard, knotty, jointed together into short, thick rhizomes on which the old leaf bases often persist as shreddy remnants (in a few populations of coastal Fla. and Ga. having some slender, pale rhizomes). Leaves from 1/3 as long to nearly equalling the culms, the blades narrowly linear, usually involute at least toward the base, about 1 mm. wide, the backs with several raised nerves, smooth to variously pubescent, the upper surface smooth or variously pubescent, the margin pale, cartilaginous, ciliate-scabrid (this most noticeable toward the blade base and apex). Sheaths hard, thick, fibrous, a pale to dark brown, the margin broad, scarious, entire save for long ciliate at apex. Ligule inconspicuous, incomplete, or absent. Longest bract of inflorescence erect, the blade flattened, usually much surpassed by the inflorescence. Spikelets lance ovoid to ovoid or ellipsoidal, from 0.5-1.0 cm. long, reddish-brown, in a usually few-flowered, compact to open system of pedunculate cymules, or a simple umbel-like cyme. Fertile scales ovate, to obovate or even reniform, reddish-brown, dull-brown or flavescent, the backs rounded, the margin scarious, rounded, entire, ciliate or somewhat lacerate, the nerves inconspicuous, flavescent to pale brown or sometimes the central ones slightly raised, greenish and slightly excurrent as a short mucro; outer surface of at least the lower scales puberulent at least toward the apex. Stamens 3, anthers 2.0-2.5 mm. long. Style 2-branched, flattened the edges usually fimbriate from about the mid-point to the base of the style branches. Akene lenticular-obovoid, about 1 mm. long, rather flat to somewhat tumid, sometimes umbonate, flavescent to dark brown, the surface distinctly to faintly reticulate, the cells rectangular, usually arranged in several longitudinal lines (11-20 on a face) in a few cases with very many longitudinal lines with the cells isodiametric, the longitudinal lines prominently to slightly raised.

Sands, sandy peats, or clays of savannas, open pinelands, upper edges of grass-sedge bogs, meadows, and prairies, throughout the Atlantic and Gulf coastal plain from Long Island south into peninsular Florida and west in Texas nearly to the Mexican border; scattered from the central Piedmont to its southwestern edge; scattered in the interior highlands and of frequent occurrence in the moist meadows and prairies of the central lowlands, particularly along the Great Lakes on the Pleistocene shores and west into the tall and mid-grass prairies of Texas, Oklahoma, Kansas, and Nebraska. Canada ("Lambton Co.: Squirrel Island, one of delta islands of St. Clair River, near Lake St. Clair, C. K. Dodge, 26 Jun 1904").

Type locality: Georgia and Carolina. Two specimens of the Michaux material, obligingly lent me by Dr. A. Lourteig at P, and both identified as "Scirpus puberulus" are interesting in that they show the range of foliar vesture, one having dense puberulence of the leaves and scape, the other being smooth-leaved and scaped. However both are distinguishable from *F.*

caroliniana (Lam.) Fern. by their subterete scapes and narrow, eligulate foliage.

49B. FIMBRISTYLIS PUBERULA (Michx.) Vahl. var. **interior** (Britton) Kral, comb. nov.

Fimbristylis interior Britton, in Britt. & Brown, Ill. Fl. ed. 2. 1: 320. 1913.

As the species but plant base less bulbous, and producing dense clusters of short, slender, twisted, pale reddish-brown rhizomes. Foliage pale green, sometimes appearing glaucous, the blade margins distantly to approximately ciliate-scabrid. Ligule inconspicuous or present as a narrow line of short, ascending hairs. Longest involucral bract usually longer than the inflorescence. Spikelets ovoid, cylindrical, or ellipsoidal, 0.5-1.0 cm. long, stramineous to reddish-brown, the backs of the scales usually smooth, the central nerve of at least the lower scales excurrent as a definite terete mucro. Akene with several prominent to rather obscure longitudinal ridges, these interconnected with finer horizontal lines, hence the surface made up of longitudinal rows of roughly idodiametric, shallowly concave cells.

Sandy sloughs in prairie and along major river systems, prairie provinces, particularly in western Kansas and Nebraska, but extending south into western Texas and southwest into Arizona.

Type locality: Colorado, Logan Co.: Starling, *G. E. Osterhout,* 13 Aug 1896 (NY).

Fimbristylis puberula is perhaps the most widespread species of the genus in North America. It is found in prairie swales of the plains country as well as in acid sandy oak or pine barrens of the forested east. It is not unusual in perennial grass-sedge formations about sandy lakeshores. It particularly abounds in the lower sandy (Pleistocene) terraces of the Atlantic and Gulf coastal plains, especially in pine flatwoods and savannas, where its thickened rhizomes give it some advantage in such fire-controlled formations.

The central morphology of the species is actually a smoothish, type lacking slender rhizomes which is widely distributed through the central prairie provinces of the U. S. A. or in savannas eastward. However, several other forms appear in the coastal plain, some extremely difficult to distinguish from *F. caroliniana.* A field appraisal reveals the following sorts: (1.) a puberulent, bulbous-based form of acid pinelands, bogs and savannas, which is the same as one of the Michaux specimens and which is easily distinguished from the usually glabrous-leaved. *F. caroliniana* (see my numbers *15272, 15437, 17912, 17924, 18001, 19312, 20488, 22951, 22970, 24109, 27107 27066, 27120, 27156, 27144, 27166, 27179*): this form is most abundant in peninsular and northeastern Florida but is occasional north into eastern North Carolina and west into southern Mississippi. (2.) an otherwise similar, but smooth-leaved form of similar habitat and which is often in mixed populations with no. 1; it is indistinguishable from populations from the prairie provinces of interior U. S. A. (see numbers *17867, 17894, 17956, 18260, 18419,* *18451, 18470, 19374, 20106, 20155, 20165, 20173, 21996, 22089, 22268, 22319, 23041, 24173, 21996, 22089, 22268, 22319, 23041, 24173, 25795, 25822, 26872, 27114,* etc.): (3.) a frequently rhizomatous, smooth or hairy plant of areas near the coast in peninsular Florida, Georgia, North Carolina, and Virginia which appears intermediate between *F. caroliniana* and *F. puberula,* (see numbers *15329, 18359, 18369, 18400, 22861, 22909*): such forms always occur in broad, only slightly acid marshes such as those which develop along the St. Johns River in Brevard County or between the present east coast of Florida and the acid pinelands that develop inland. In the latter areas there are almost invariably large populations of knotty-based *F. puberula.* In the former situations, usually in duneswales or at the upper edges of salt marshes, are usually stands of robust *F. caroliniana.* The plants of the ecotone, and which I am designating at least in part as *F. puberula* are *puberula*-like in all respects save that they produce slender rhizomes. All chromosome counts of the robust, coastal forms of *F. caroliniana* (treated by Small as *F. harperi*) have haploid chromosome complements of 30; all counts of *F. puberula* taken thus far show a haploid complement of 10 or less commonly 20. A genetic connection between all three sorts of populations is perhaps possible, perhaps through a failure at meiosis of *puberula* types (haploid of 10) to reduce their chromosome numbers and some of these fertilising or being fertilised to form hexaploid *F. caroliniana.* A solution to this problem remains to be worked out.

The western part of the range of *F. puberula,* beginning in western Texas, eastern Nebraska and Kansas, is occupied by the variety *interior* (see numbers *28872, 28879, 28923, 28927, 28955, 28963*). The most striking characteristic of this entity is its production of numerous, very slender, twisted orangish rhizomes which arise from a base that is usually not thickened as it is in *F. puberula* var. *puberula.* The longest bract of the inflorescence of these plants usually surpasses the inflorescence, and the scales of the spikelets are smoothish. Britton (l.c.) treated it as a species, but its great resemblance to *F. puberula* in all other respects than those mentioned above have led me to consider it a variety of that species. The varieties are sympatric in Nebraska and Kansas and Texas, only *F. puberula* var. *puberula* being found to the east of this longitude. However, it would seem that the two varieties are fairly well isolated even where their ranges overlap. The variety *puberula* is usually through flowering by early summer, which is the time the variety *interior* begins to flower.

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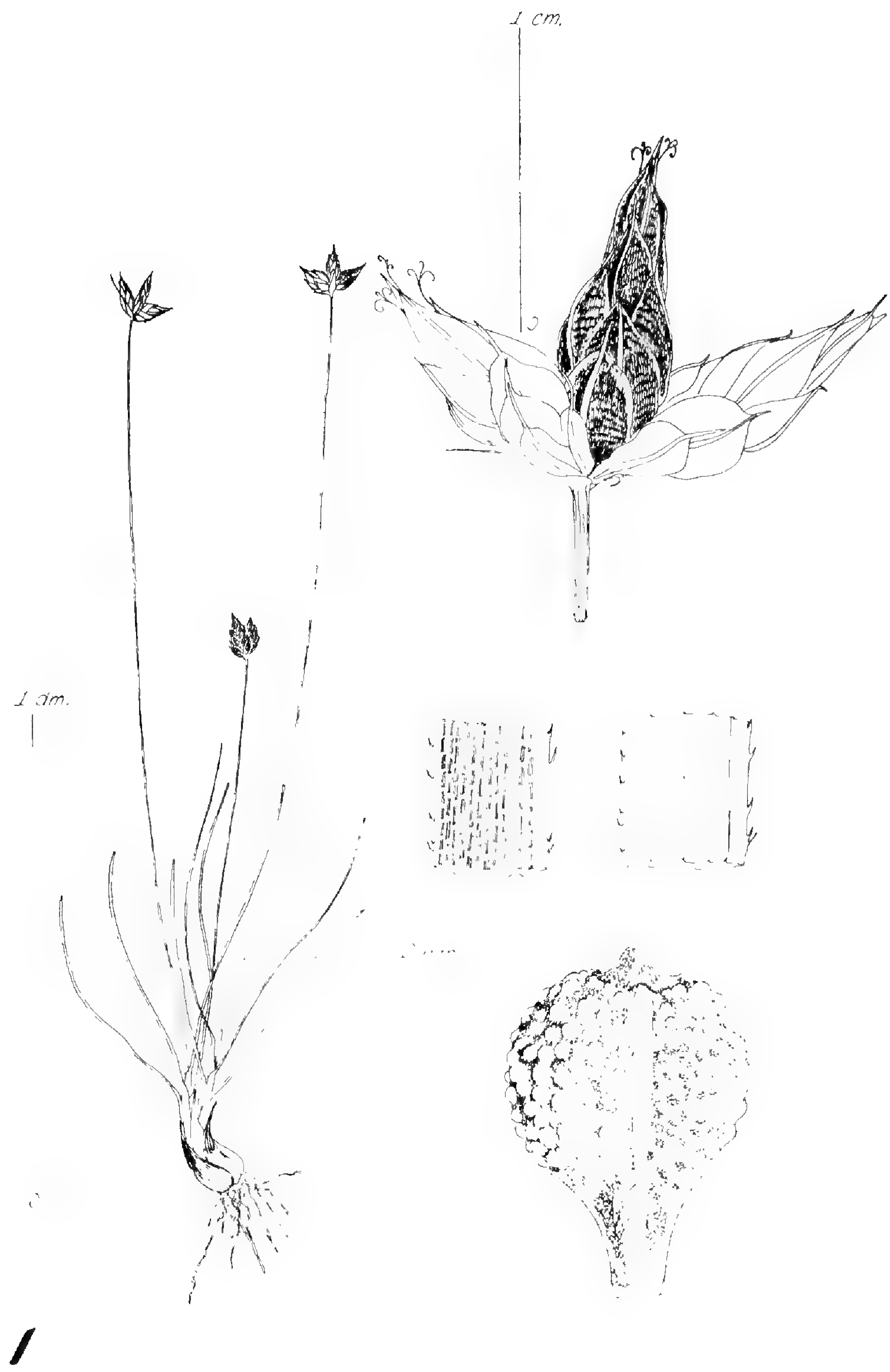
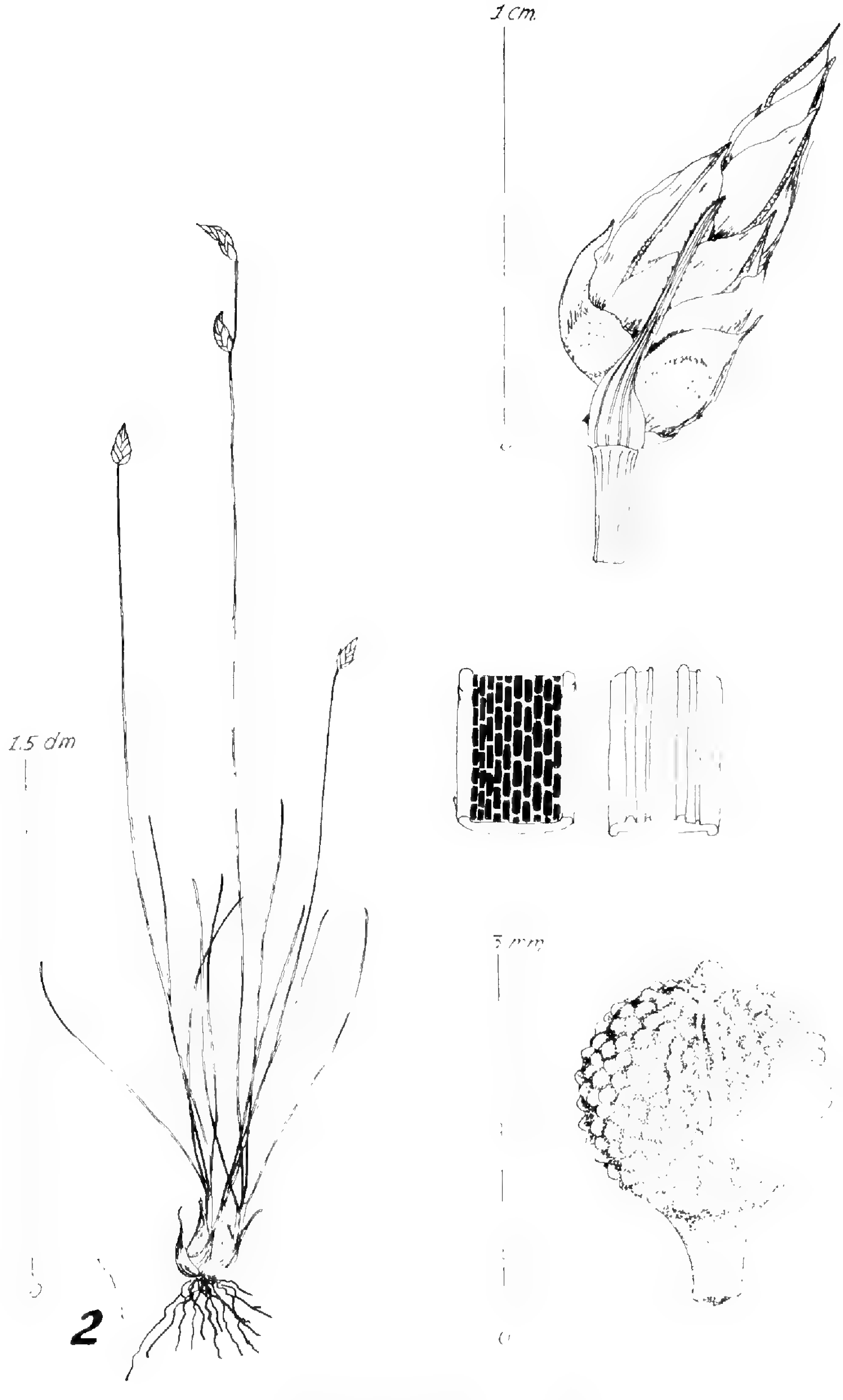
ILLUSTRATIONS

These are numbered to correspond with text treatment. Each plate shows a whole plant reduced, with enlarged details of spikelets and achene, and in most cases of a principal leaf sheath. Plates 33b. *Fimbristylis polytrichoides*, 33c. *F. tristachya*, 37b. *F. bisumbellata*, 40b. *F. aestivalis*, 42b. *F. dipsacea*, 42c. *F. stauntoni*, and 43b. *F. cymosa* are for purposes of comparison only; these species are extra-limital and not fully treated in the text.

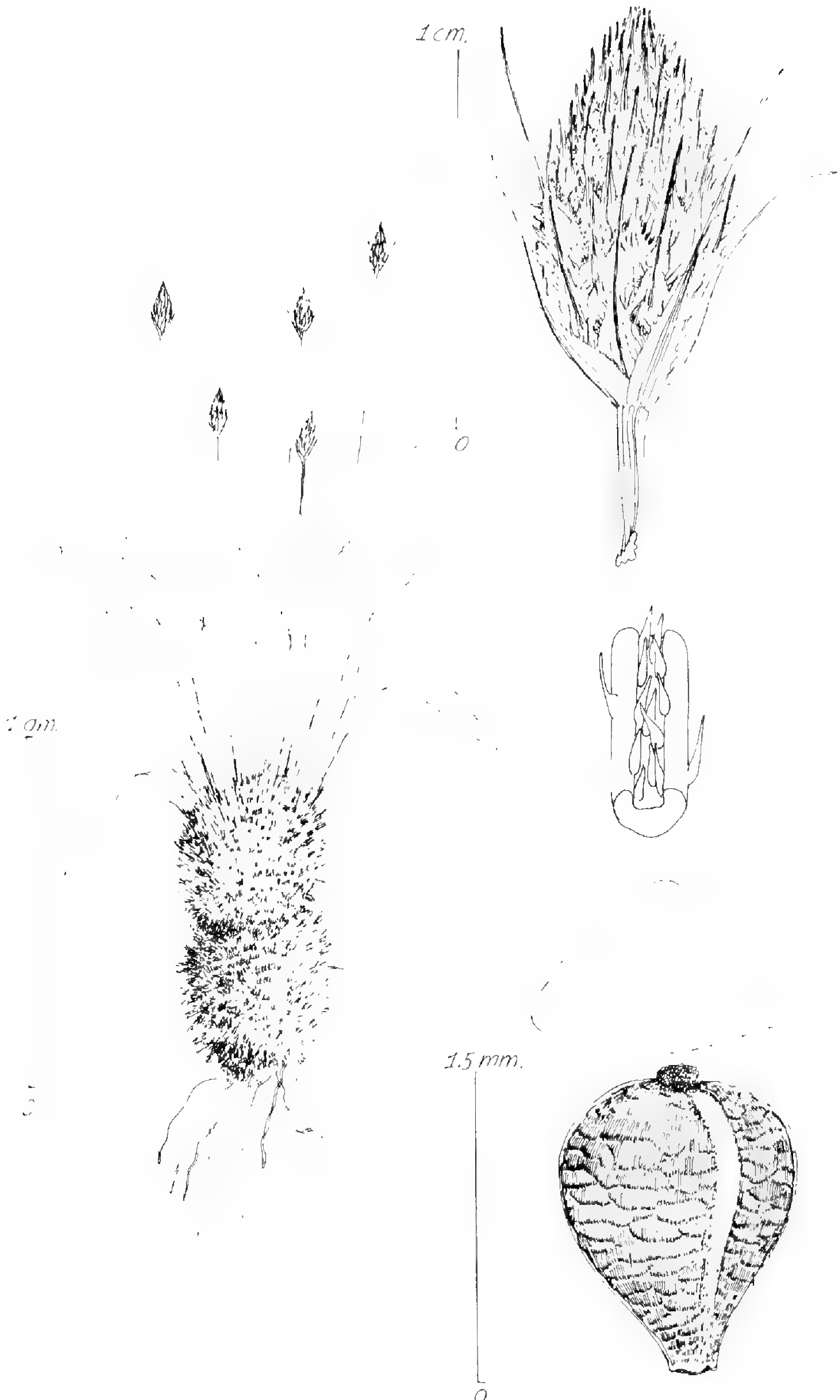
All illustrations are by the author.



1. ABILDGAARDIA MEXICANA



2. ABILDGAARDIA OVATA



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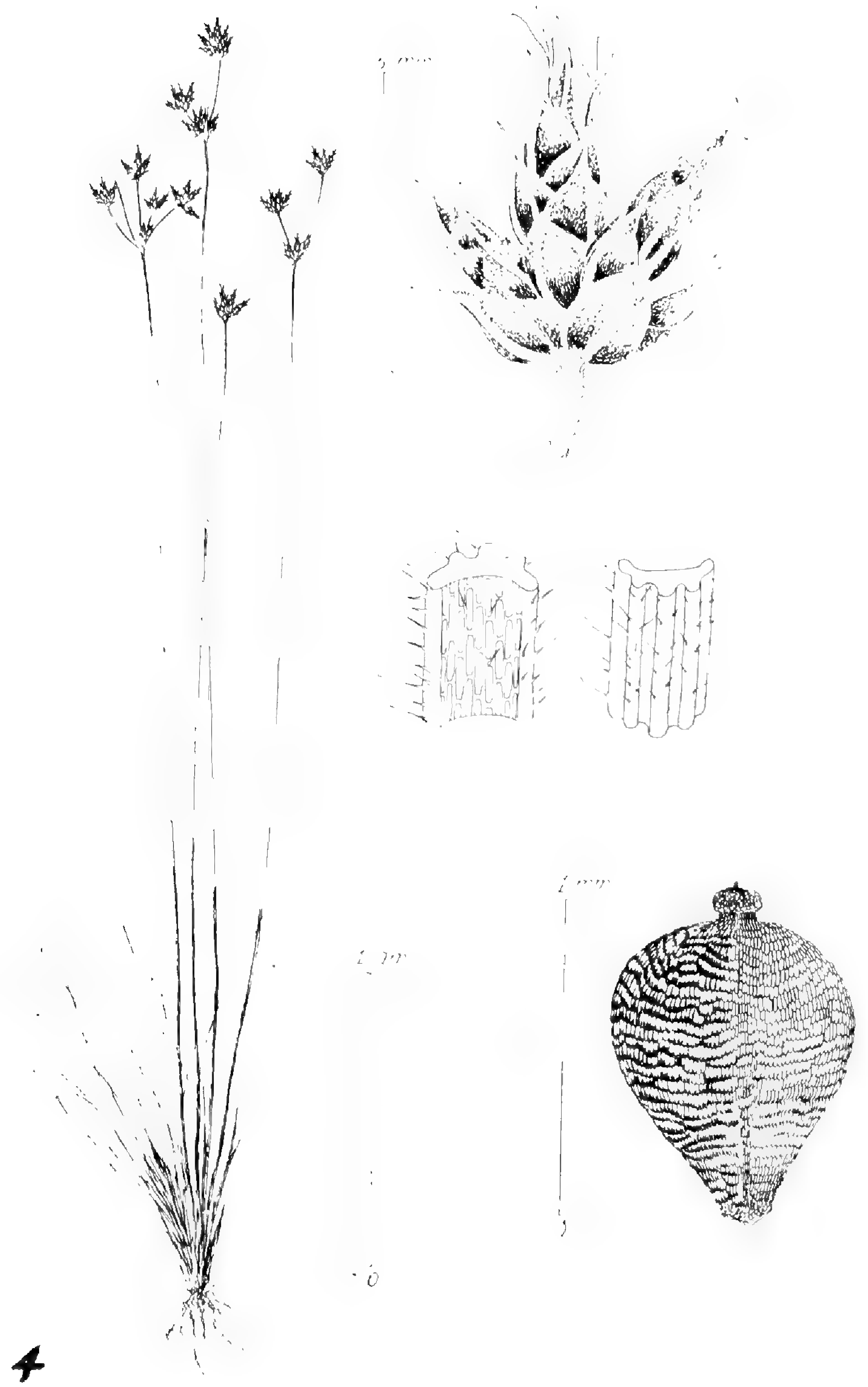
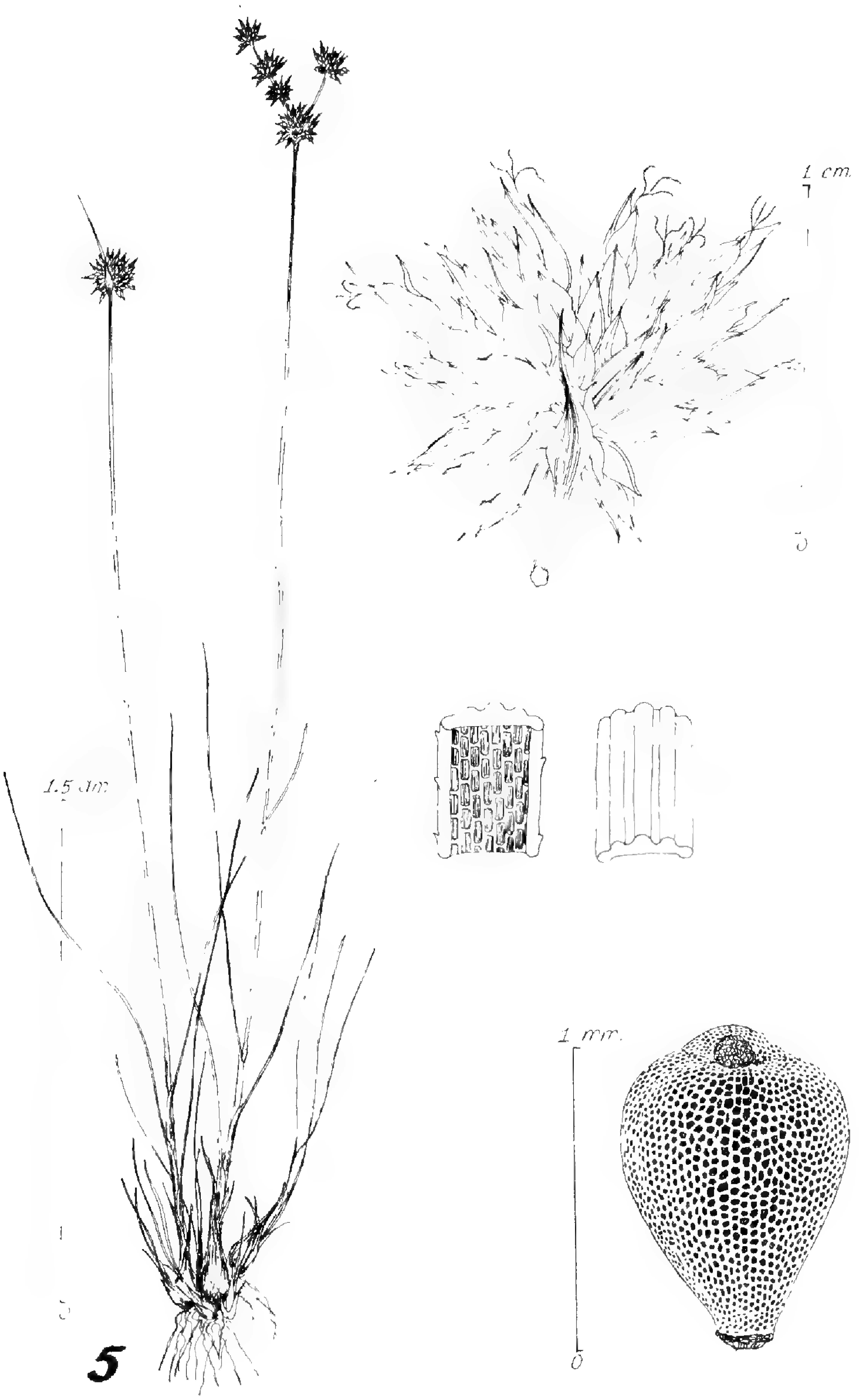
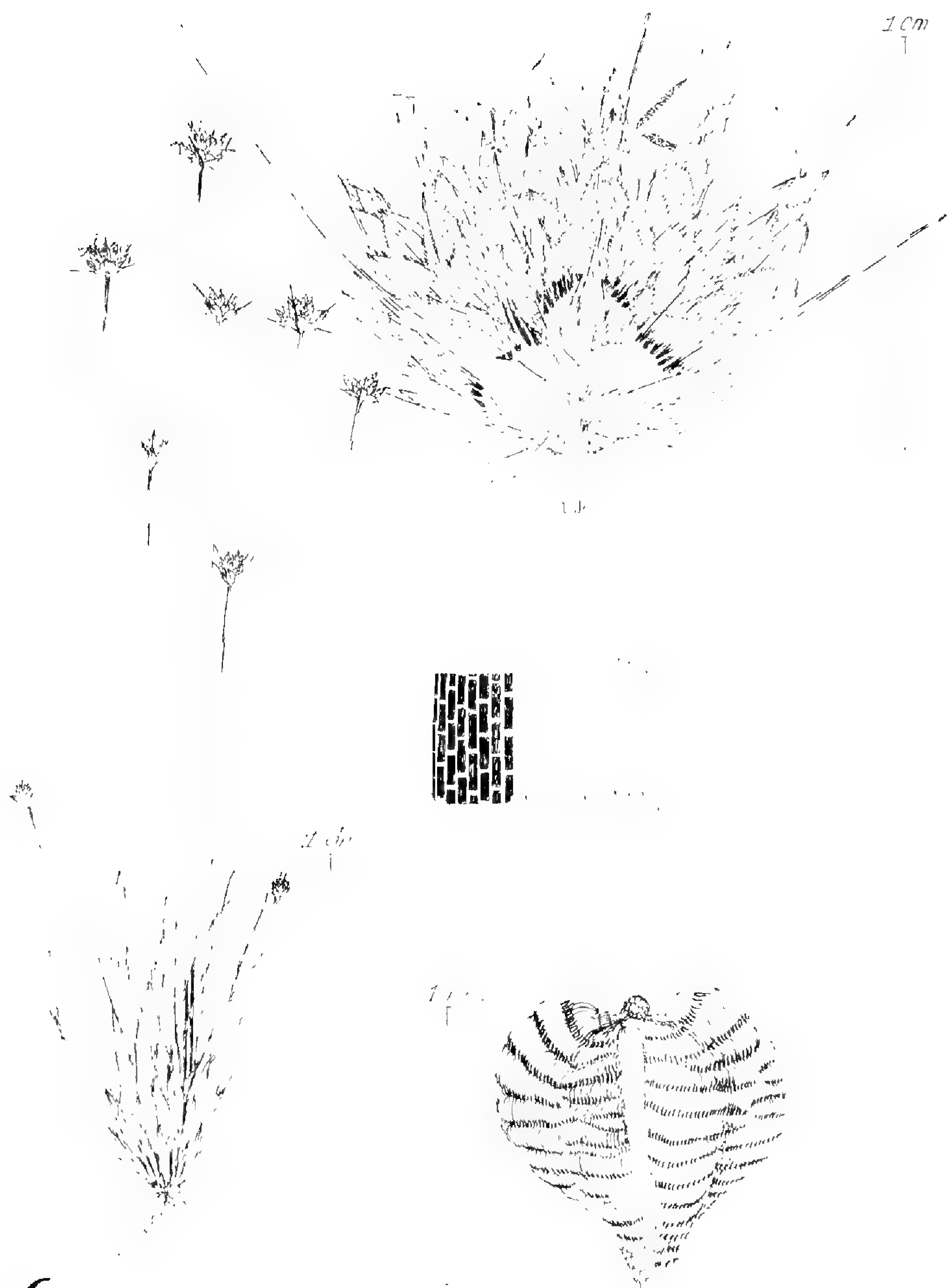
3. BULBOSTYLIS PARADOXA



4. BULBOSTYLIS VESTITA



5. BULBOSTYLIS JUNCIFORMIS



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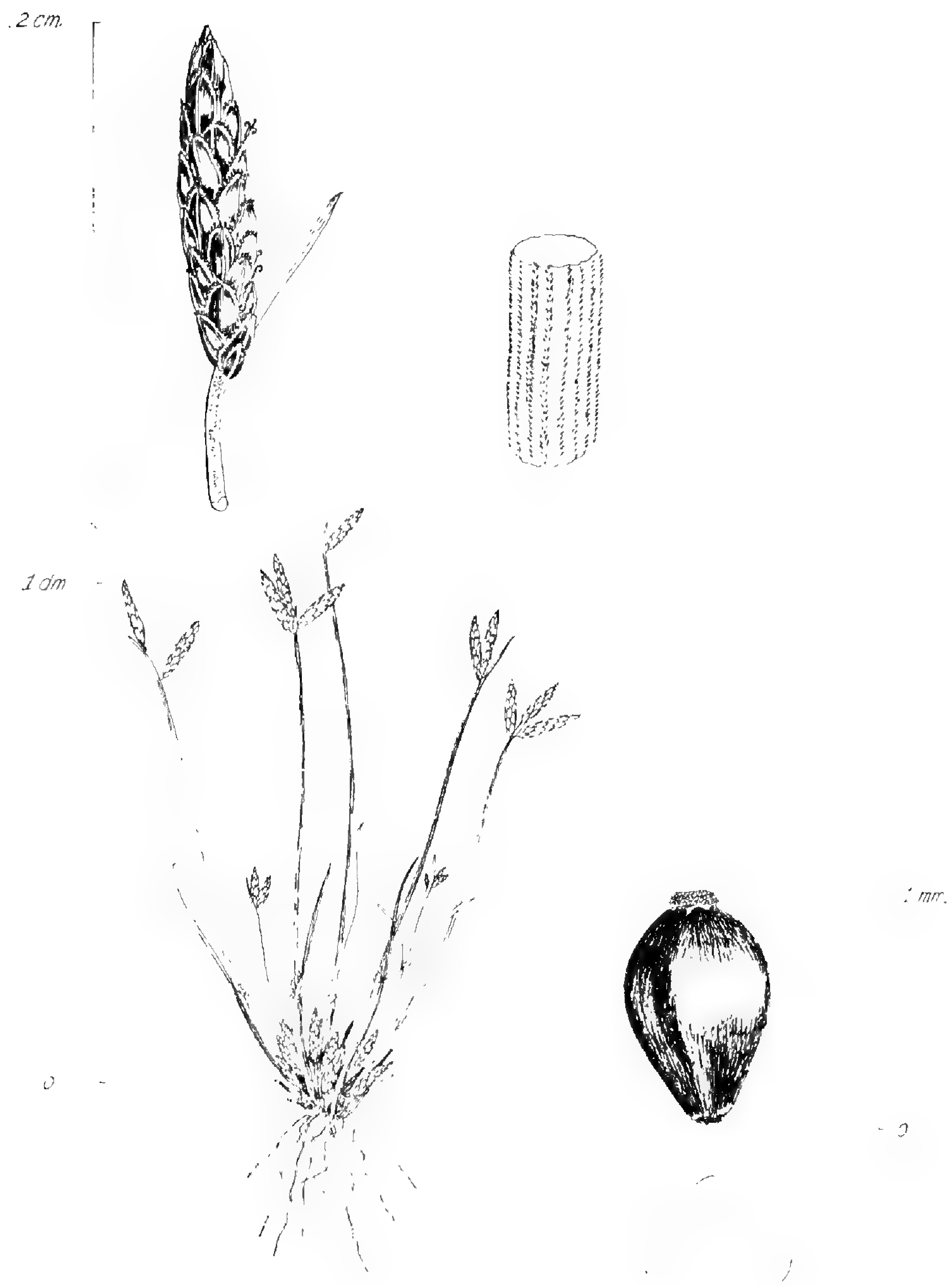
6. BULBOSTYLIS WAREI



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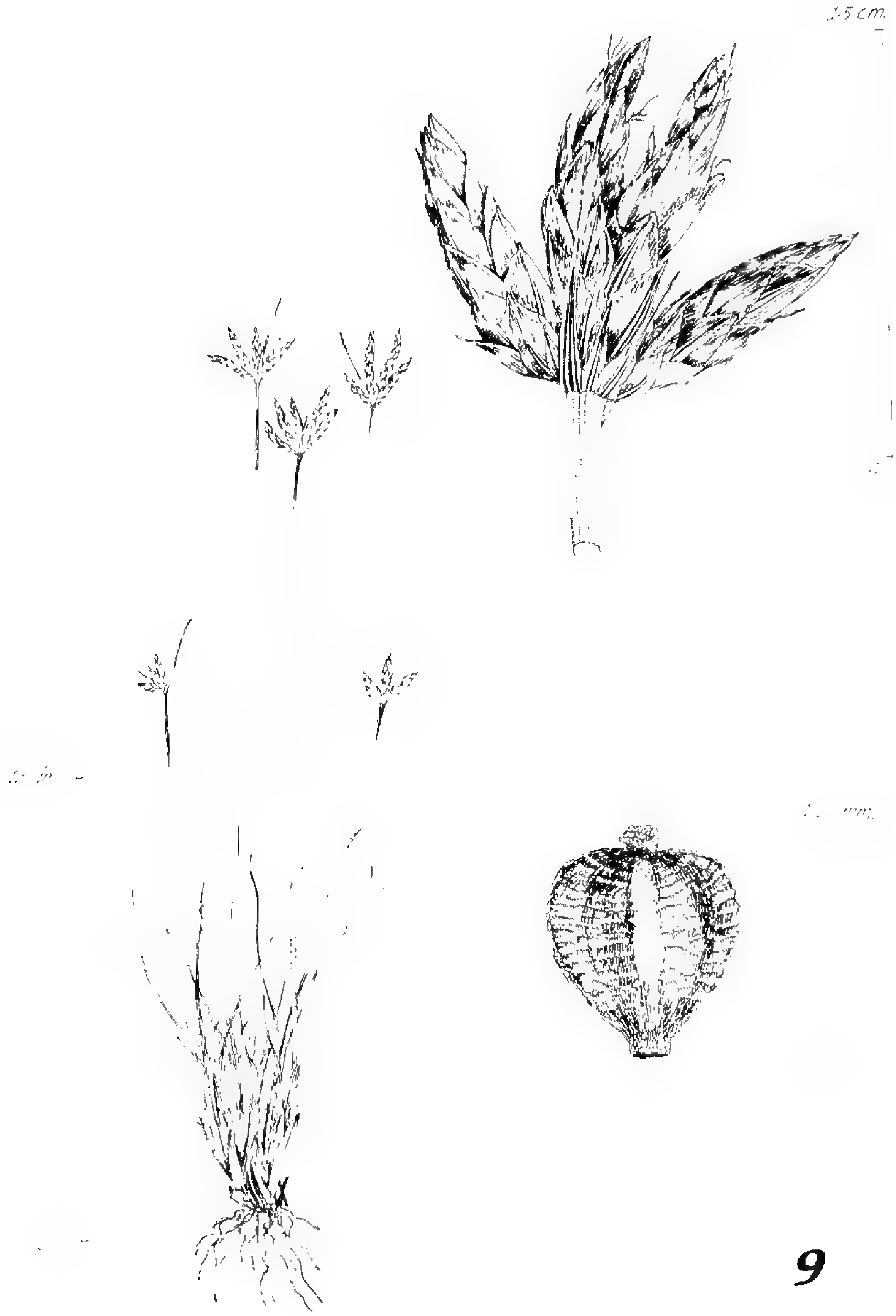
7. BULBOSTYLIS FLOCCOSA

8. BULBOSTYLIS SUBAPHYLLA



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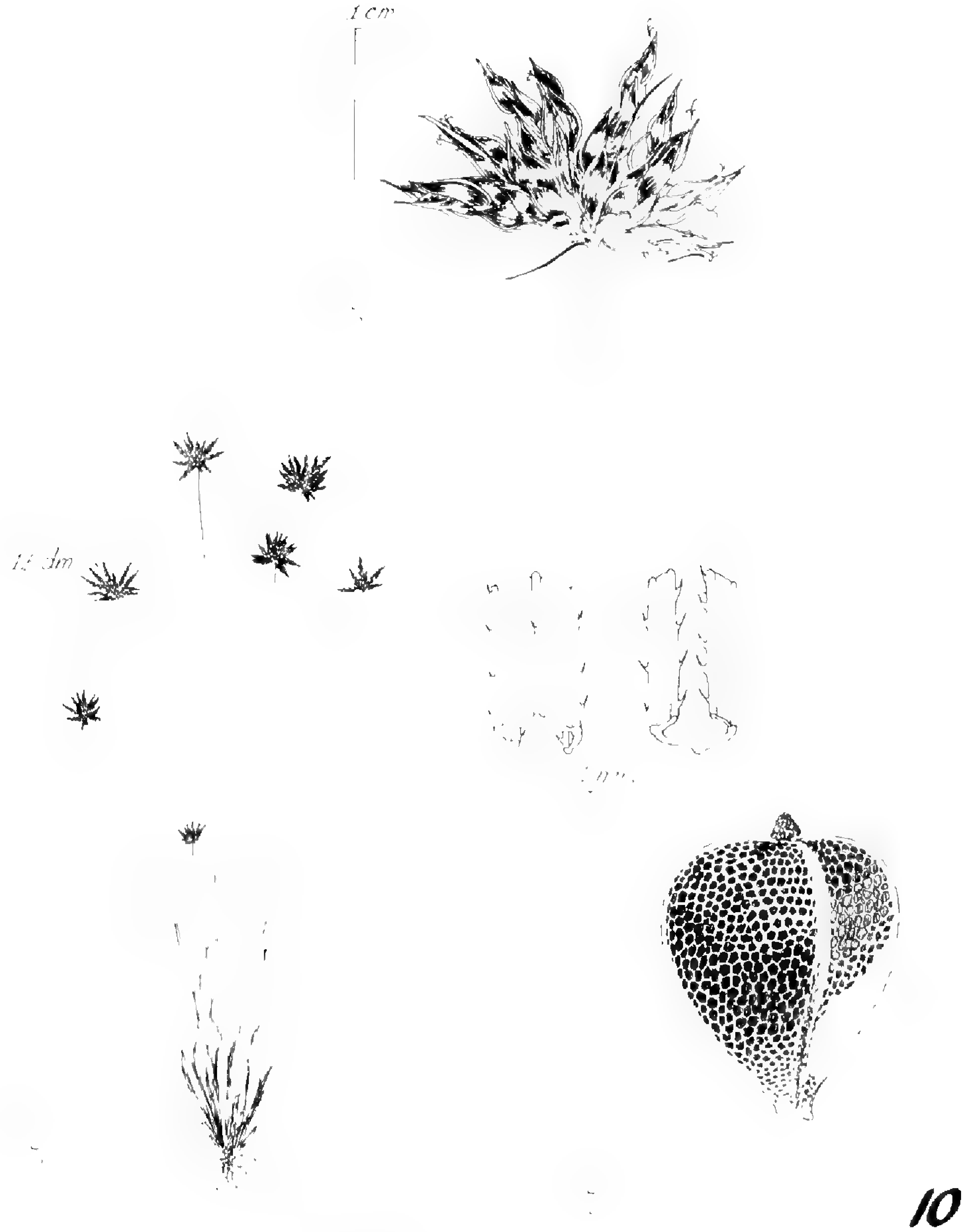
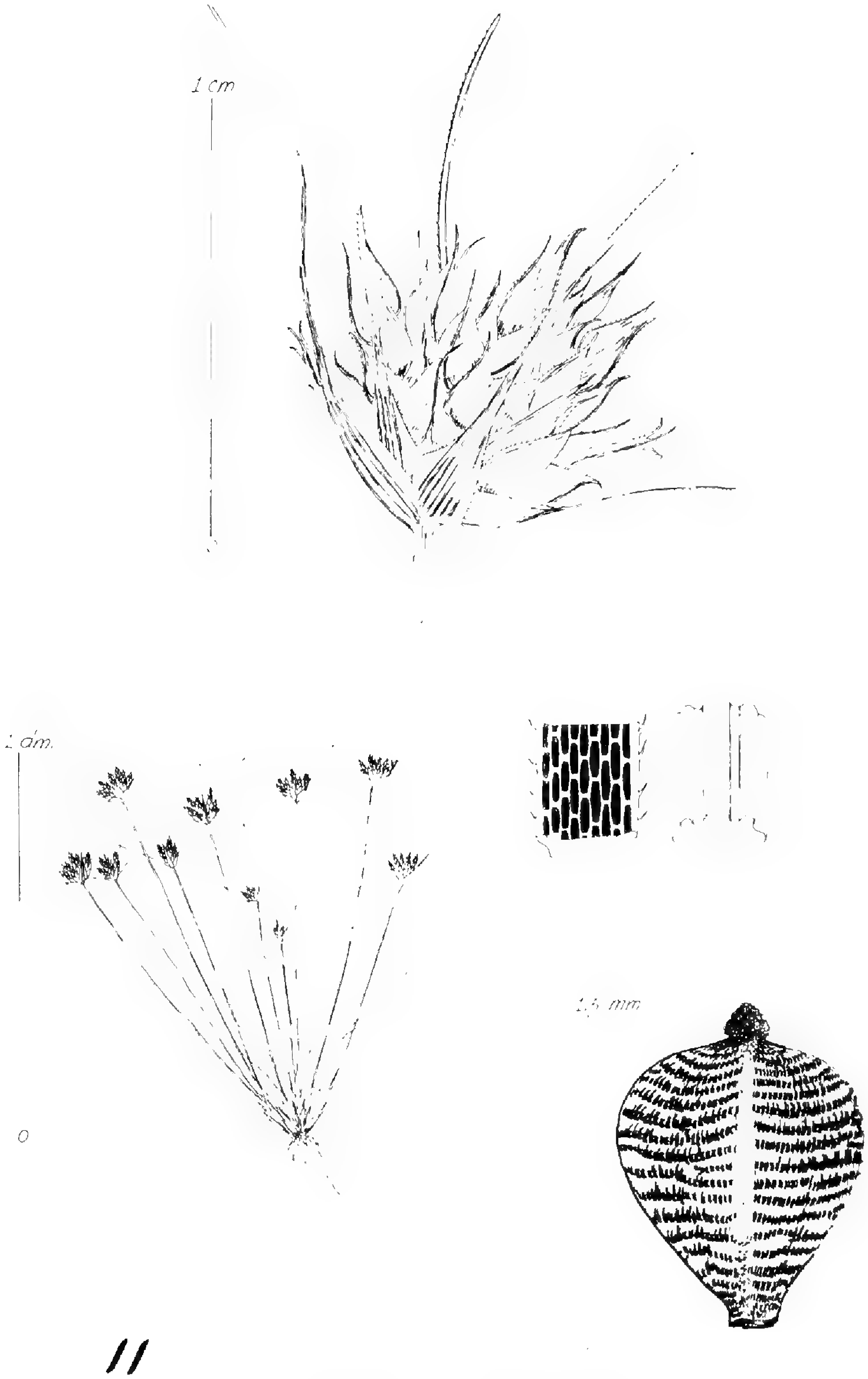
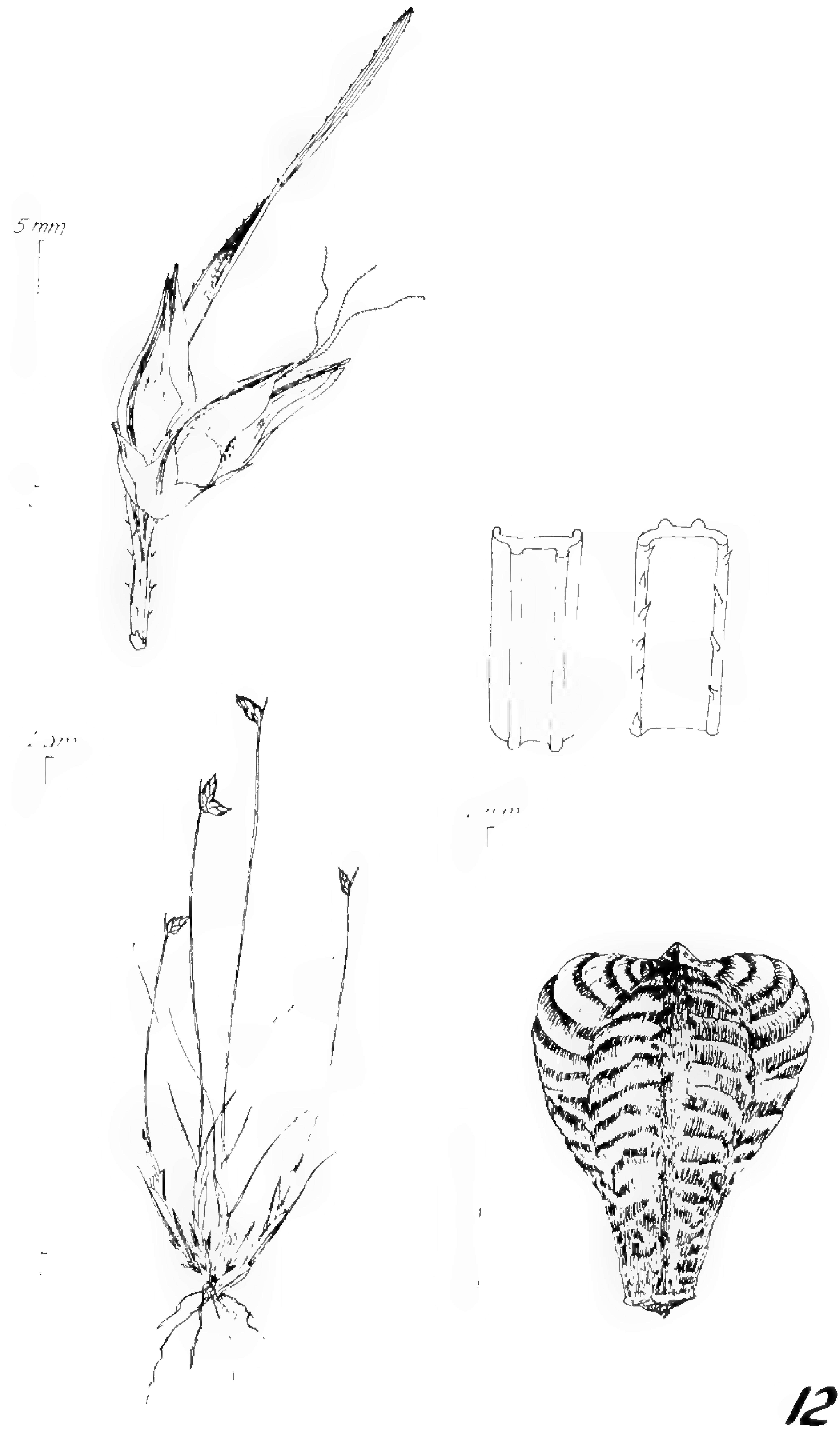
9. BULBOSTYLIS NESIOTICA



10. BULBOSTYLIS BARBATA



11. BULBOSTYLIS STENOPHYLLA



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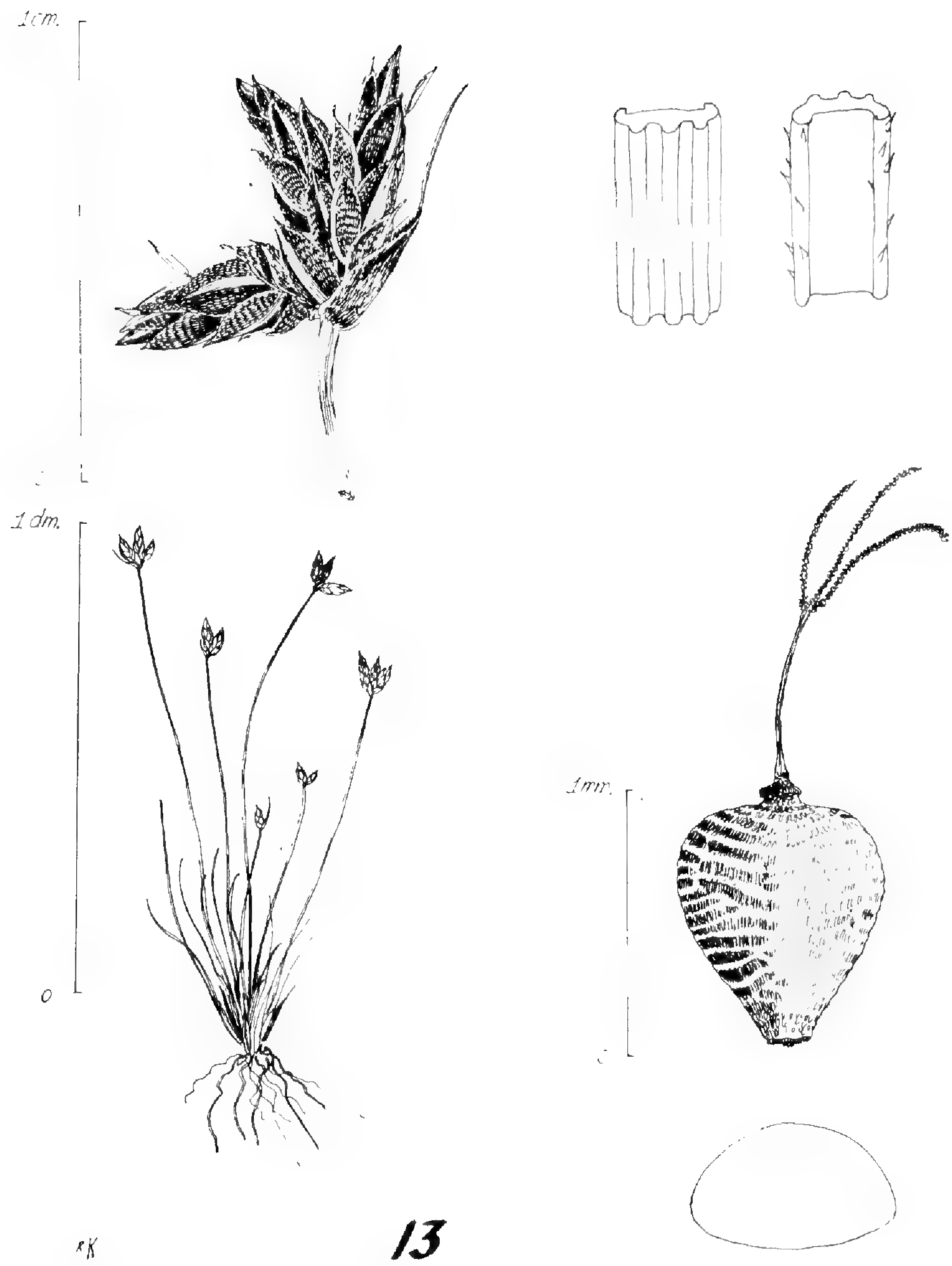
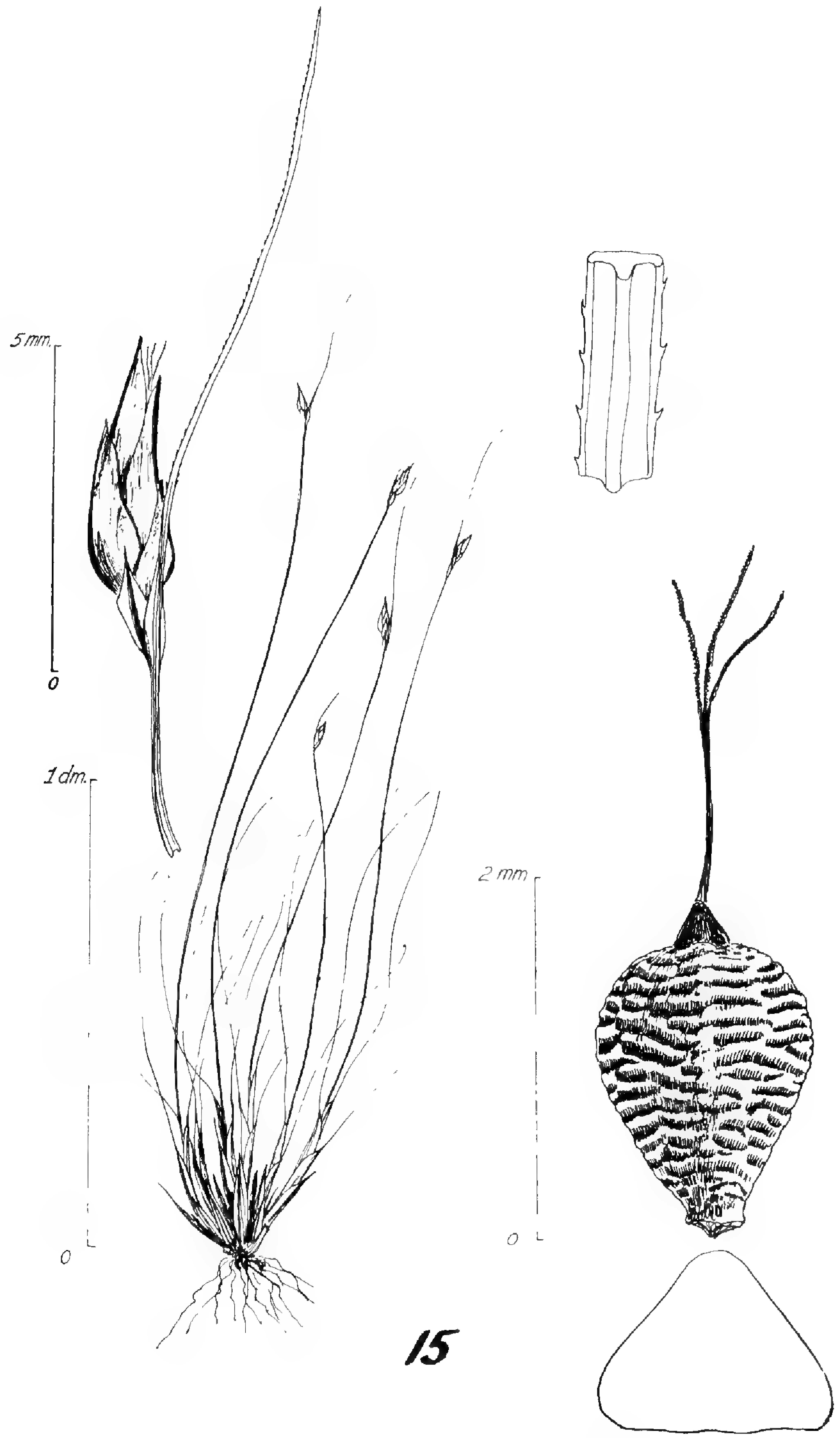
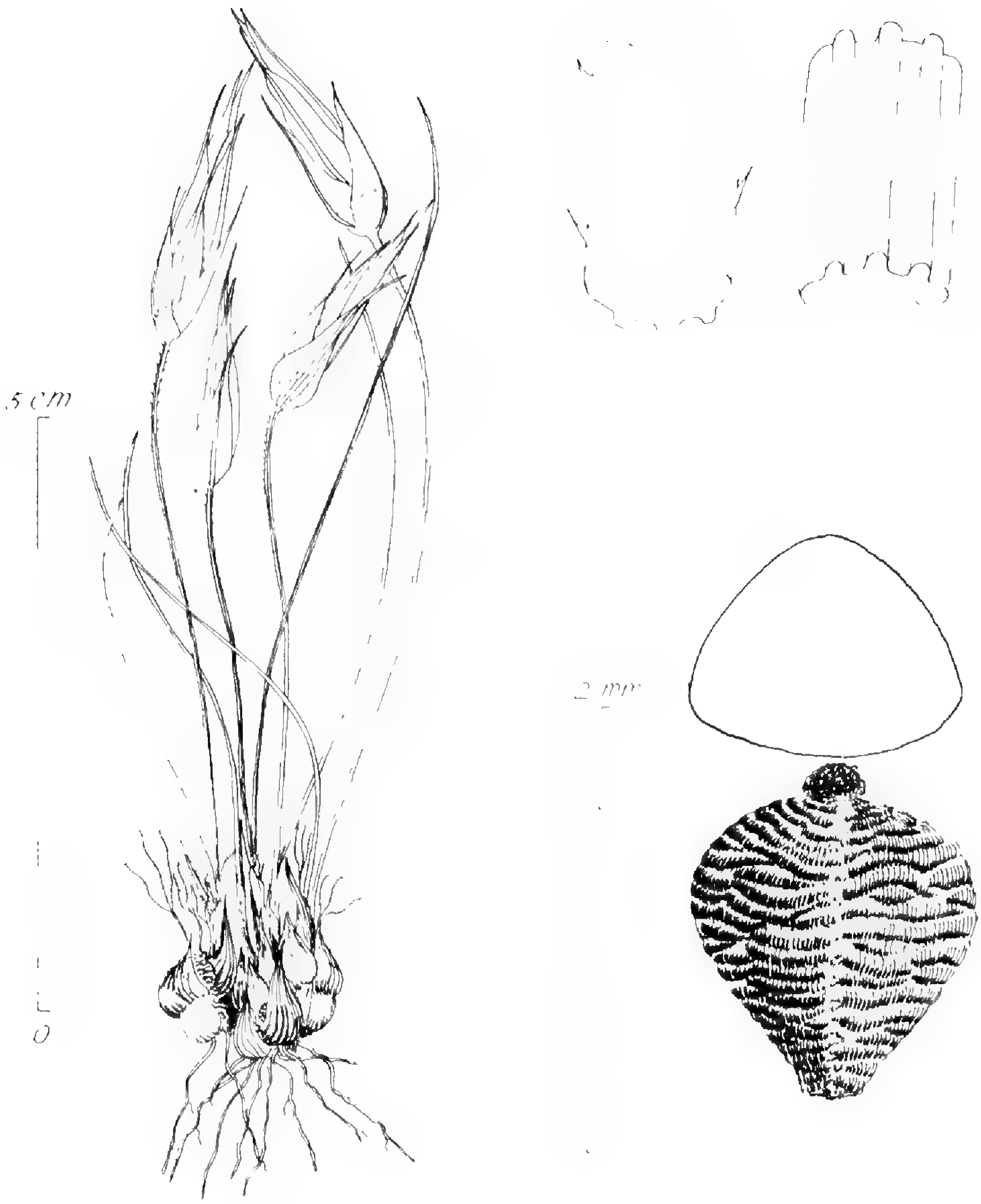


13. BULBOSTYLIS SEPIACEA

14. BULBOSTYLIS CURASSAVICA



15. BULBOSTYLIS PAUCIFLORA



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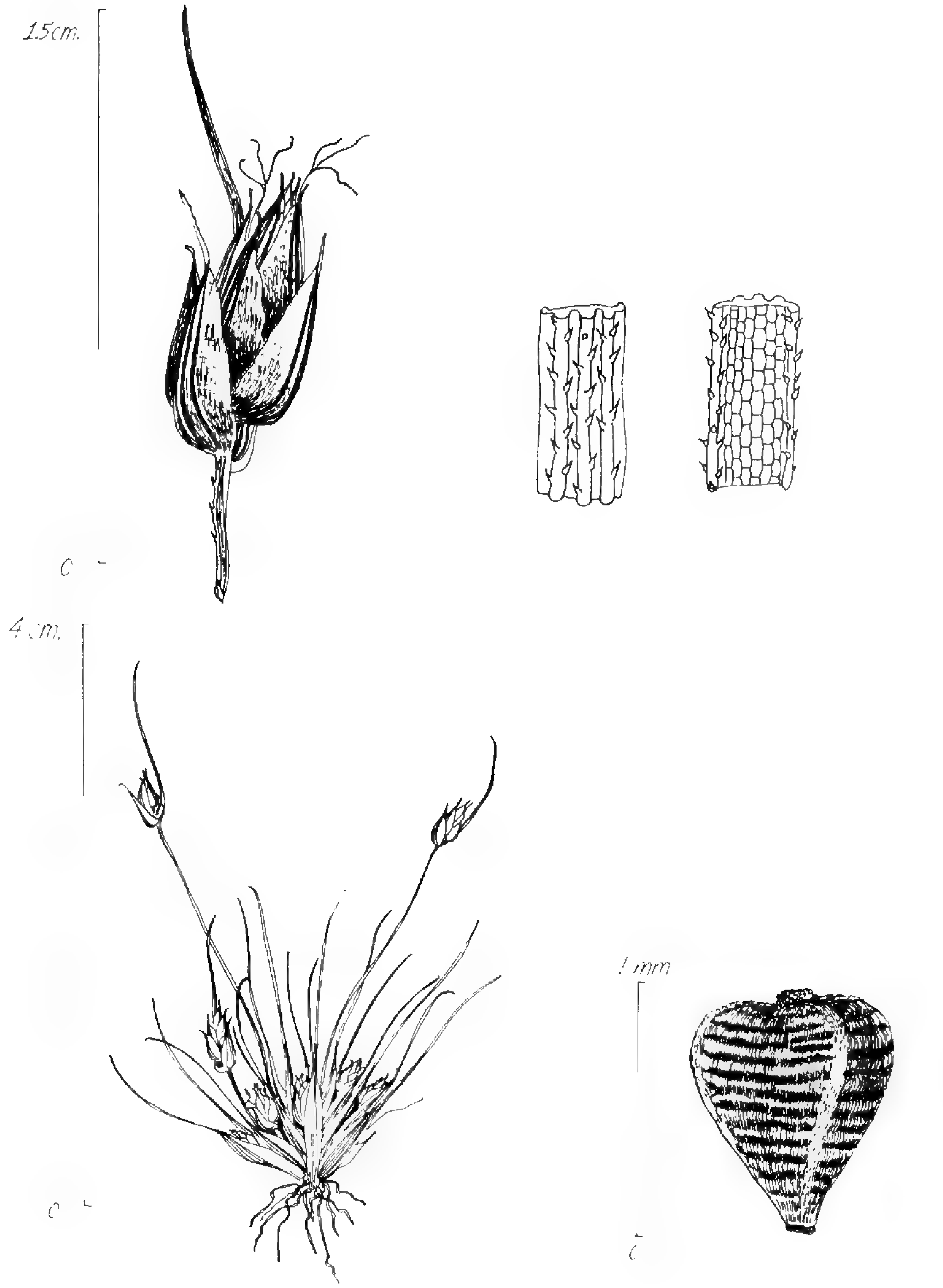
16. BULBOSTYLIS FUNCKII



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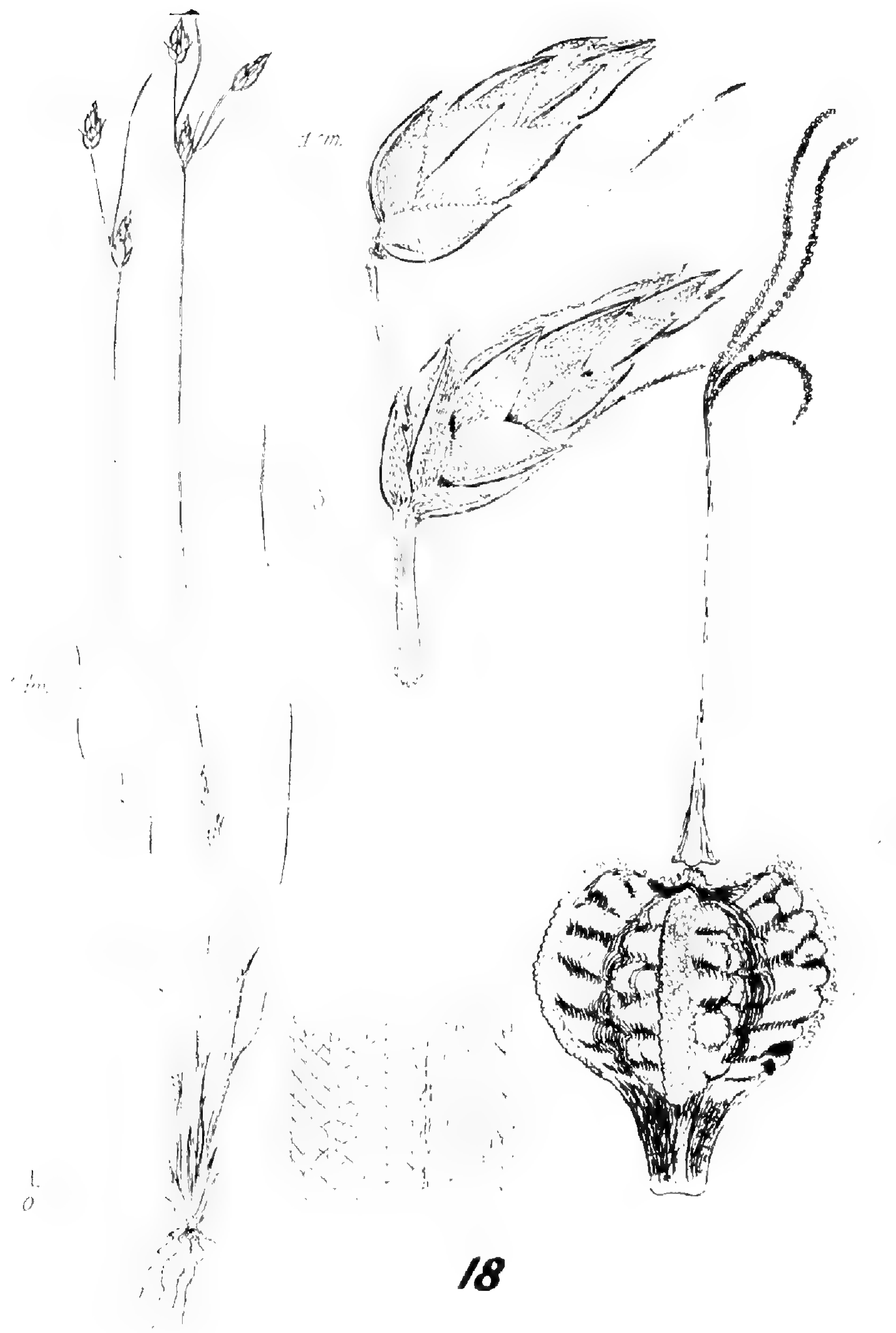
17. BULBOSTYLIS SCHAFFNERI



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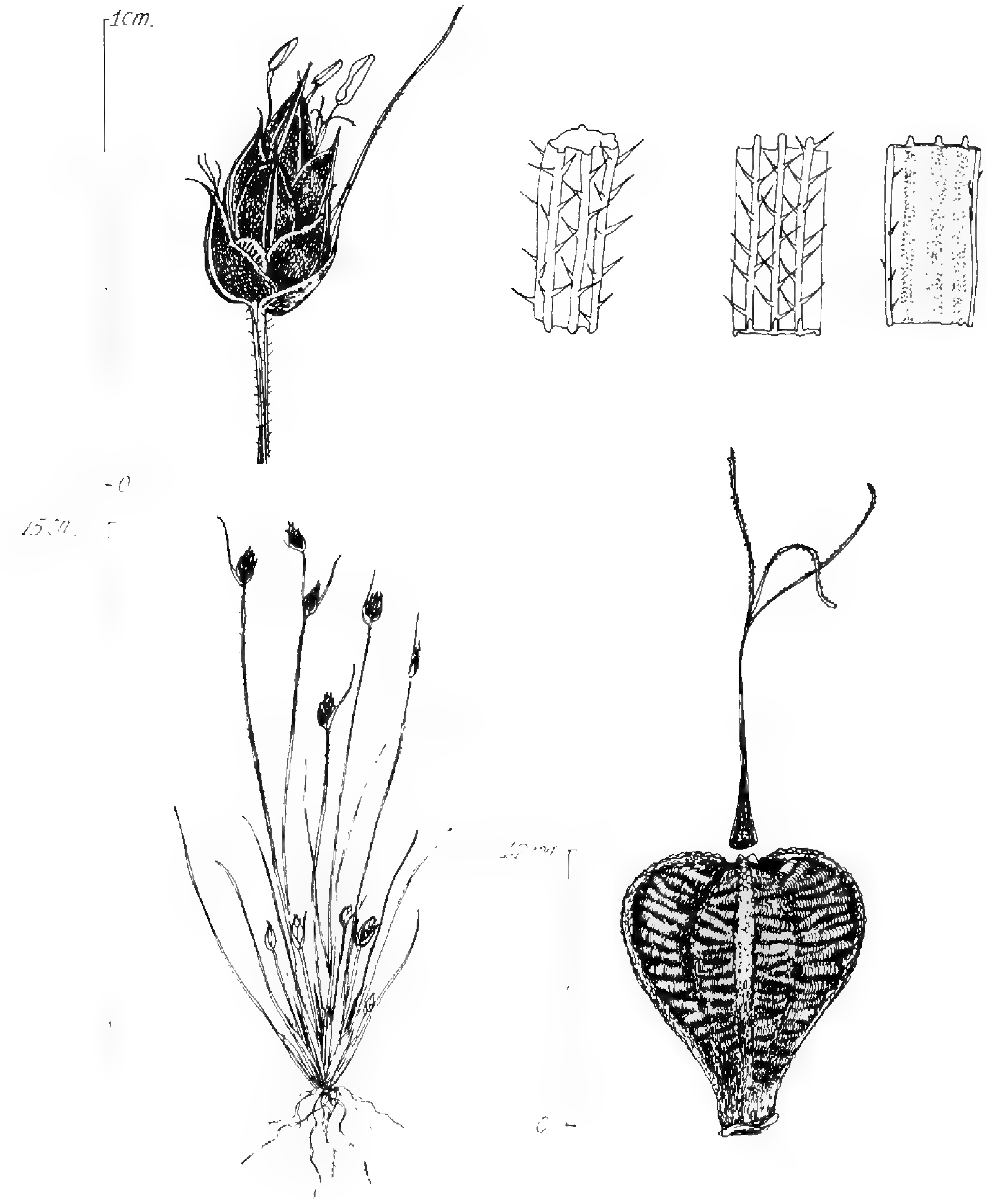
18. BULBOSTYLIS TRILOBATA



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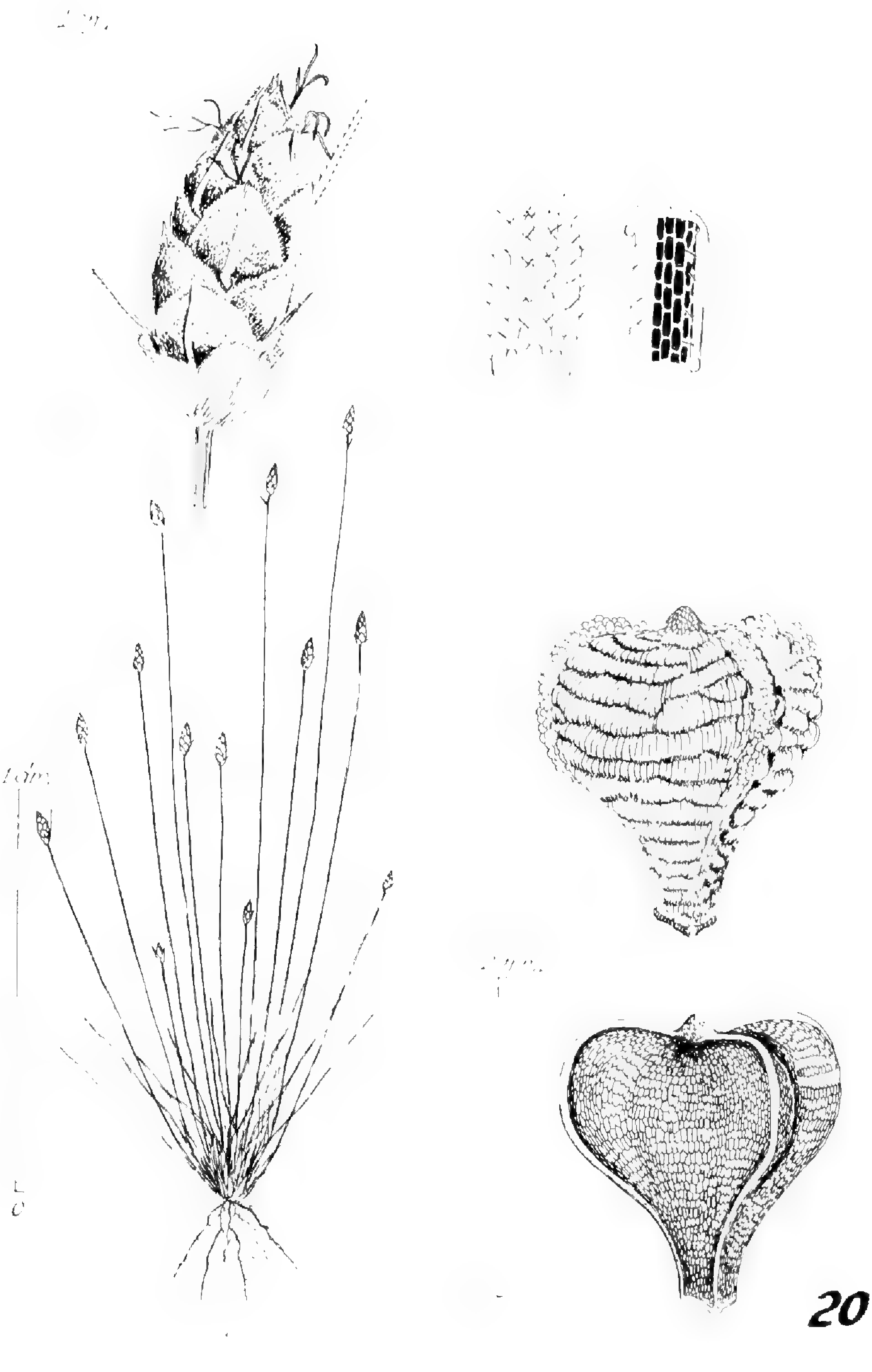
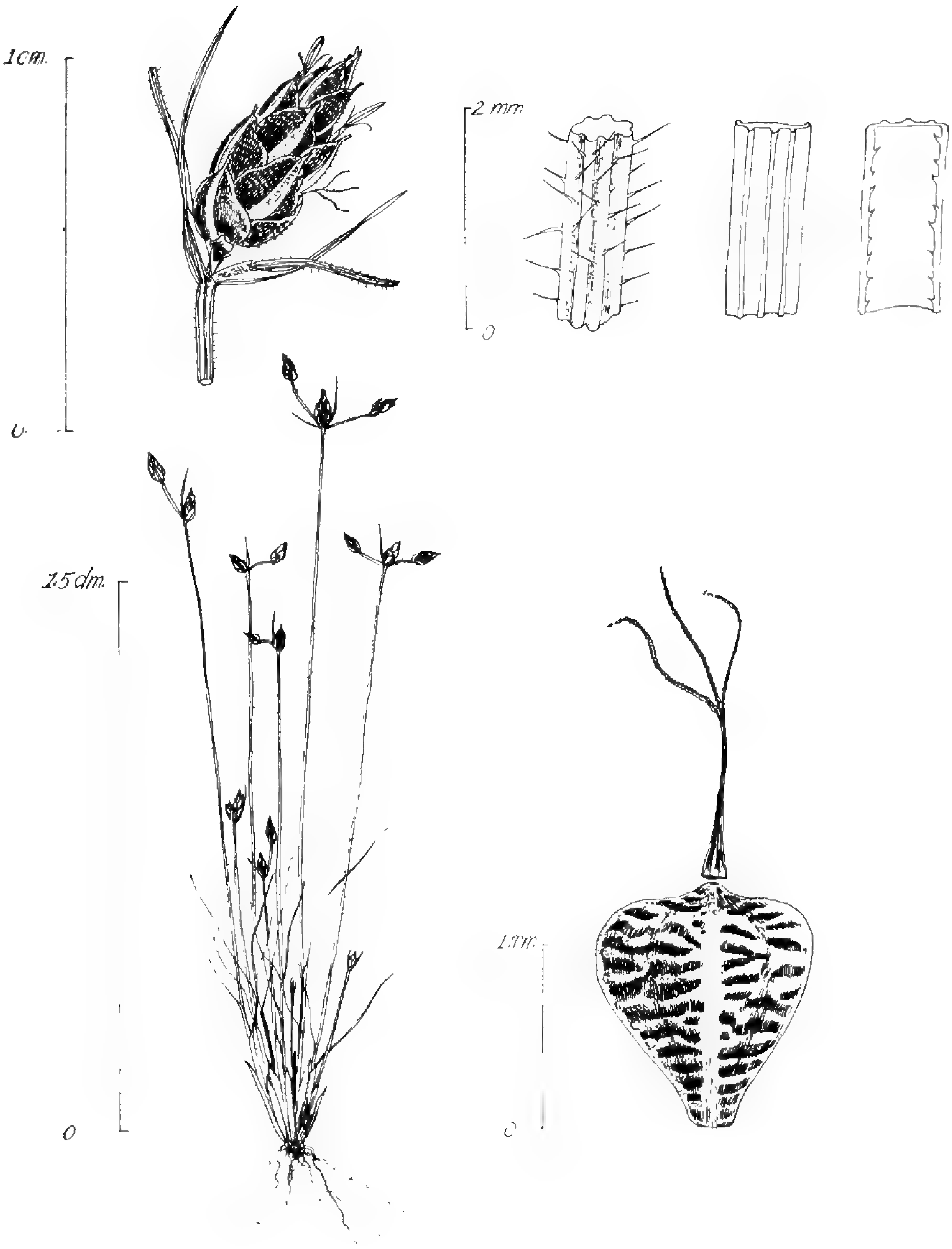
19. BULBOSTYLIS ARCUATA



20. BULBOSTYLIS PUBESCENS



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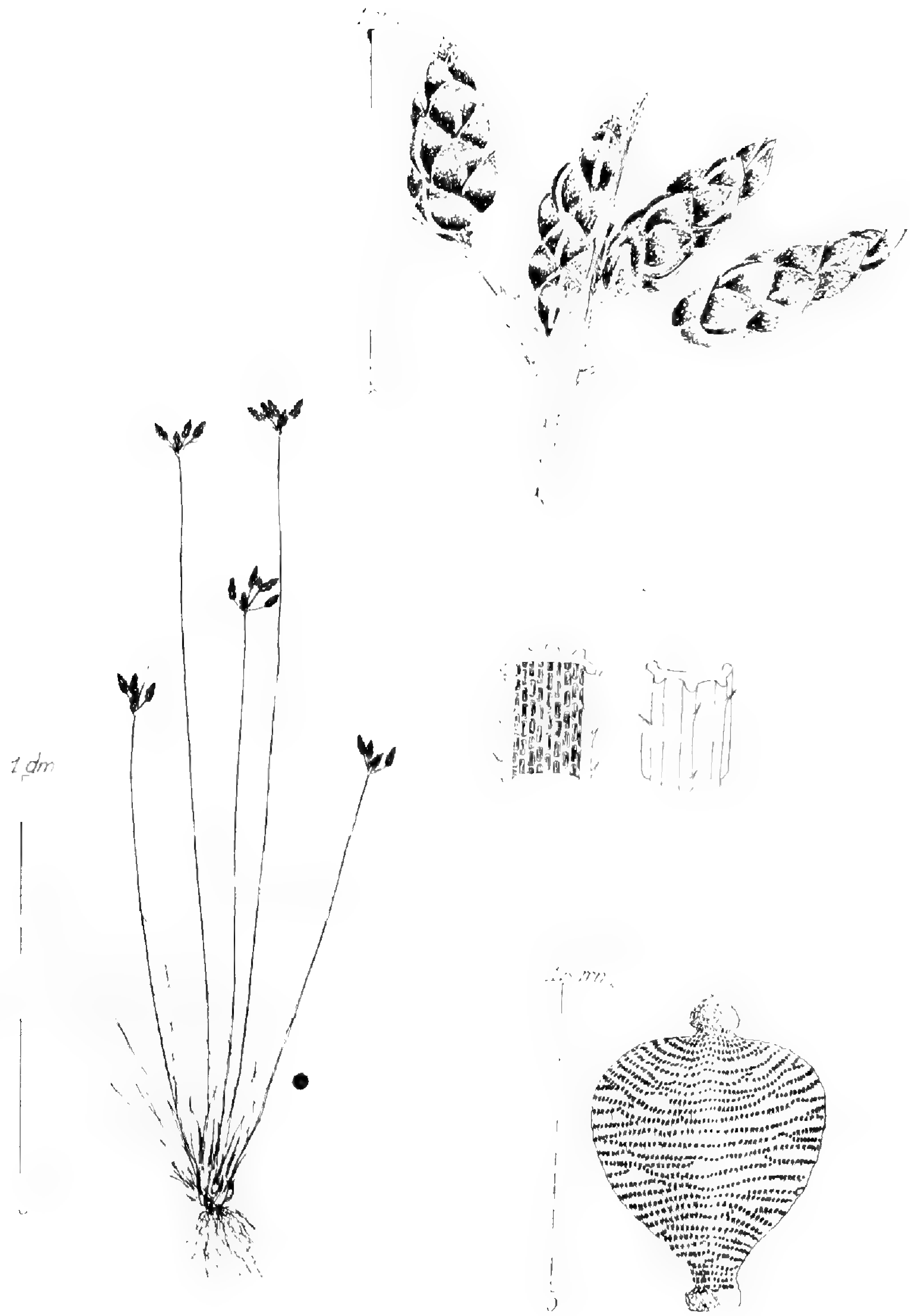
21. BULBOSTYLIS HIRTA



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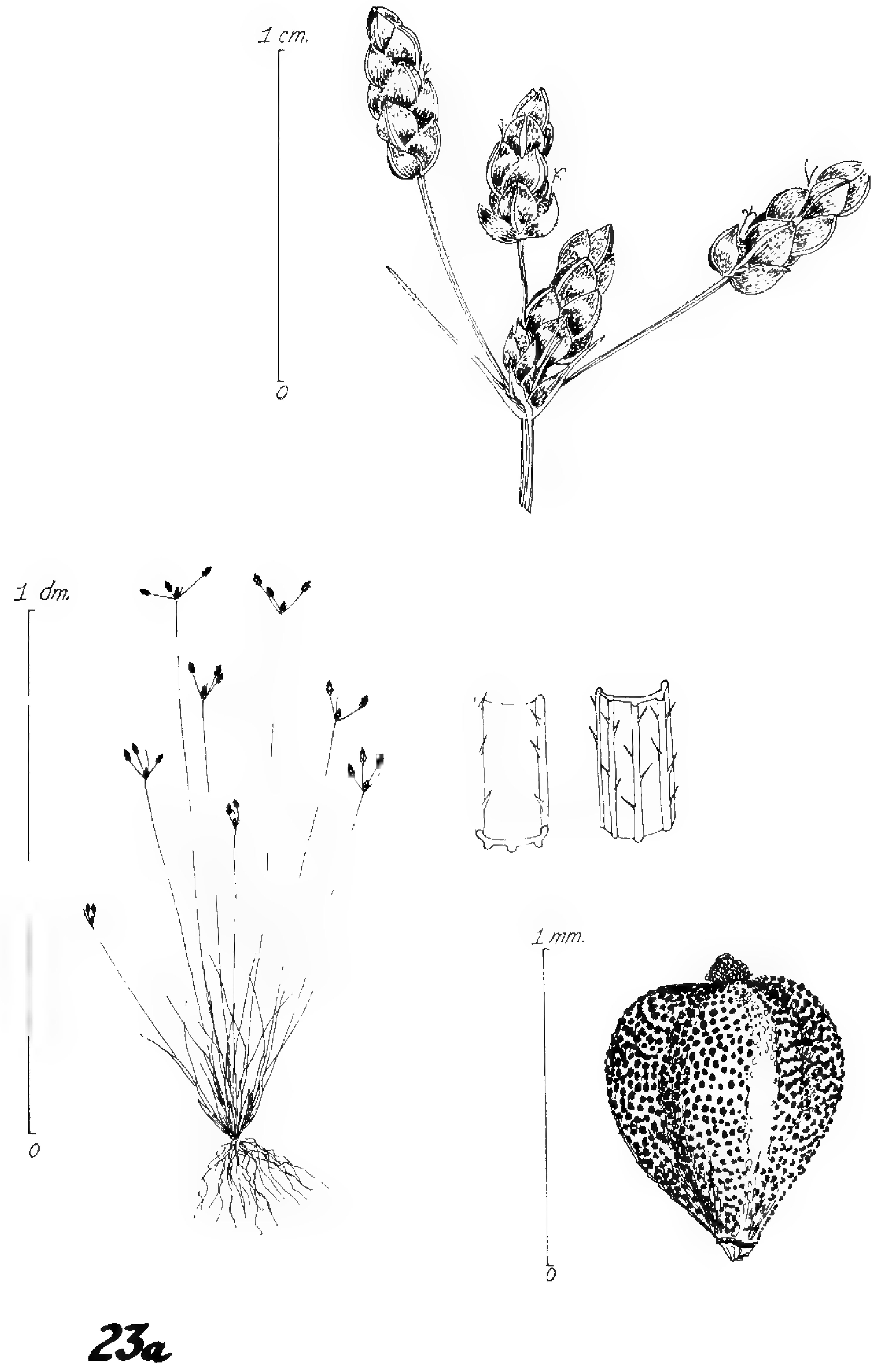
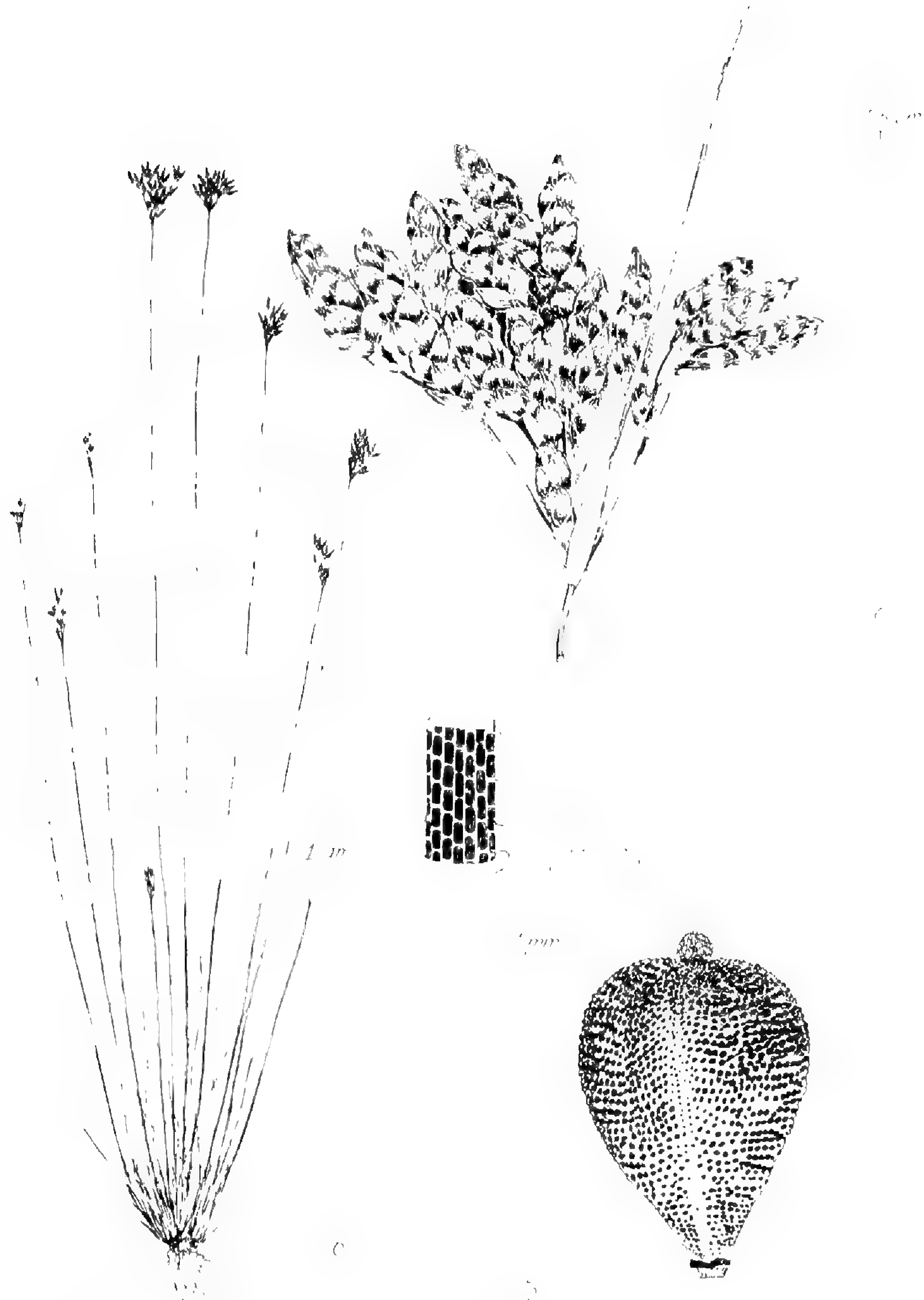
22. BULBOSTYLIS JUNCOIDES

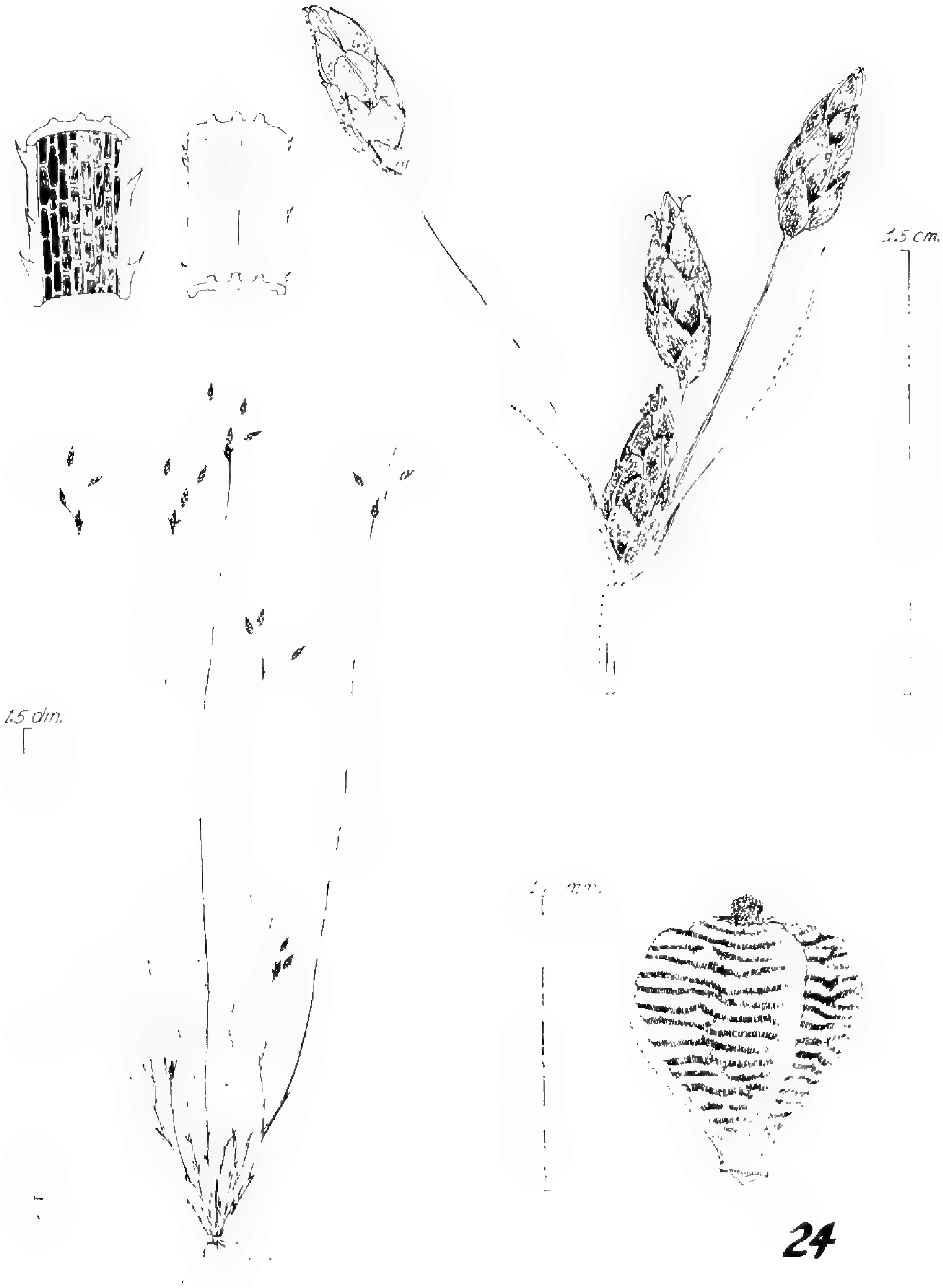


23a. BULBOSTYLIS CILIATIFOLIA VAR. CILIATIFOLIA

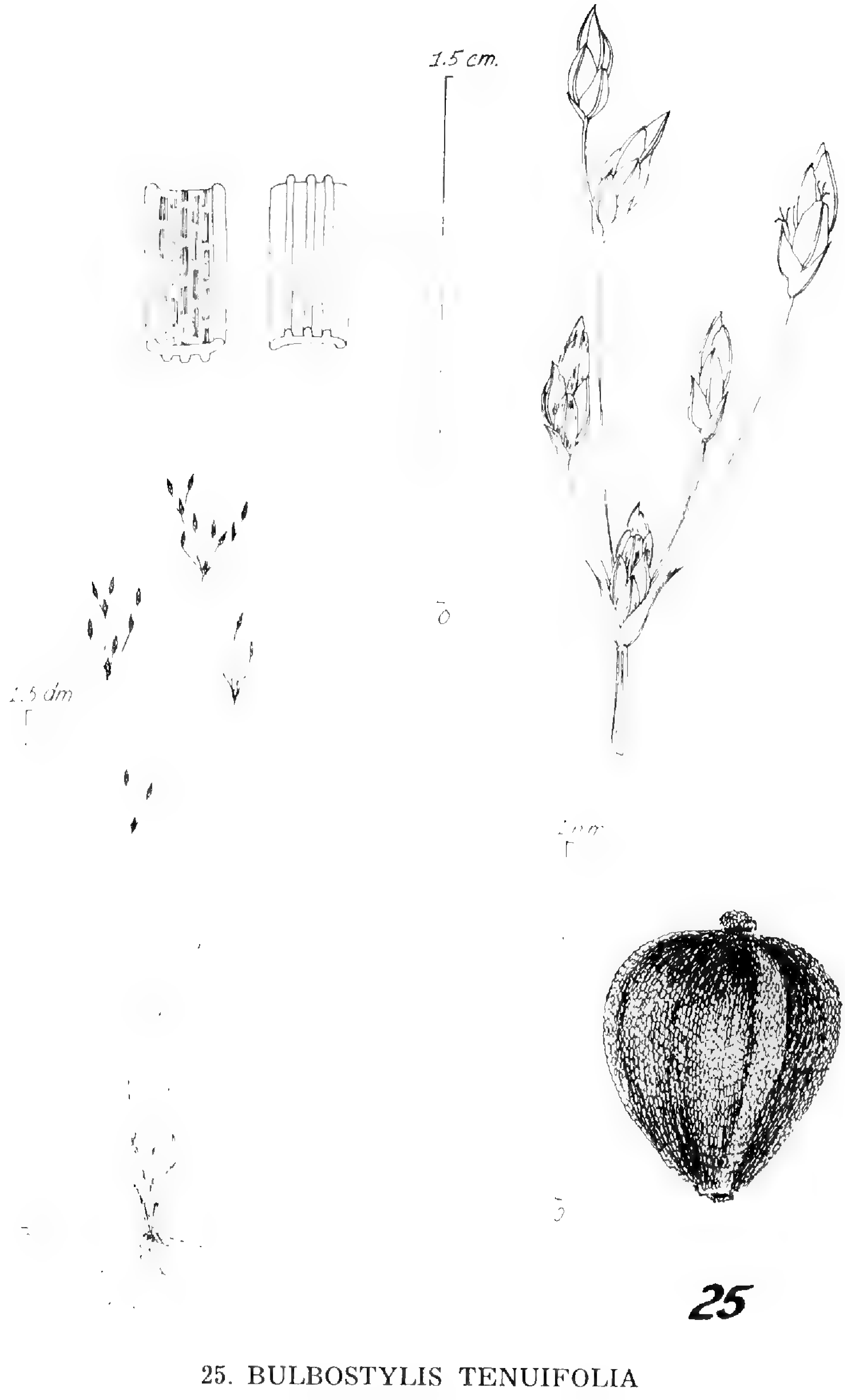


23b

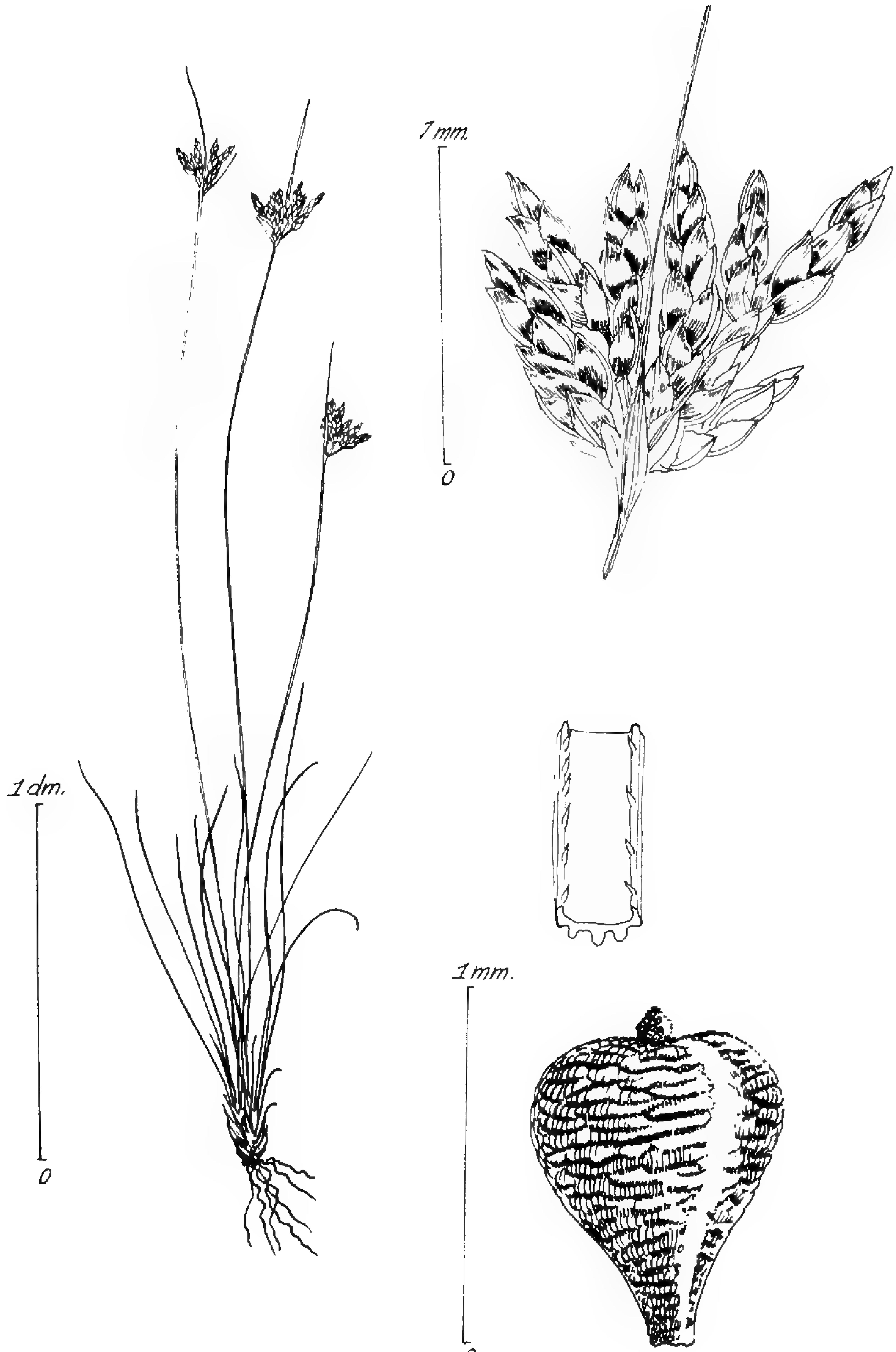
23b. BULBOSTYLIS CILIATIFOLIA VAR. COARCTATA



24. BULBOSTYLIS CAPILLARIS

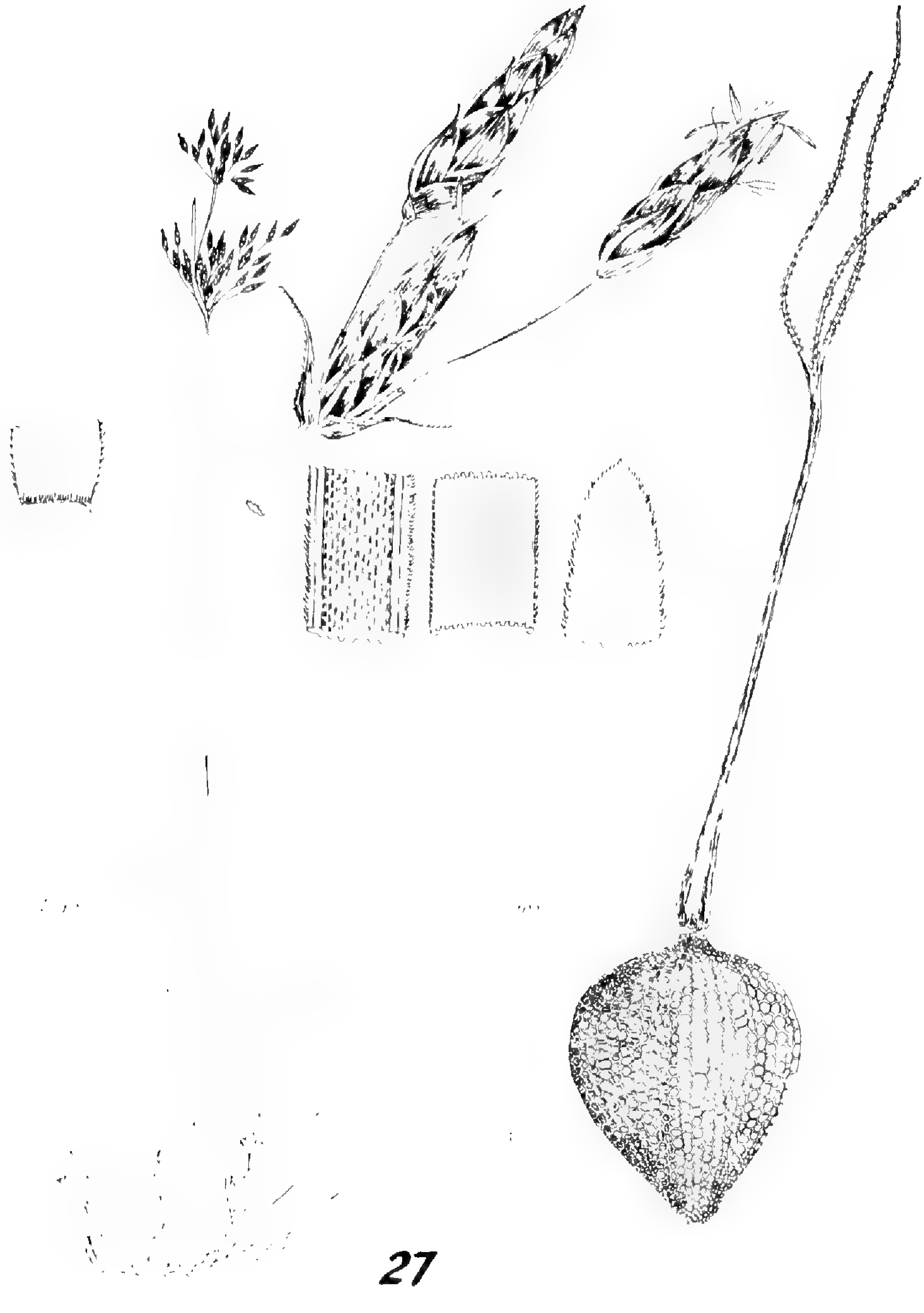


25. BULBOSTYLIS TENUIFOLIA



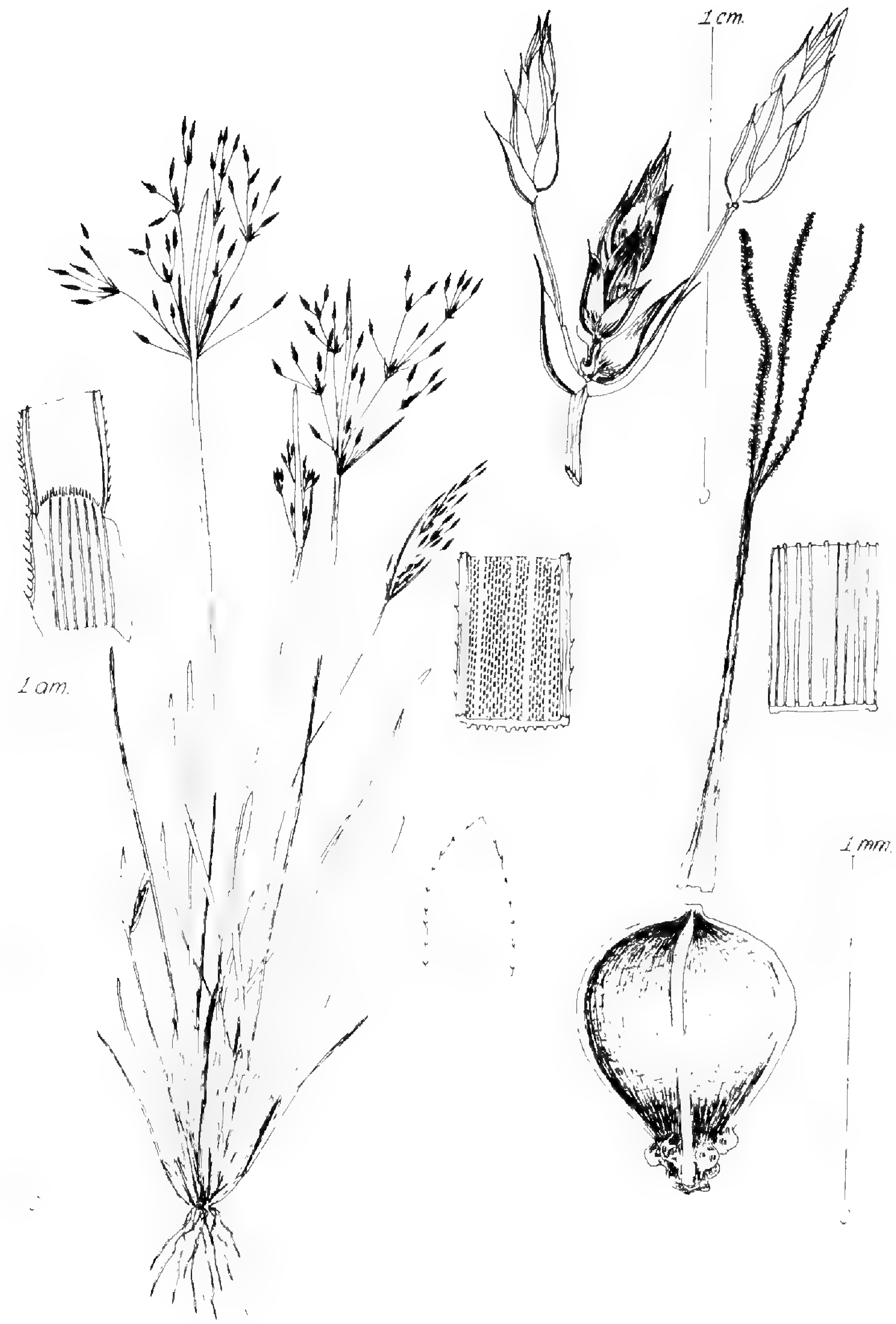
26

26. BULBOSTYLIS ANTILLANA

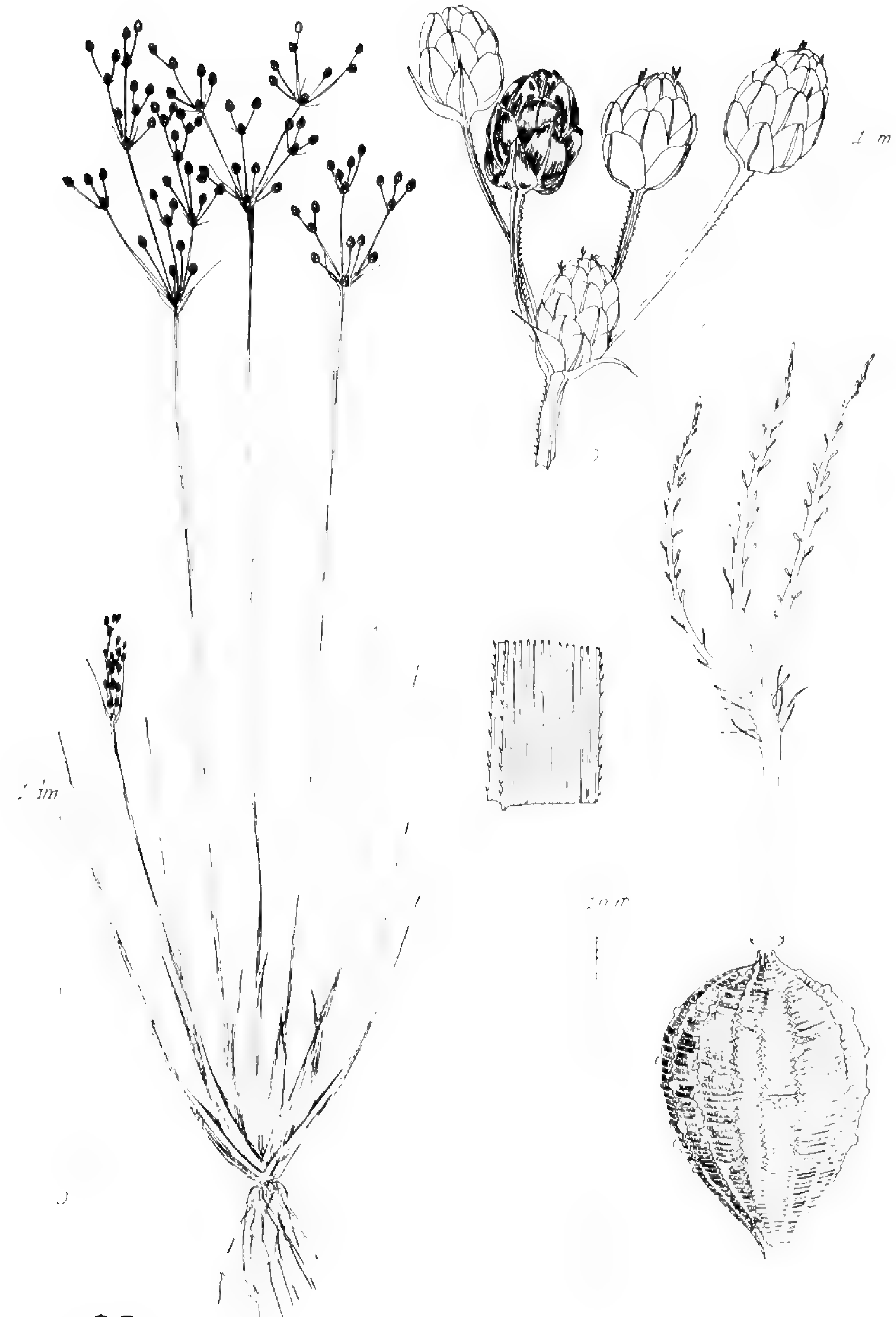


27

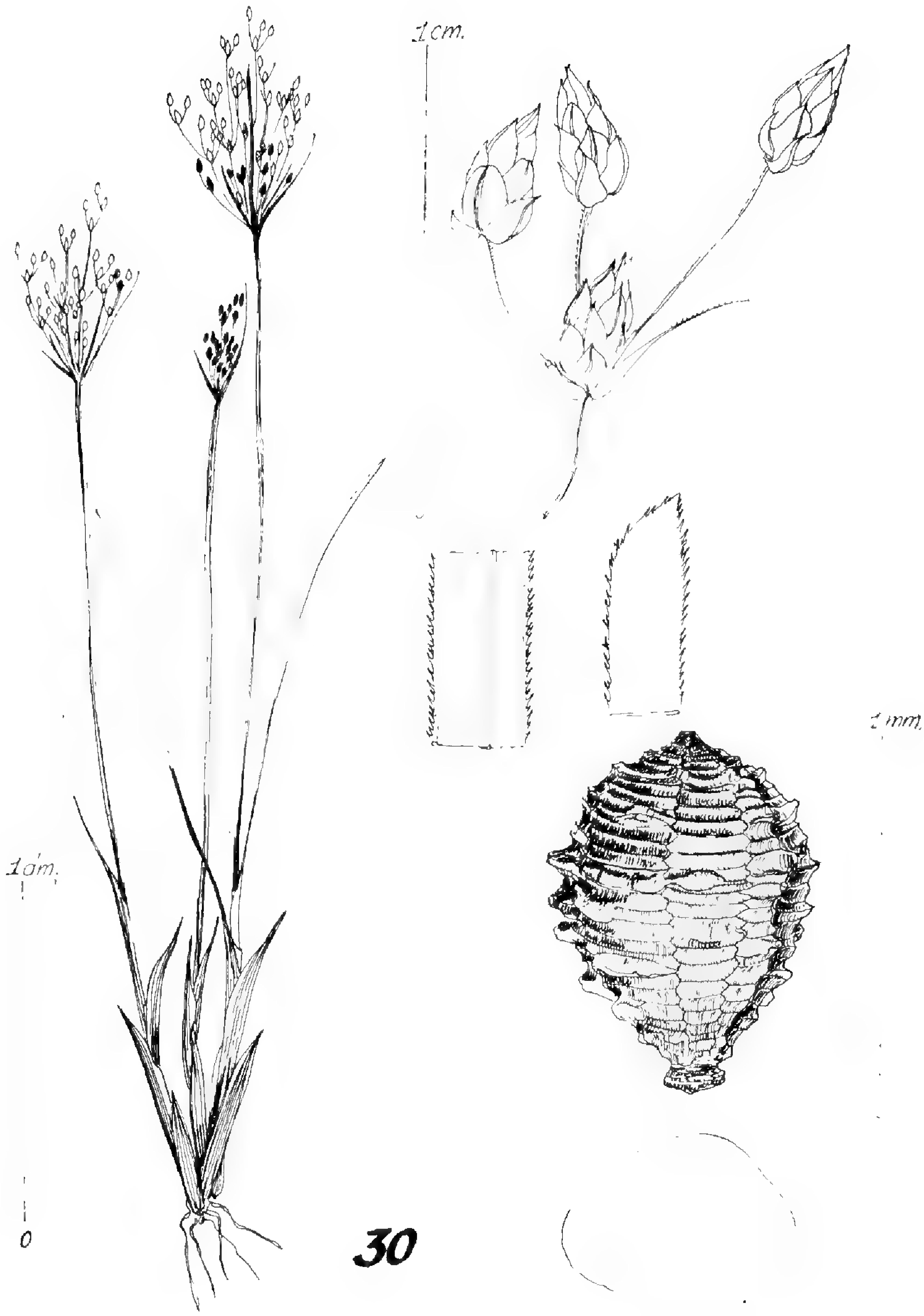
27. FIMBRISTYLIS COMPLANATA



28. FIMBRISTYLIS AUTUMNALIS

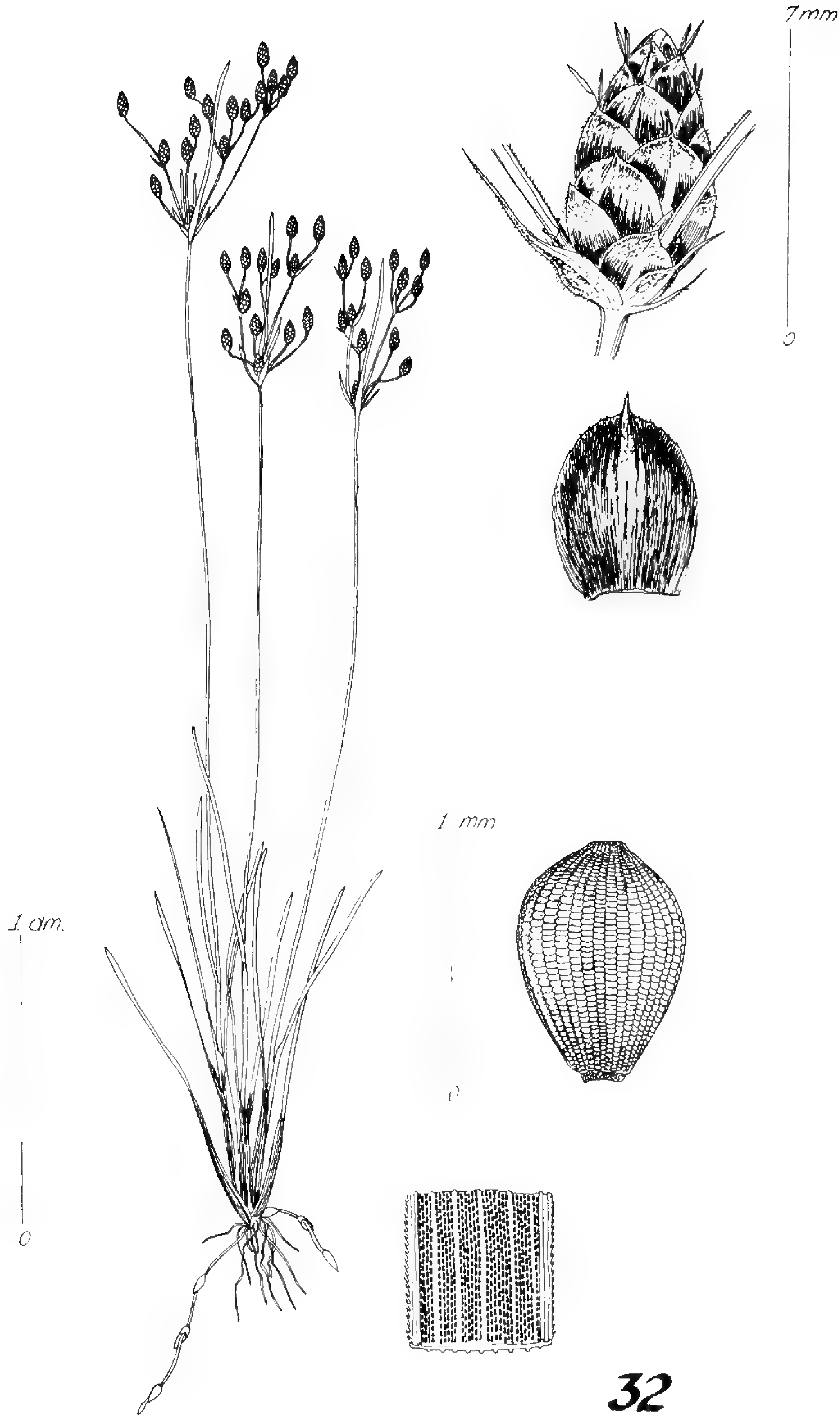


29. FIMBRISTYLIS MILIACEA

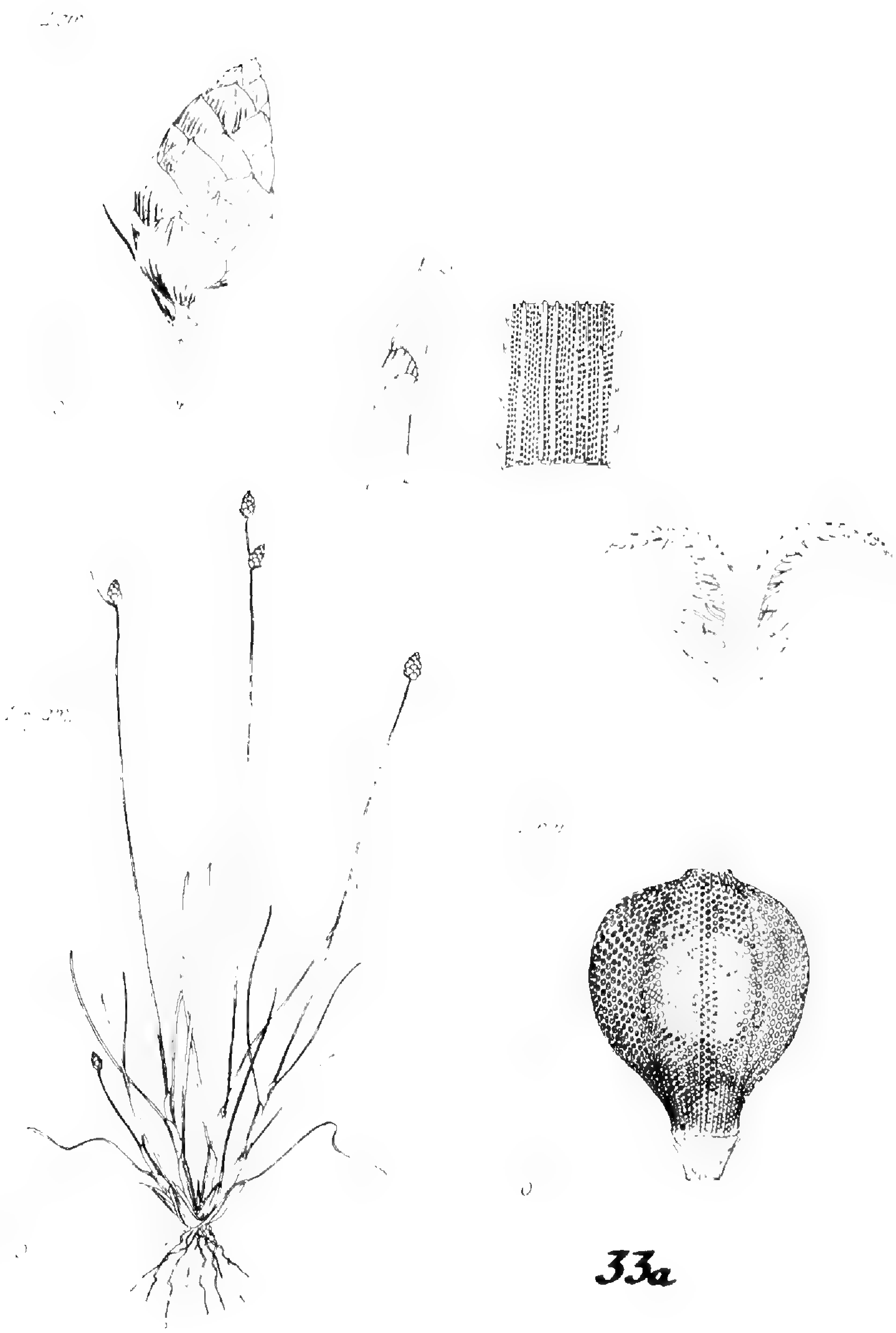


30. FIMBRISTYLIS QUINQUANGULARIS

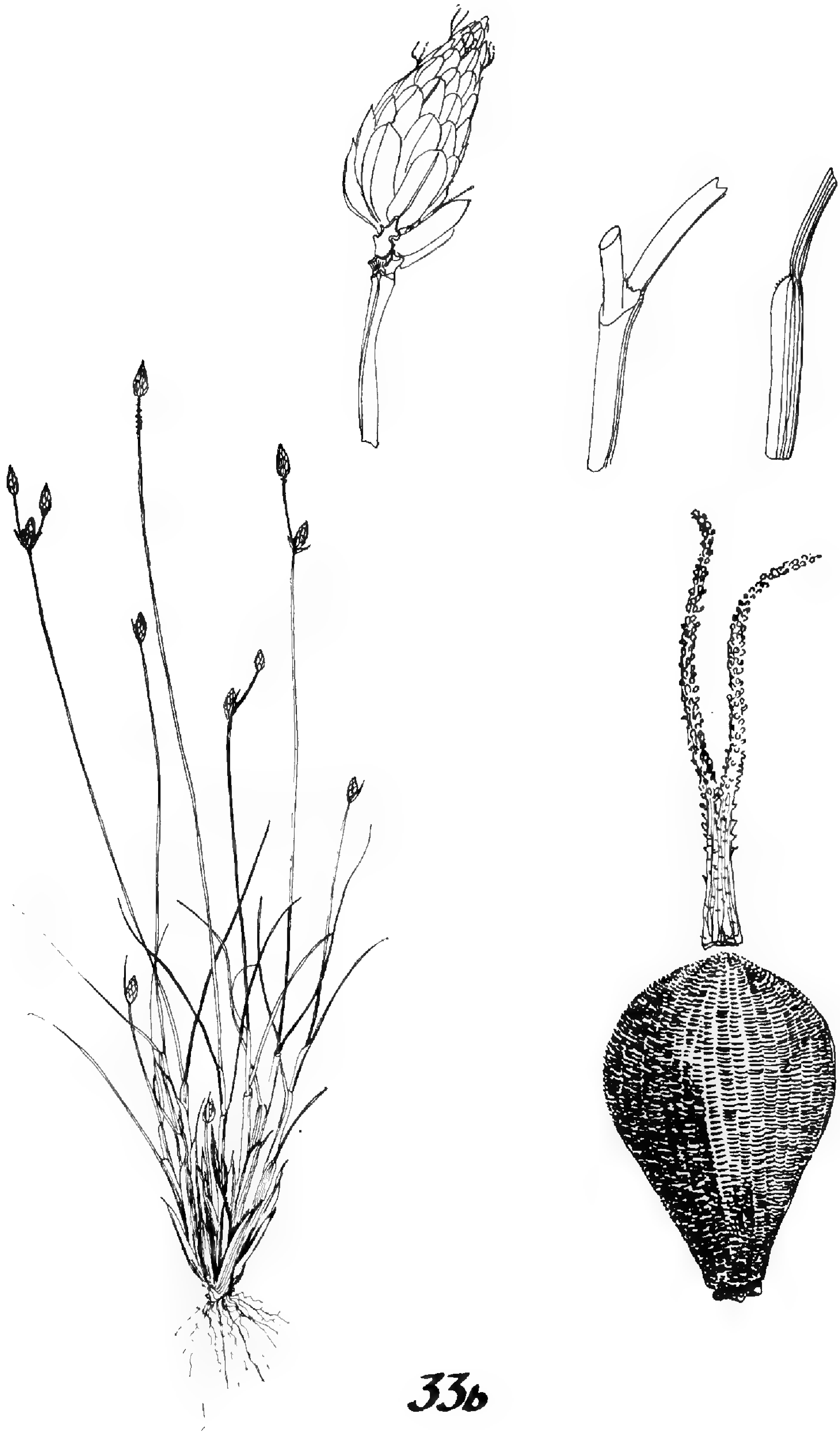
31. FIMBRISTYLIS THERMALIS



32. FIMBRISTYLIS CAROLINIANA



33a. FIMBRISTYLIS SCHOENOIDES

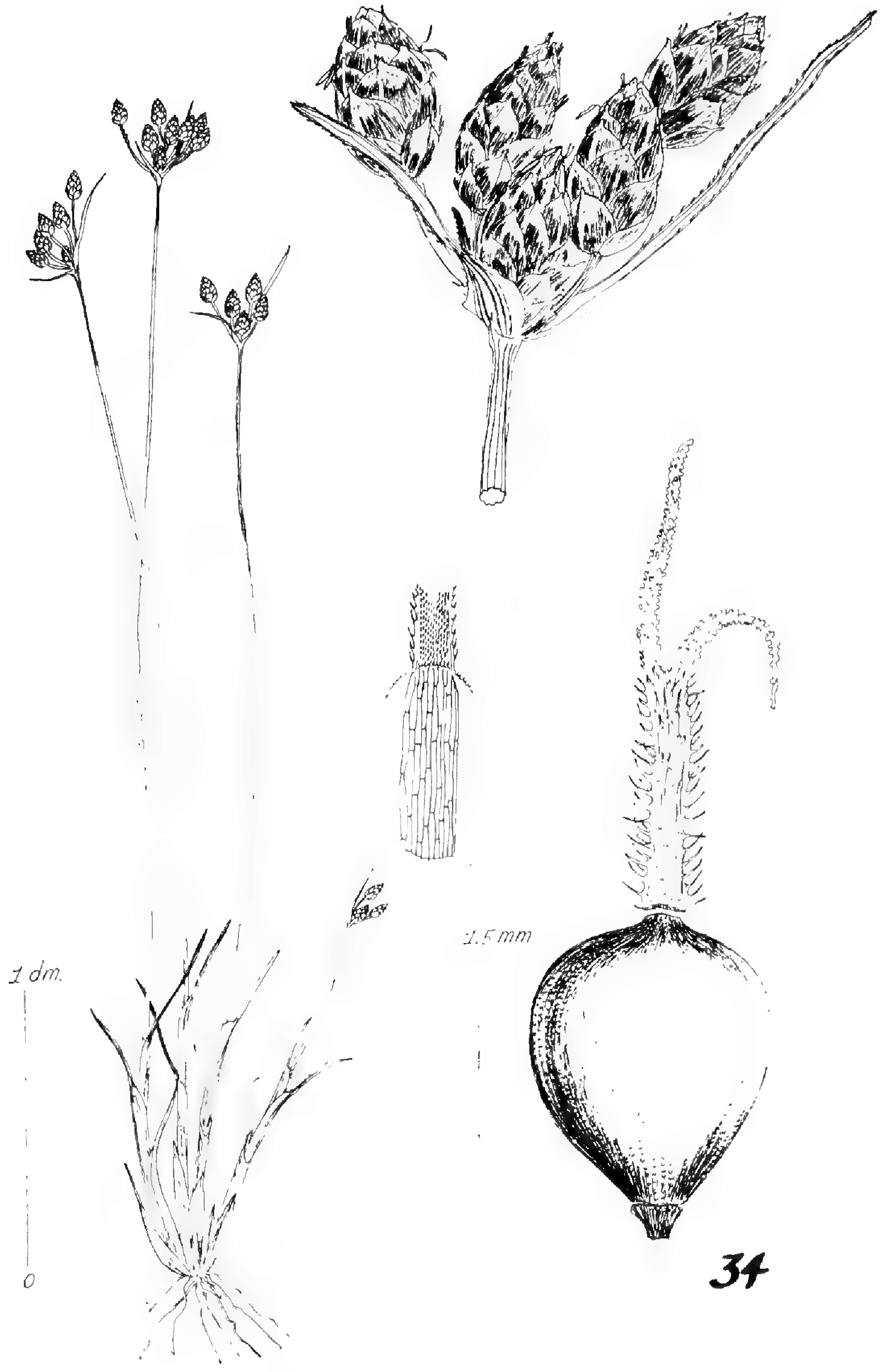


33b

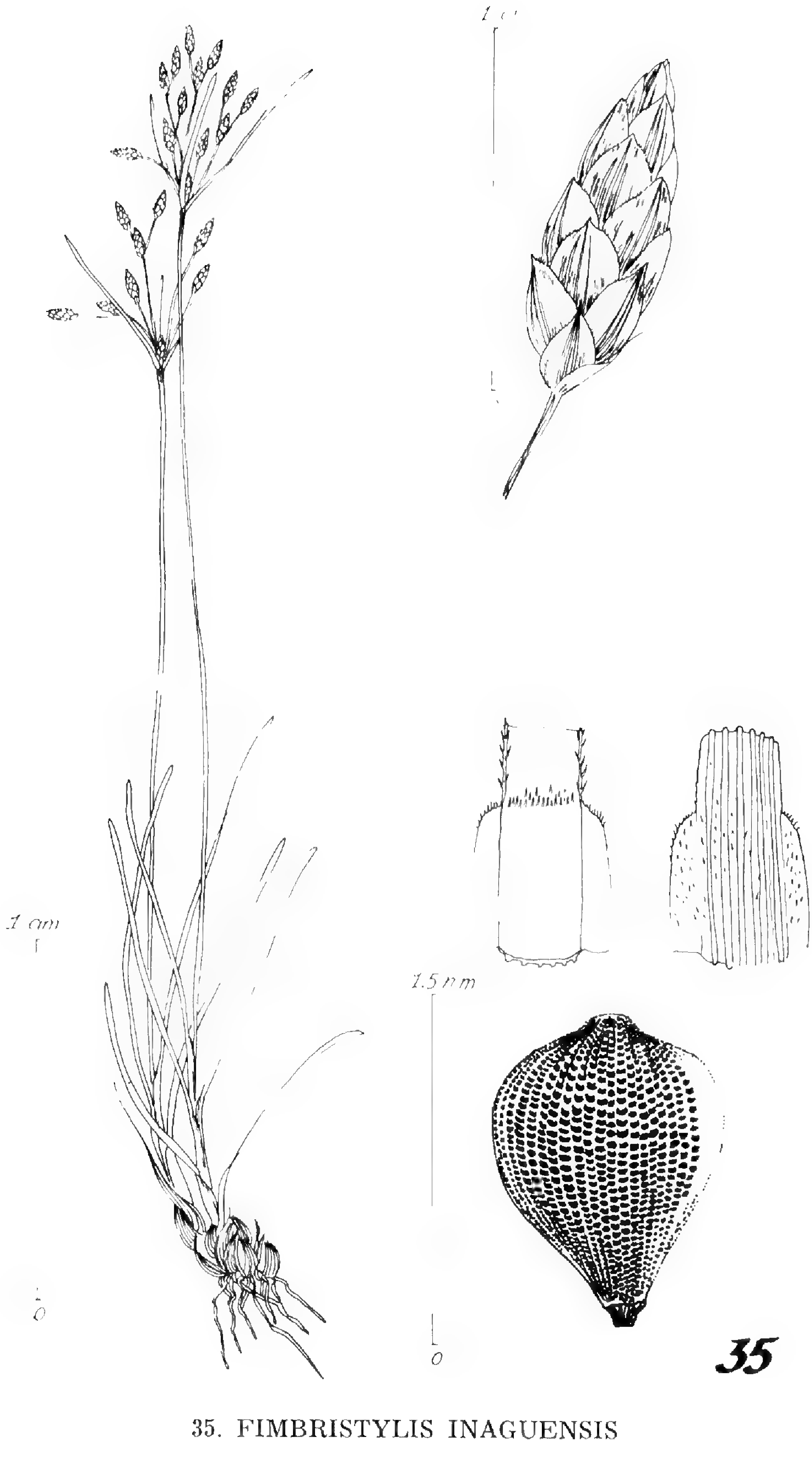
33b. FIMBRISTYLIS POLYTRICHOIDES

33c

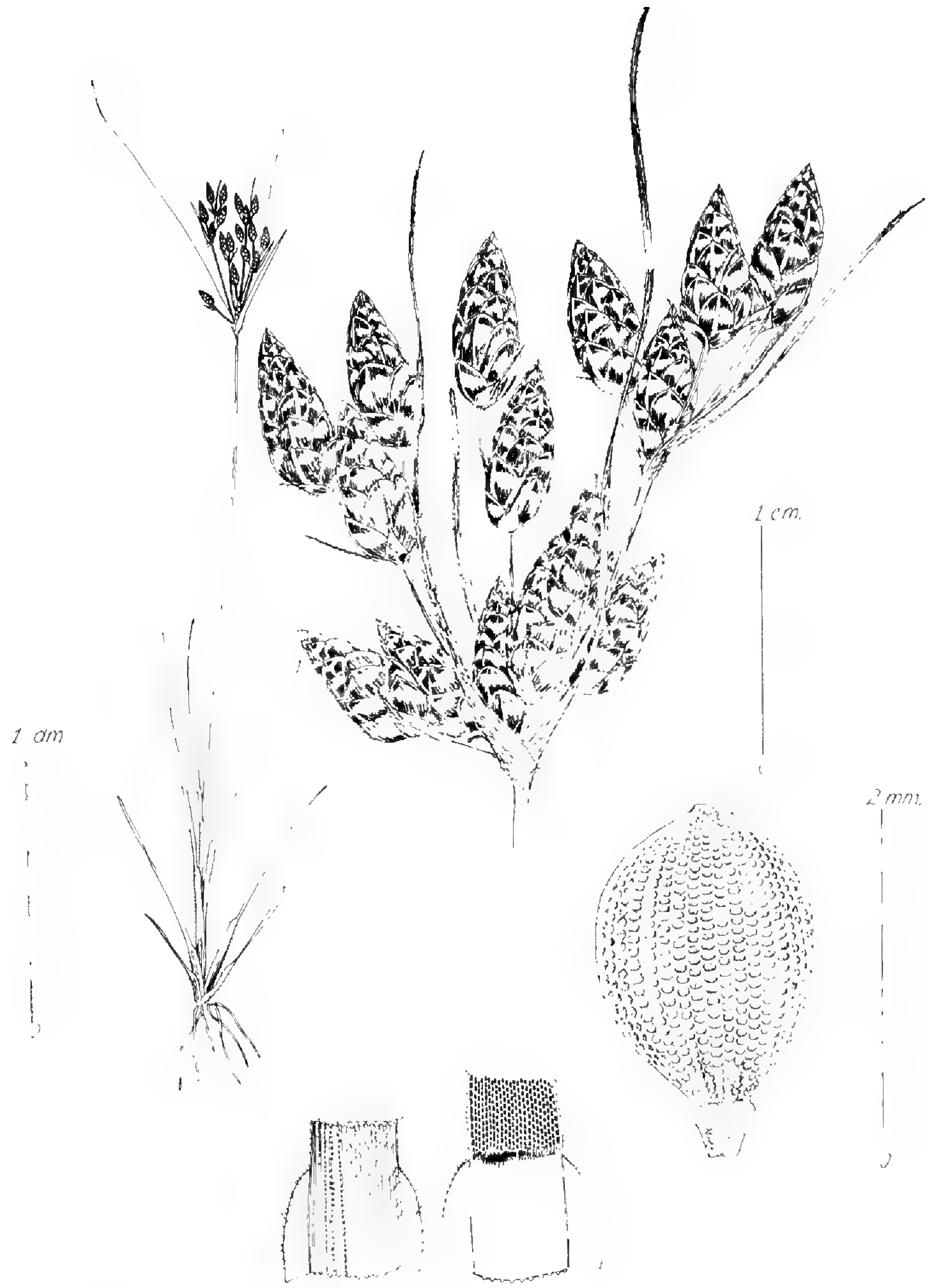
33c. FIMBRISTYLIS TRISTACHYA



34. FIMBRISTYLIS FERRUGINEA

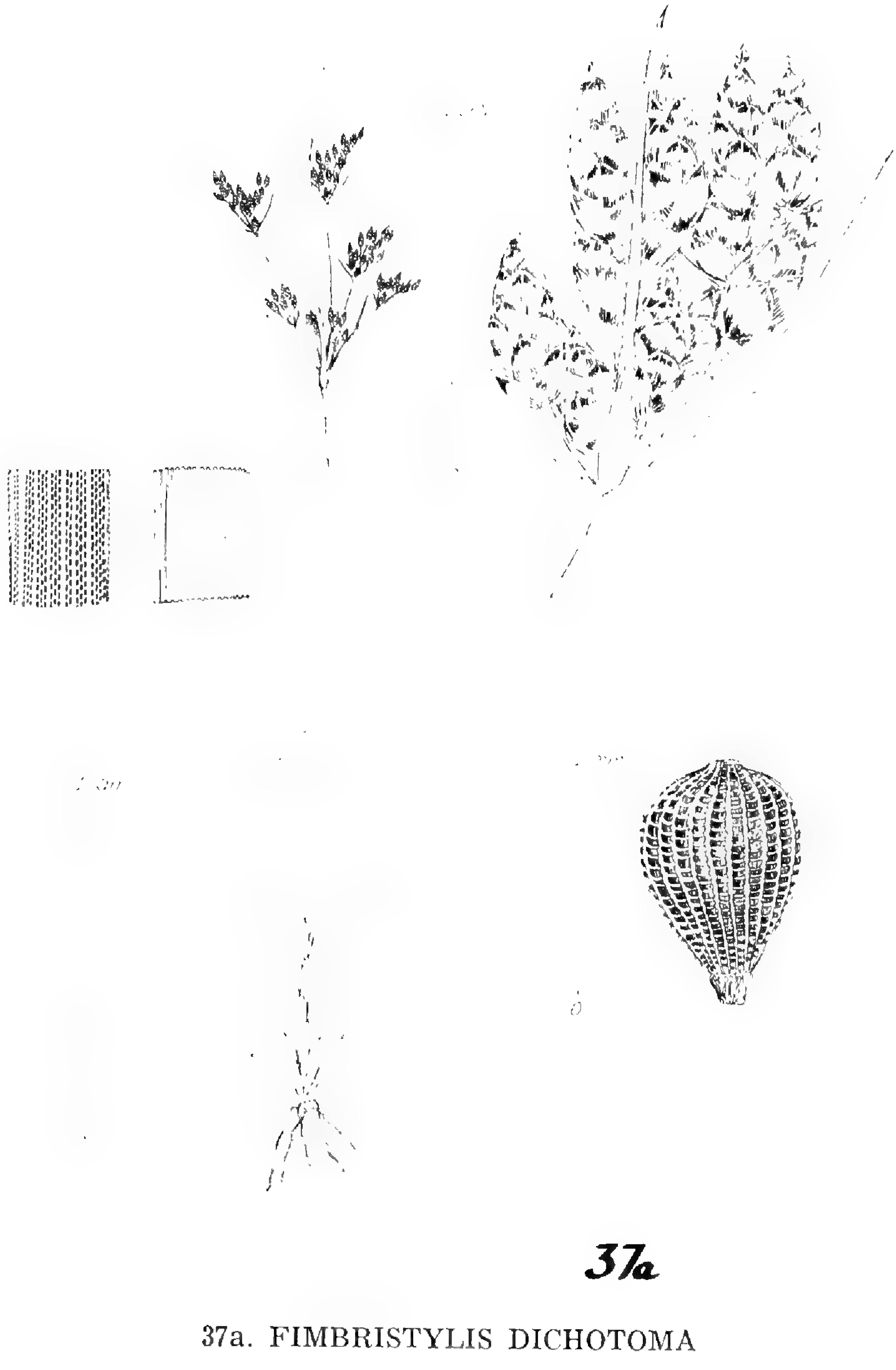


35. FIMBRISTYLIS INAGUENSIS

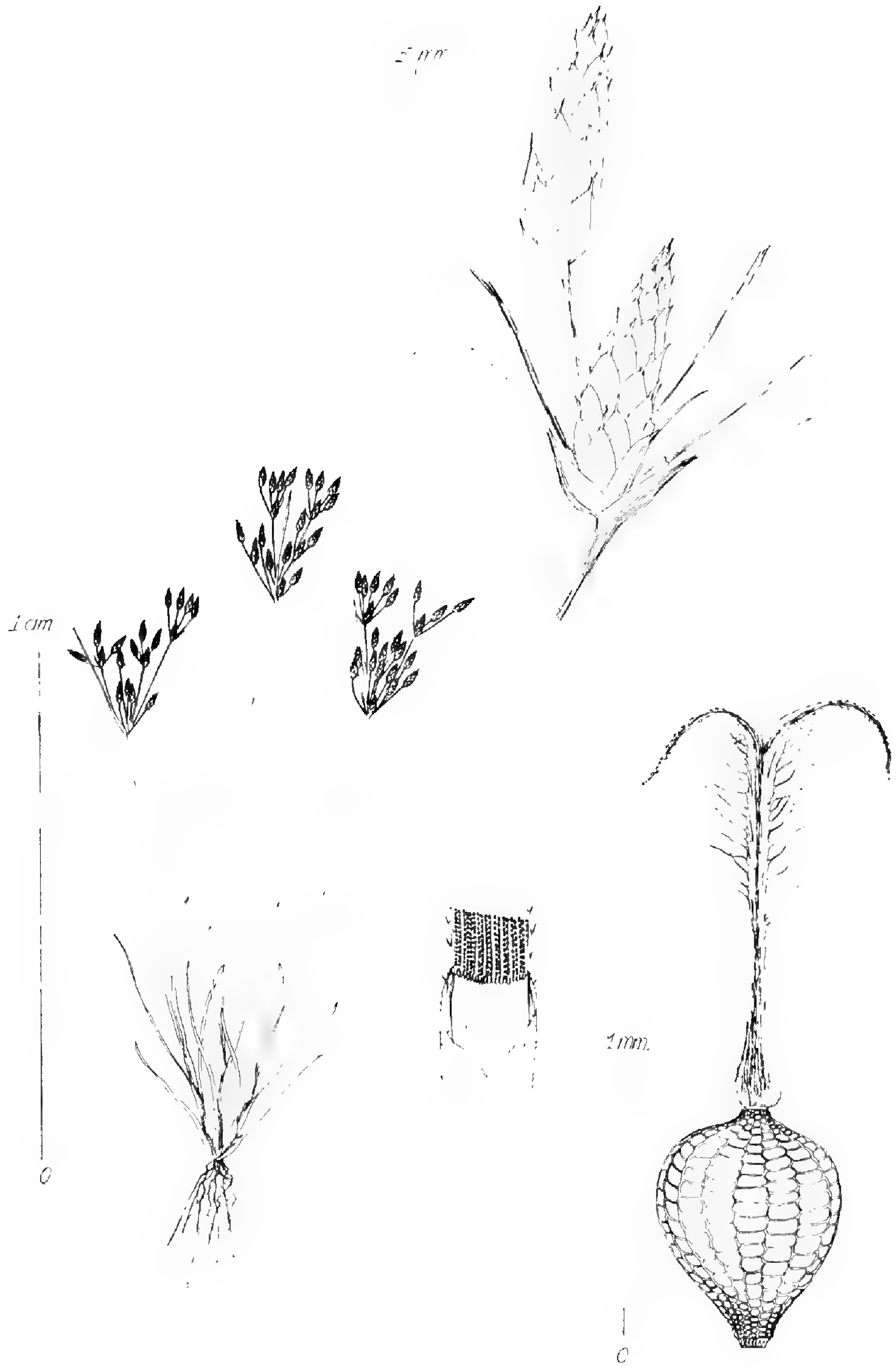


36

36. FIMBRISTYLIS TOMENTOSA



37a. FIMBRISTYLIS DICHOTOMA

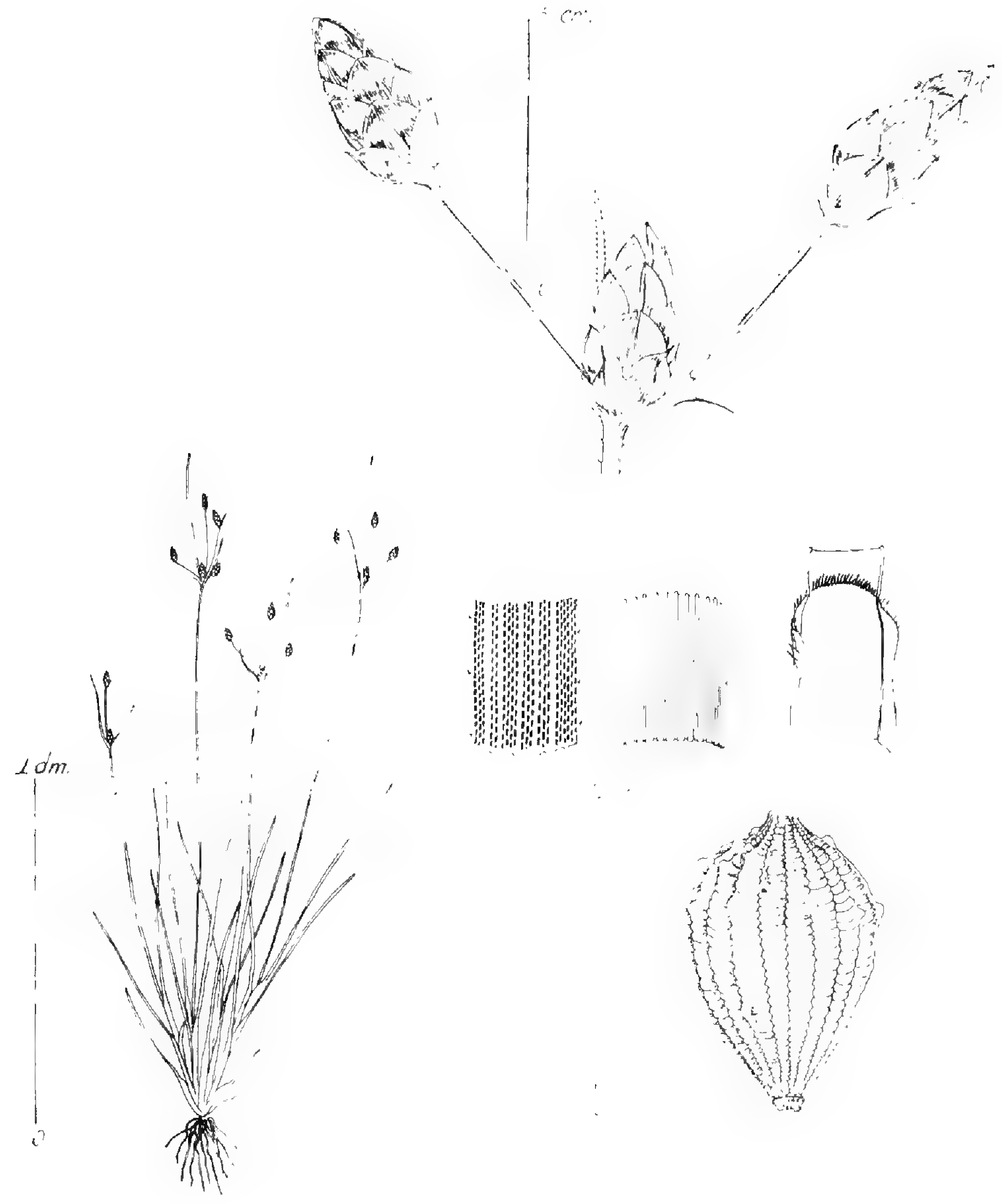


37b

37b. FIMBRISTYLIS BISUMBELLATA

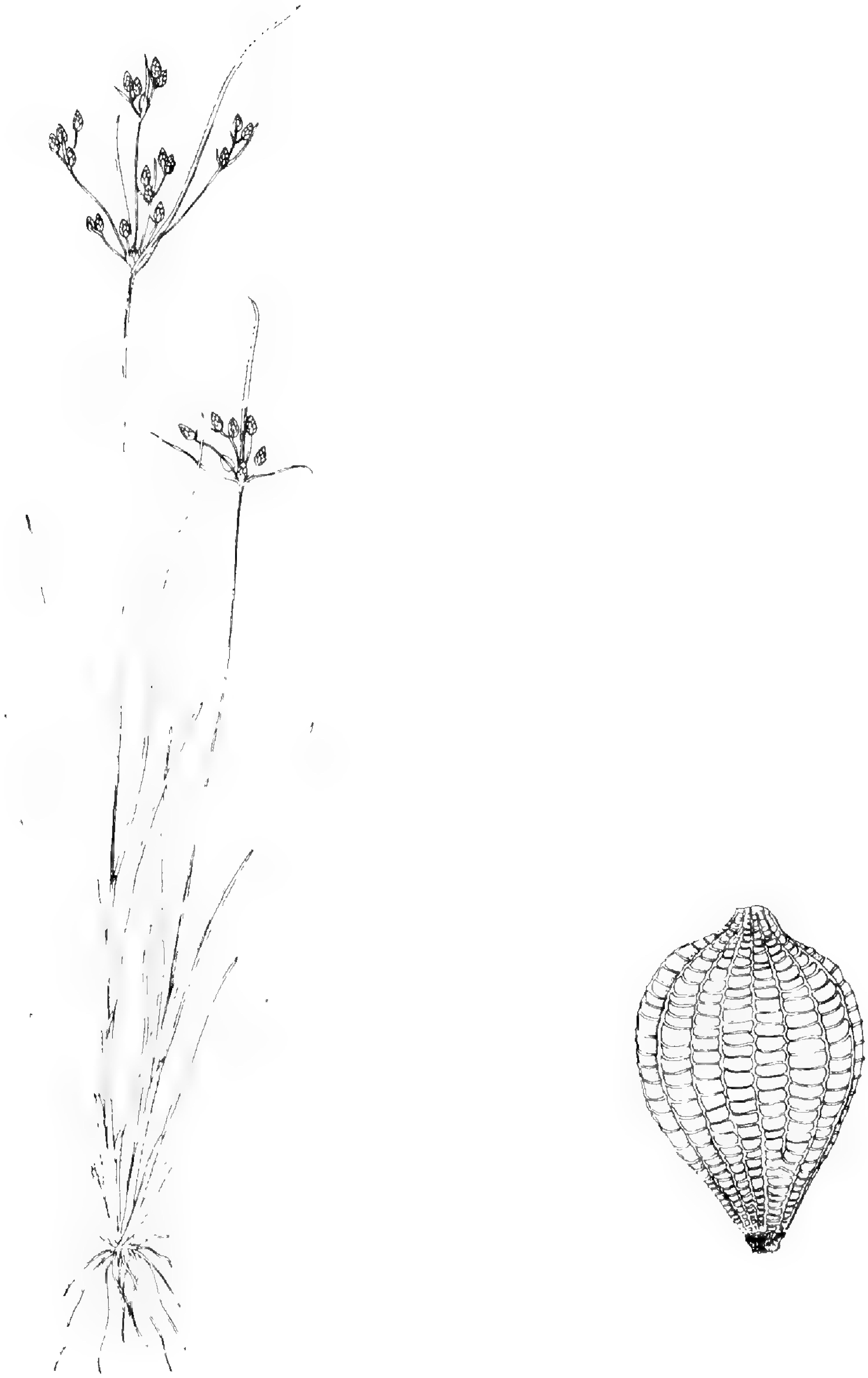
38

38. FIMBRISTYLIS DECIPIENS



39a

39a. FIMBRISTYLIS ANNUA



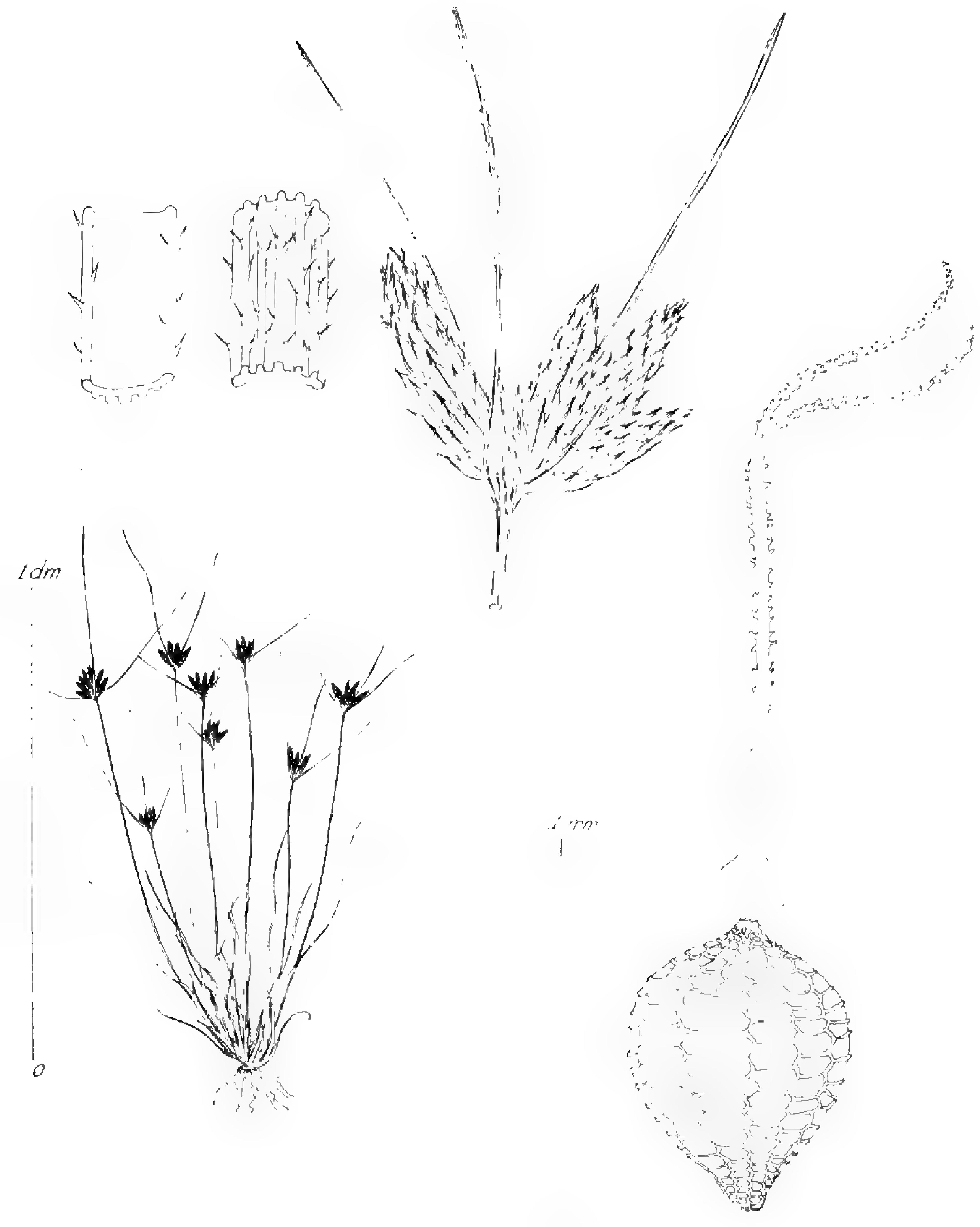
39b

39b. FIMBRISTYLIS ANNUA

40a. FIMBRISTYLIS SQUARROSA

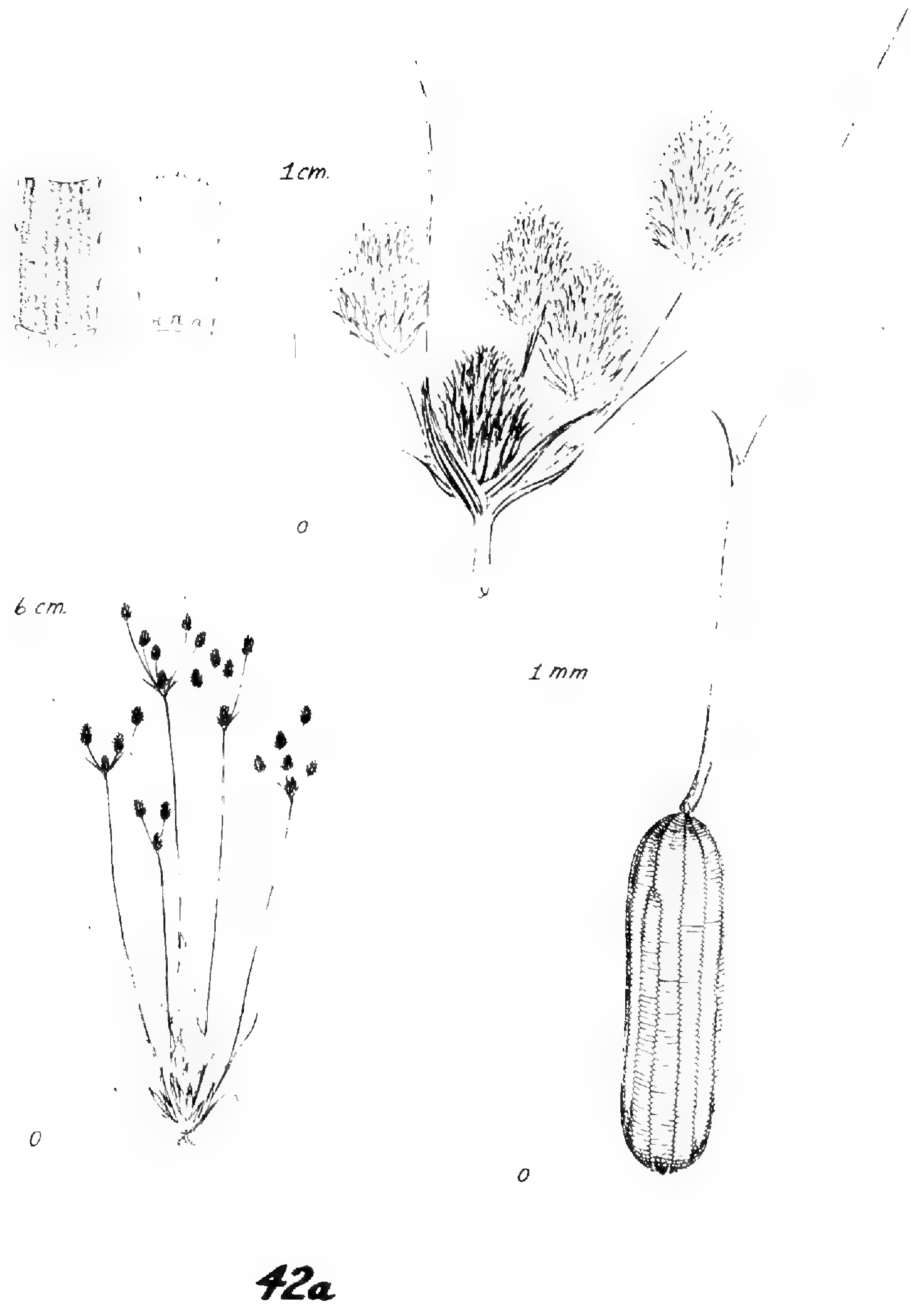
40b

40b. FIMBRISTYLIS AESTIVALIS

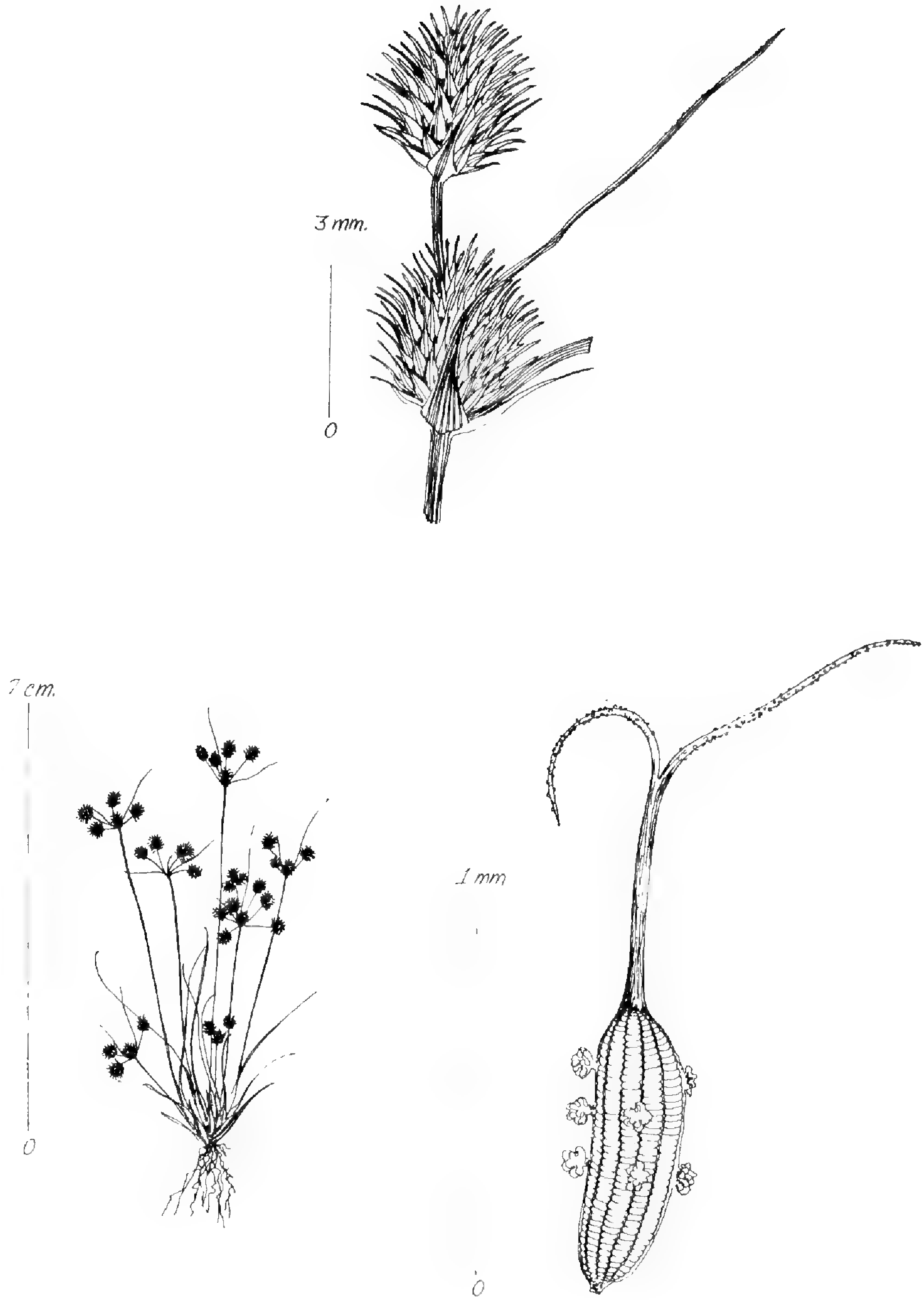


41

41. FIMBRISTYLIS VAHLII



42a. FIMBRISTYLIS PERPUSILLA

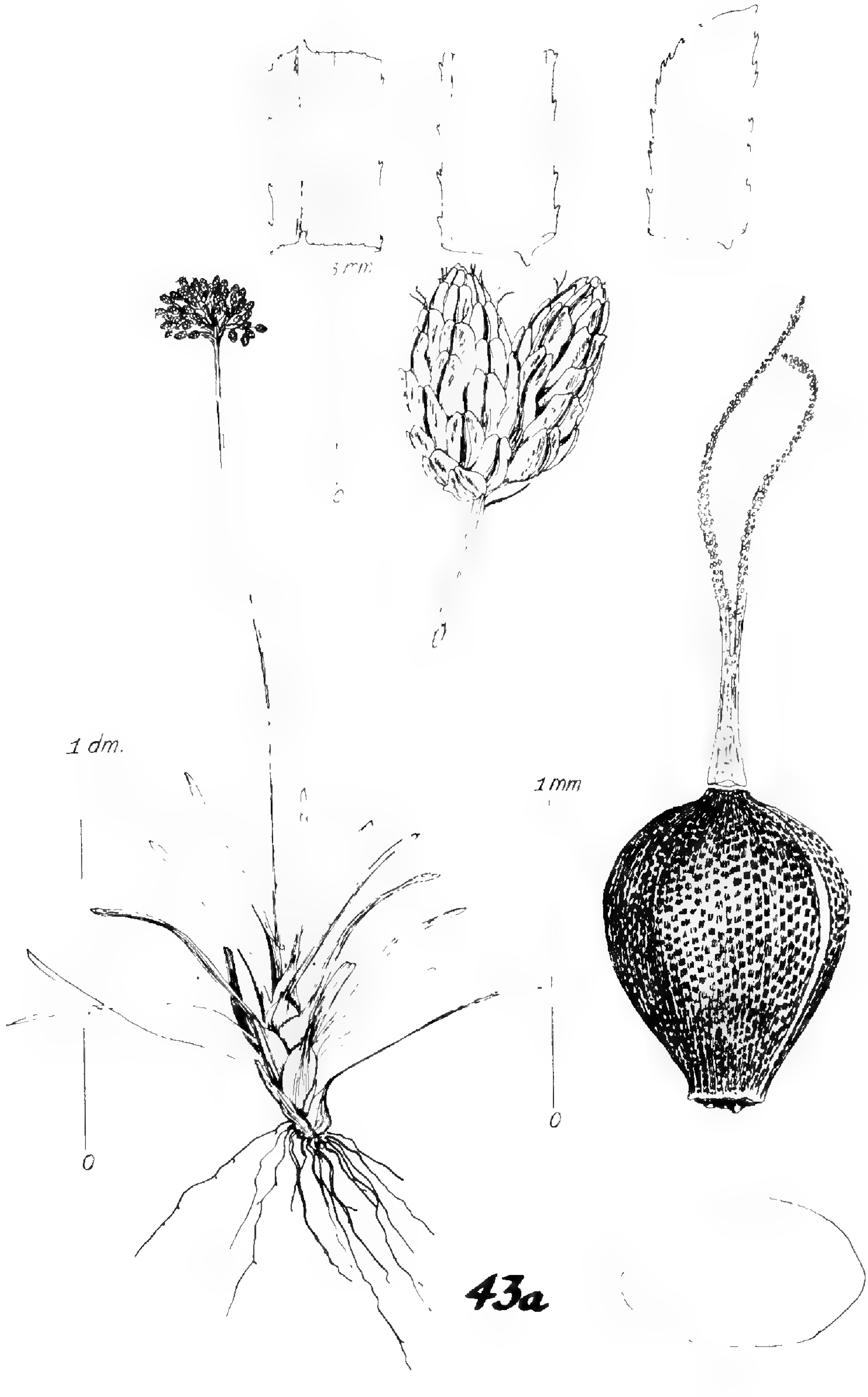


42b

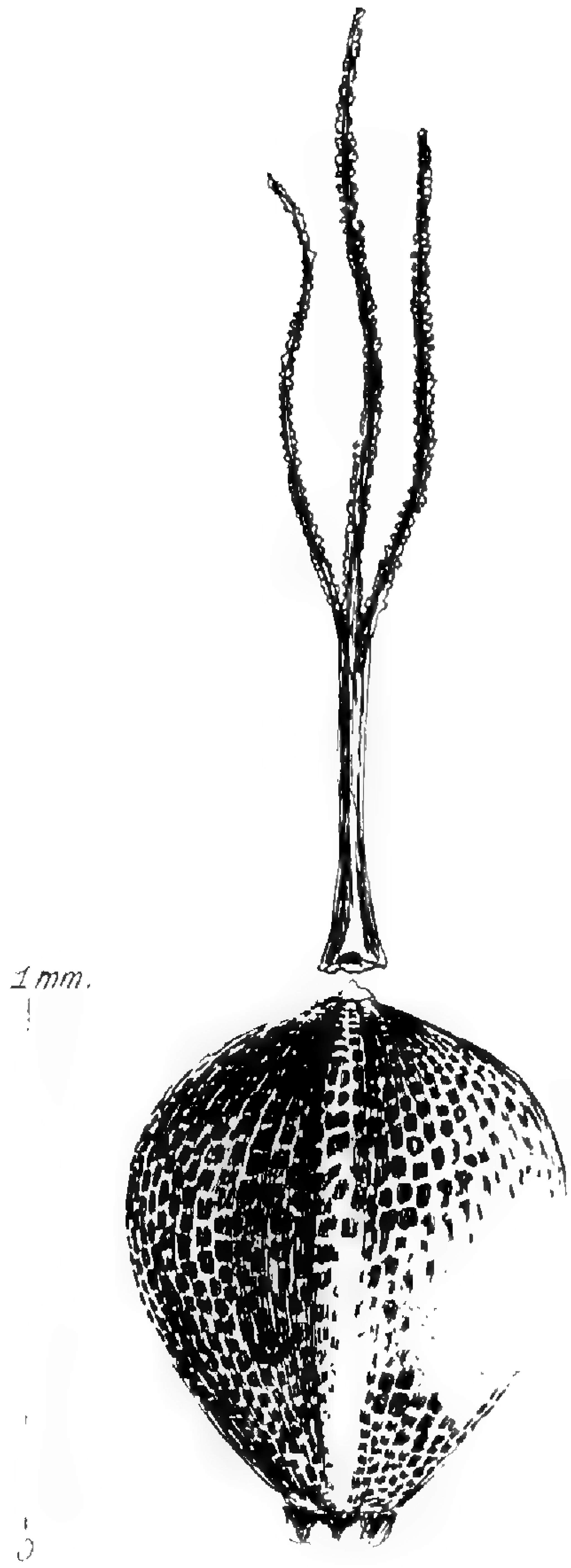
42b. FIMBRISTYLIS DIPSACEA

42c

42c. FIMBRISTYLIS STAUNTONI

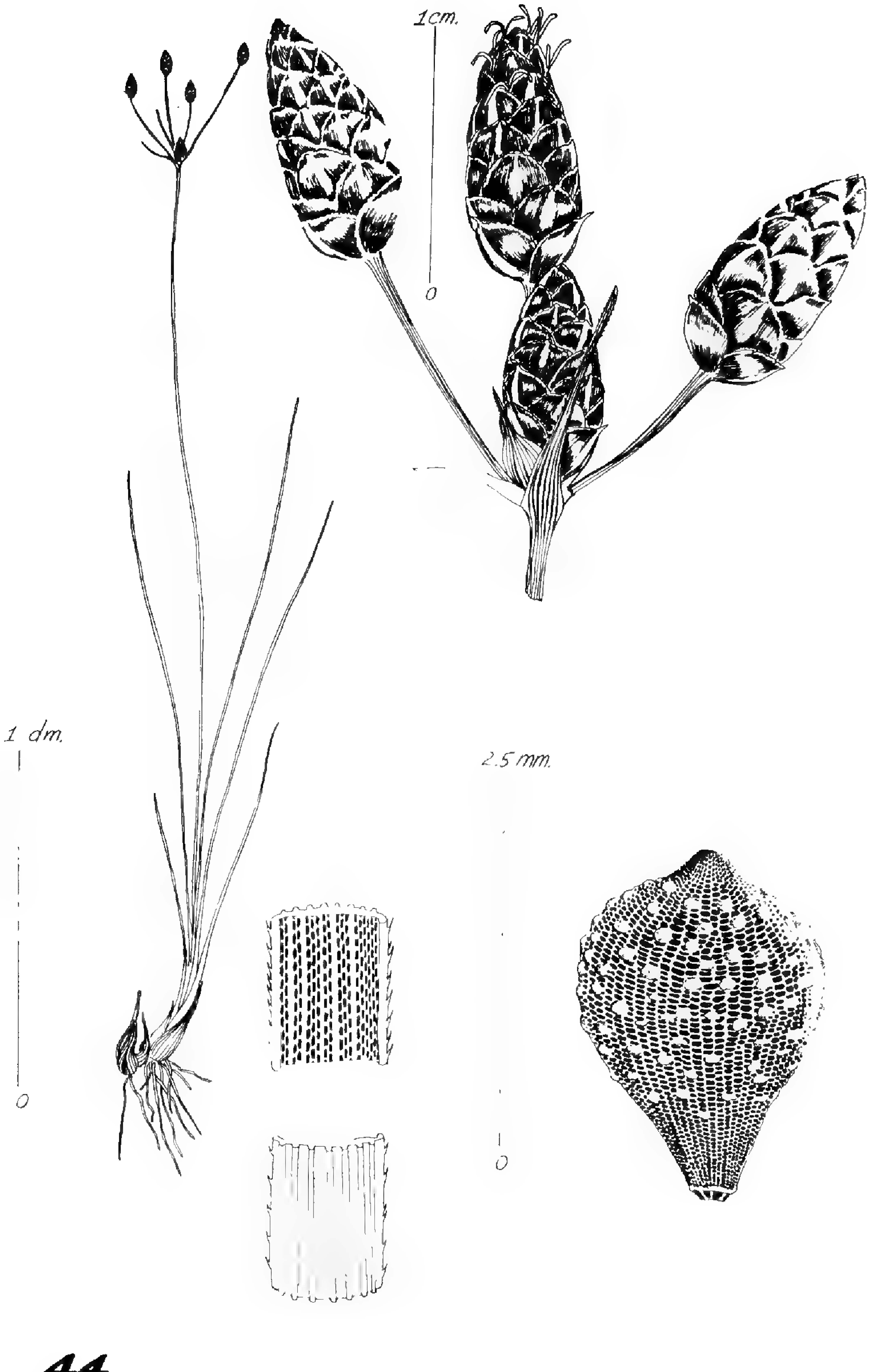


43a. FIMBRISTYLIS SPATHACEA



43b

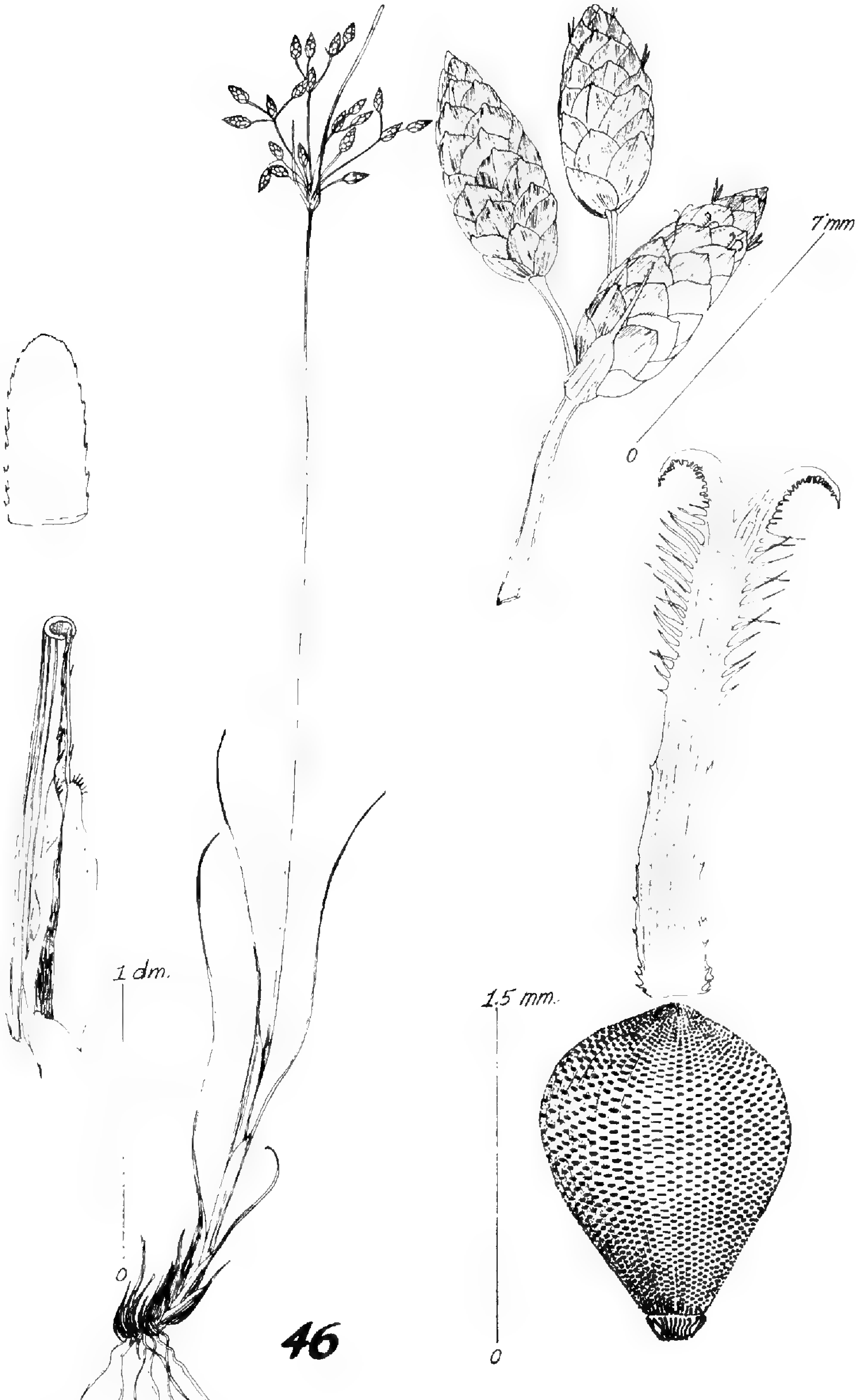
43b. FIMBRISTYLIS CYMOSA



44. FIMBRISTYLIS ARGILLICOLA

45

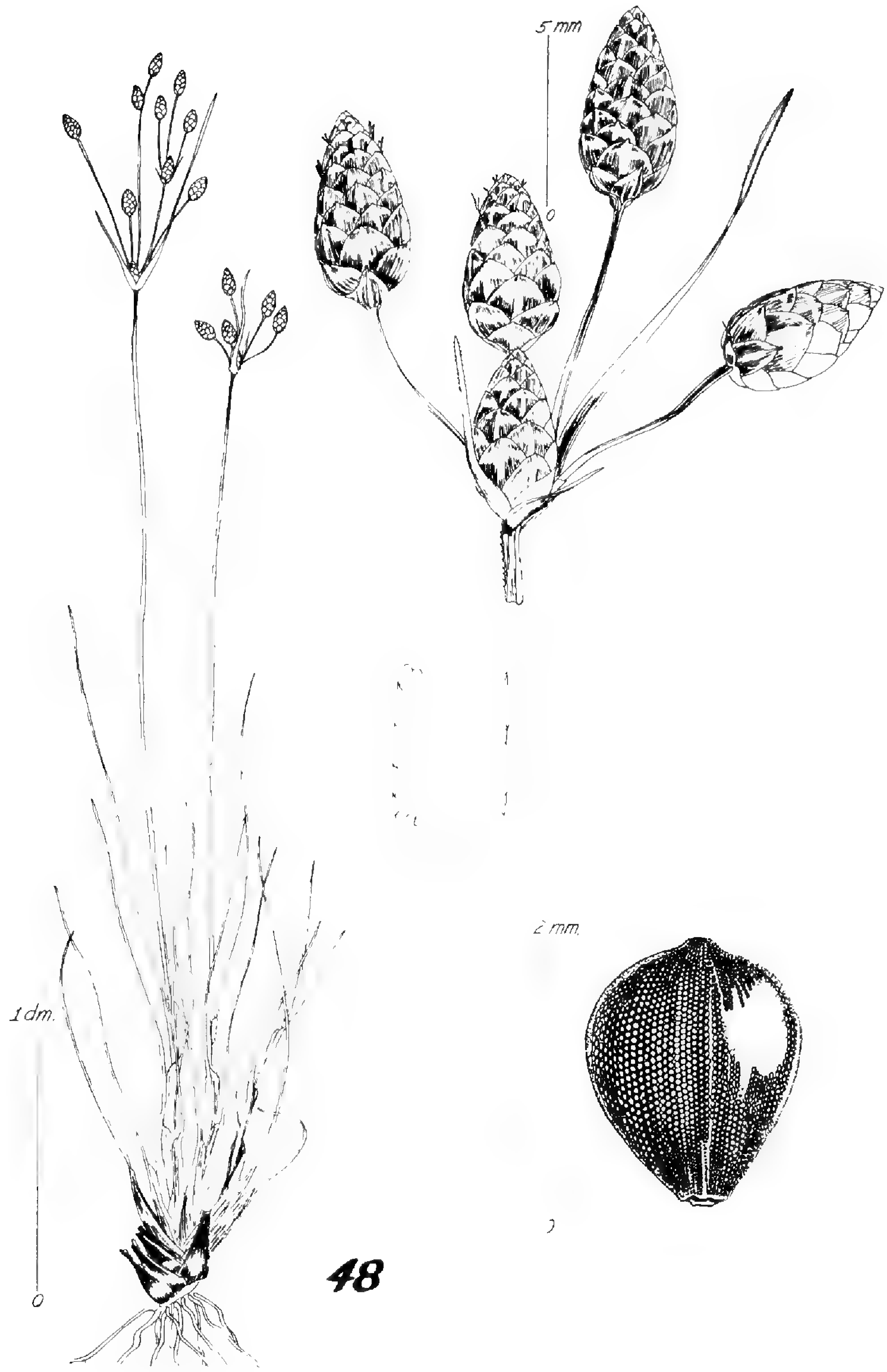
45. FIMBRISTYLIS PENTASTACHYA



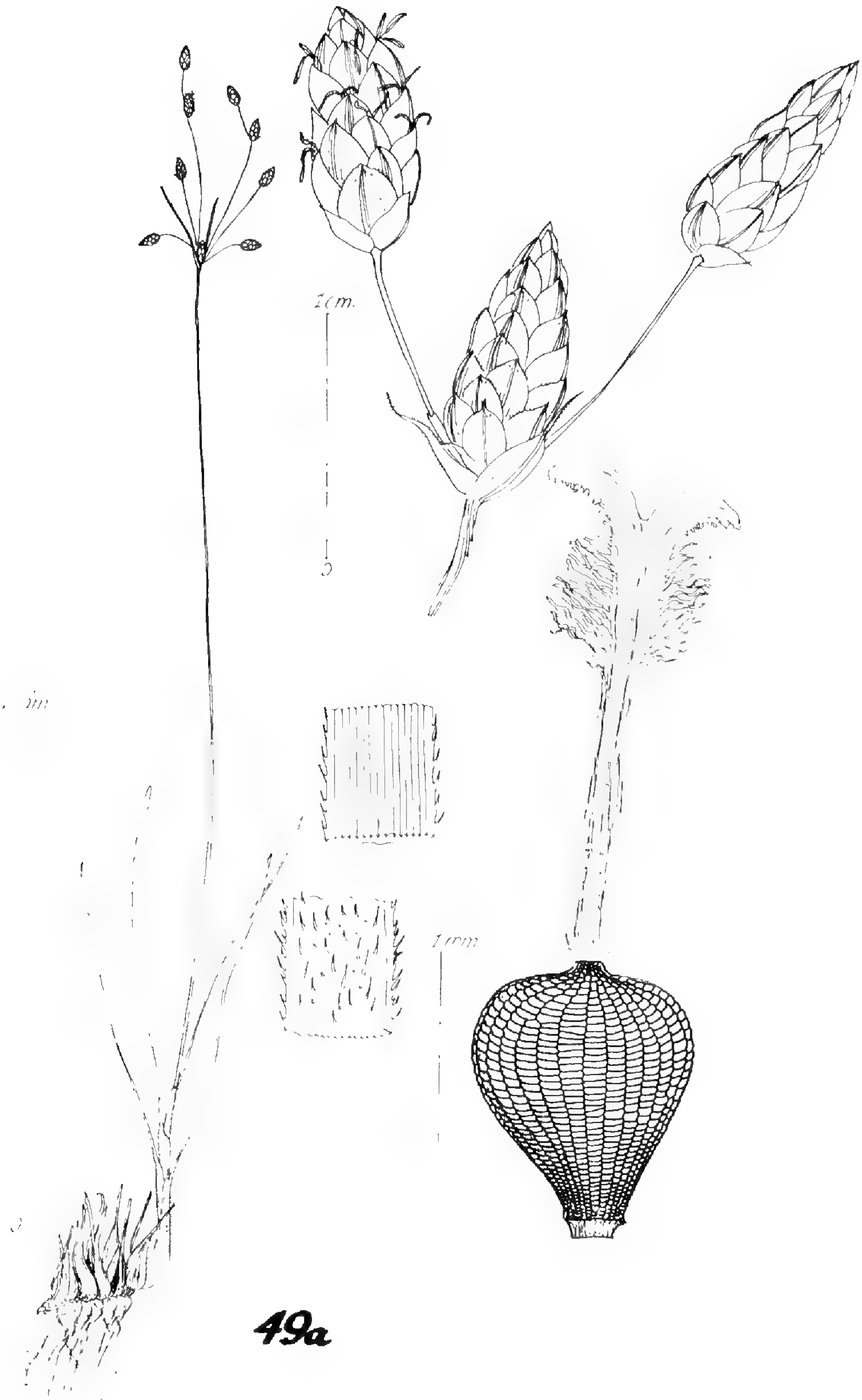
46. FIMBRISTYLIS PALLIDULA

47

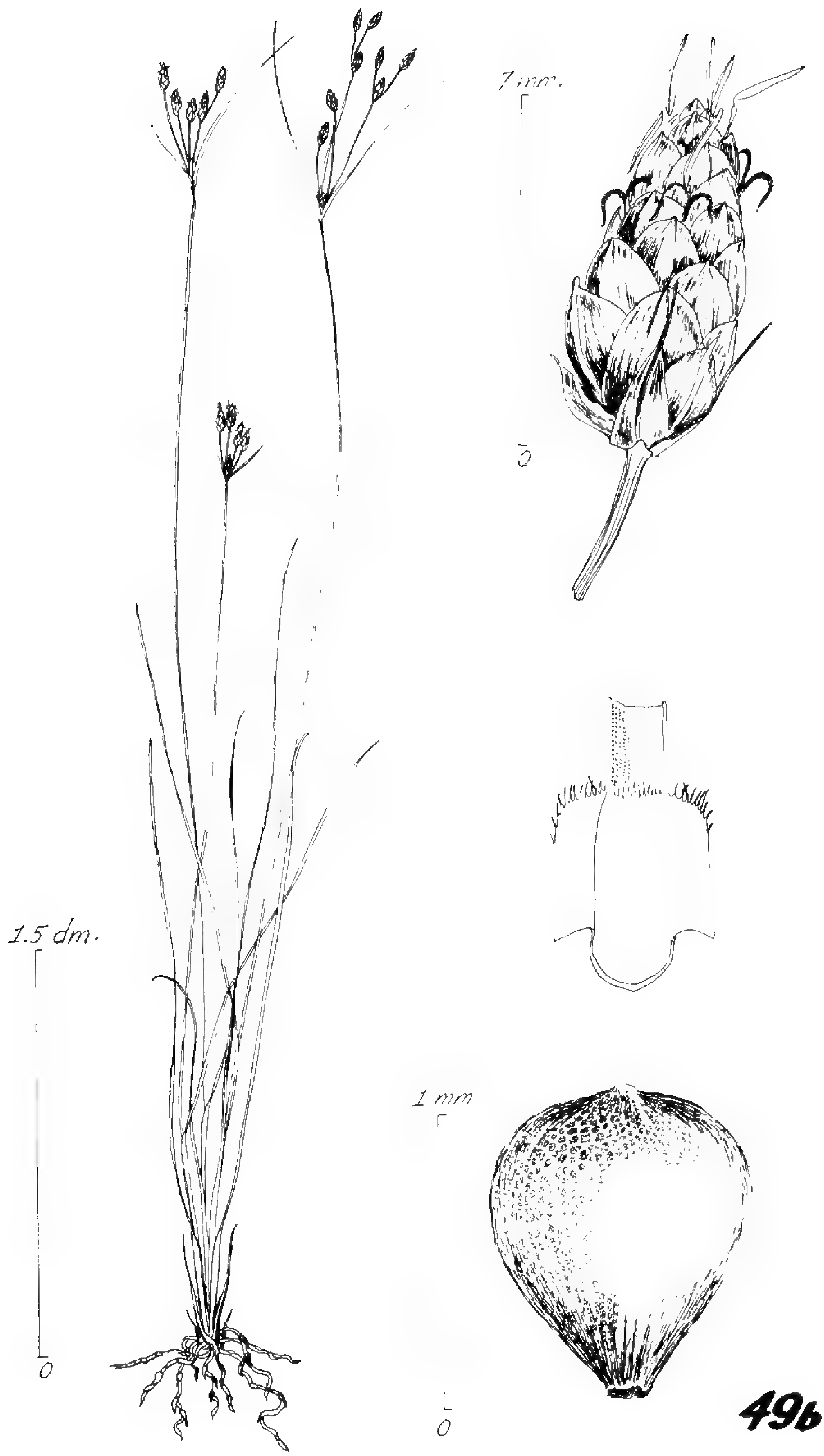
47. FIMBRISTYLIS SPADICEA



48. FIMBRISTYLIS CASTANEA



49a. FIMBRISTYLIS PUBERULA VAR. PUBERULA



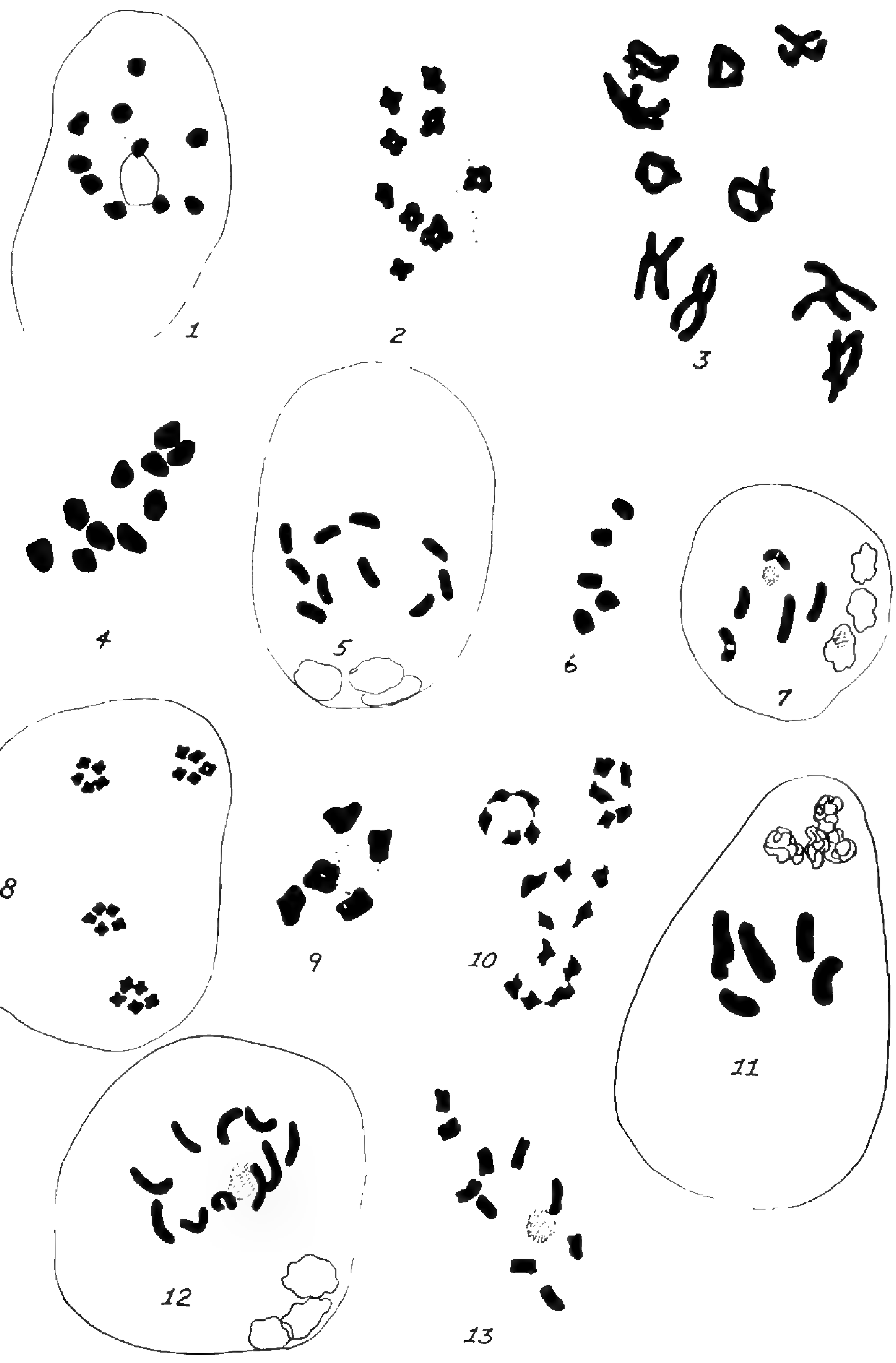
49b. FIMBRISTYLIS PUBERULA VAR. INTERIOR

MICROSPOROGENESIS IN ABILDGAARDIA. 1. *A. ovata* (*Kral 18128*, prophase 1). 2. *A. ovata* (*Kral 27767*, prophase 1). 3. *A. mexicana* (*Kral 27695*, prophase 1). 4. *A. mexicana* (*Kral 27685*, metaphase 1). 5. *A. mexicana* (*Kral 27694*, 3rd division).

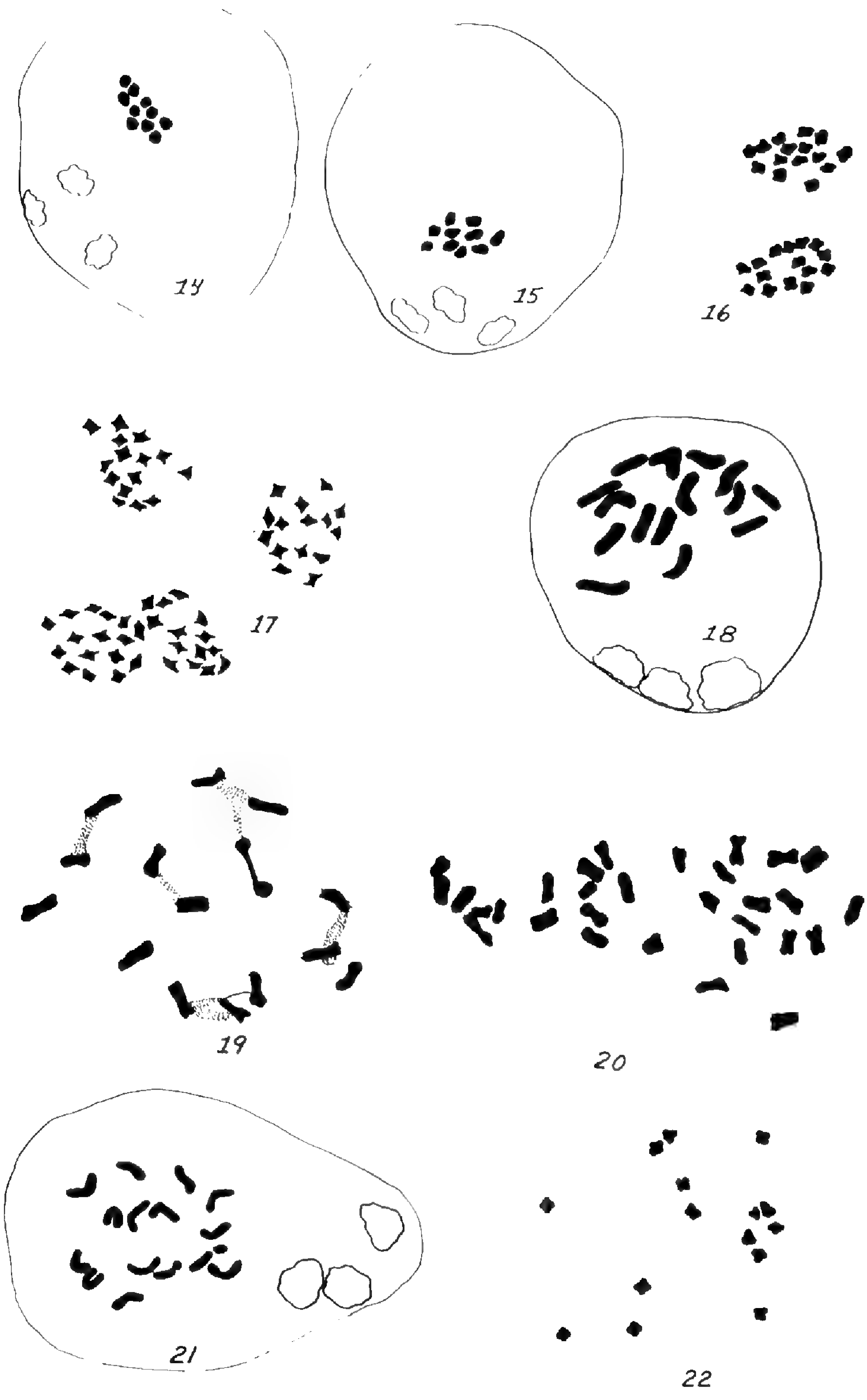
MICROSPOROGENESIS IN BULBOSTYLIS. 6. *B. barbata* (*Kral 28602*, metaphase 1). 7. *B. barbata* (*Kral 28602*, 3rd division). 8. *B. barbata* (*Kral 27155*, end of 2nd division). 9. *B. pubescens* (*Kral 27509*, prophase 1). 10. *B. pubescens* (*Kral 27504*, end of 2nd division). 11. *B. pubescens* (*Kral 27739*, 3rd division). 12. *B. pubescens* (*Kral 27738*, 3rd division). 13. *B. pubescens* (*Kral 27738*, prophase 1). 14. *B. funckii* (*Kral 27643*, 3rd division). 15. *B. funckii* (*Kral 27643*, 3rd division). 16. *B. hirta* (*Kral 27553*, prophase 2). 17. *B. hirta* (*Kral 27540*, end of 2nd division). 18. *B. hirta* (*Kral 27553*, 3rd division). 19. *B. warei* (*Kral 27335*, prophase 1). 20. *B. warei* (*Kral 28751*, prophase 1). 21. *B. warei* (*Kral 22378*, 3rd division). 22. *B. stenophylla* (*Kral 23039*, prophase 1).

23. *B. stenophylla* (*Kral 23039*, 3rd division). 24. *B. trilobata* (*Kral 25329*, 3rd division). 25. *B. trilobata* (*Kral 27733*, 3rd division). 26. *B. vestita* (*Kral 27783*, prophase 1). 27. *B. junciformis* (*Kral 27778*, 3rd division). 28. *B. junciformis* (*Kral 27796*, prophase 1). 29. *B. ciliatifolia* var. *coarctata* (*Kral 27187*, prophase 1). 30. *B. juncoides* (*Kral 27696*, prophase 1).

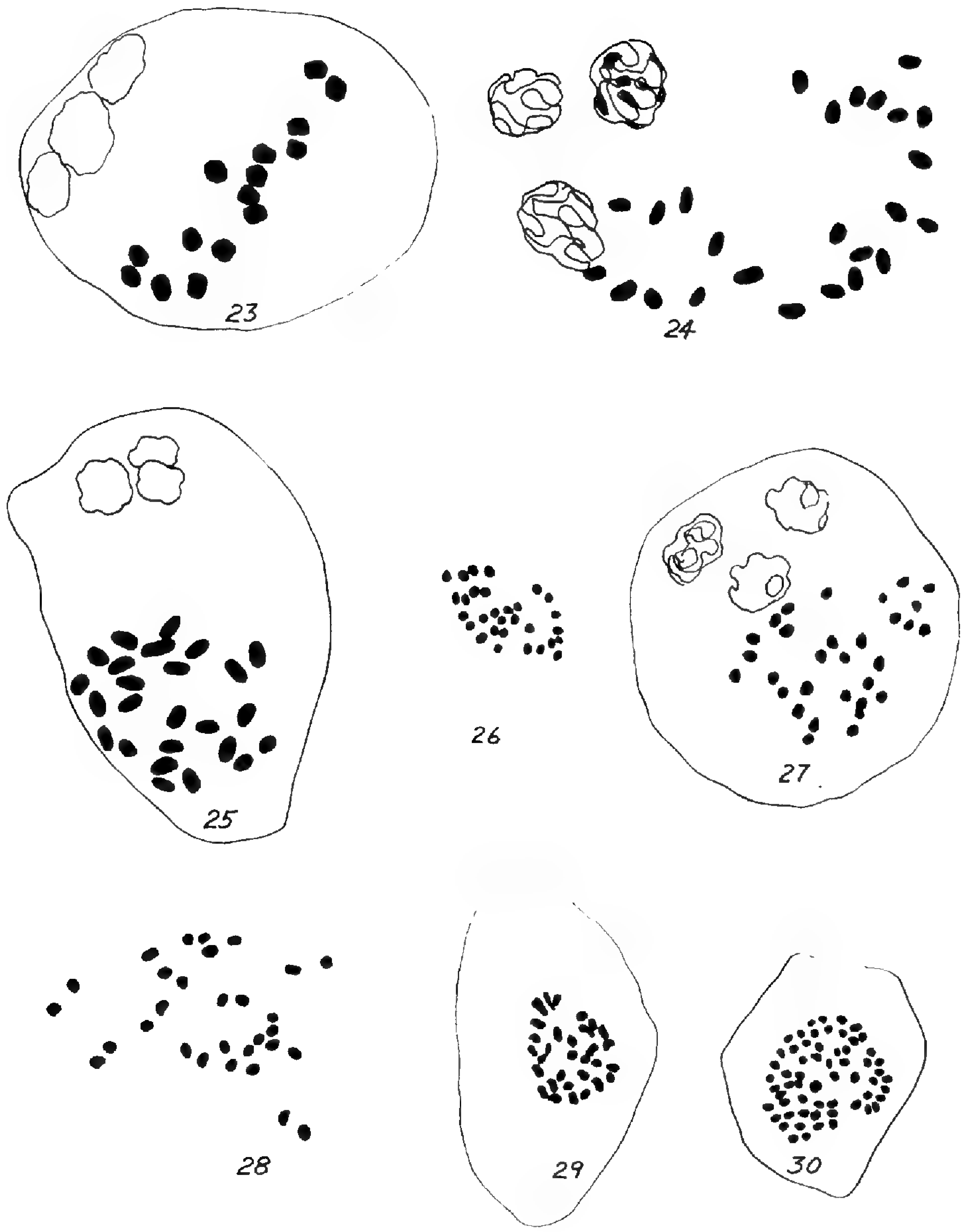
MICROSPOROGENESIS IN FIMBRISTYLIS. 31, *F. complanata* (*Kral 25456*, prophase 1). 32. *F. complanata* (*Kral 25456*, prophase 1). 33. *F. complanata* (*Kral 27561*, 3rd division). 34. *F. complanata* (*Kral 27587*, end of 3rd division). 35. *F. autumnalis* (*Kral 20798*, end of 2nd division). 36. *F. autumnalis* (*Kral 27068*, 3rd division). 37. *F. miliacea* (*Kral 19320*, end of 2nd division). 38. *F. miliacea* (*Kral 19380*, 3rd division). 39. *F. schoenoides* (*Kral 23142*, end of 2nd division and 3rd division). 40. *F. schoenoides* (*Kral 23142*, end of 3rd division). 41. *F. schoenoides* (*Kral 18616*, 3rd division). 42. *F. tomentosa* (*Kral 20692*, prophase 1). 43. *F. perpusilla* (from *Godfrey* collection, Seminole Co., Georgia). 44. *F. vahlii* (*Kral 15910*, 3 nuclei from end of 2nd division). 45. *F. vahlii* (*Kral 23228*, prophase 1). 46. *F. vahlii* (*Kral 29018*, 3rd division). 47. *F. decipiens* (*Kral 27852*, prophase 1). 48. *F. decipiens* (*Kral 27846*, 3rd division). 49. *F. decipiens* (*Kral 27846*, late 3rd division). 50. *F. dichotoma* (*Kral 27785*, prophase 1). 51. *F. dichotoma* (*Kral 18594*, 2nd division). 52. *F. dichotoma* (*Kral 27832*, 3rd division). 53. *F. dichotoma* (*Kral 27854*, 3rd division). 54. *F. dichotoma* (*Kral 20801*, prophase 1). 55. *F. spadicea* (*Kral 27805*, 3rd division). 56. *F. spadicea* (*Kral 24993*, 3rd division). 57. *F. thermalis* (*Kral 25771*, 3rd division). 58. *F. thermalis* (*Kral 21591*, prophase 1). 59. *F. thermalis* (*Kral 21591*, metaphase 1). 60. *F. thermalis* (*Kral 21784*, metaphase 2). 61. *F. thermalis* (*Kral 21591*, 3rd division). 62. *F. castanea* (*Kral 22470*, prophase 1). 63. *F. castanea* (*Kral 22415*, metaphase 2). 64. *F. castanea* (*Kral 22559*, prophase 1, and 3rd division). 65. *F. pallidula* (*Kral 27501*, prophase 1). 66. *F. pallidula* (*Kral 27724*, prophase 1). 67. *F. pallidula* (*Kral 27495*, 3rd division). 68. *F. argillicola* (*Kral 27447*, metaphase 2). 69. *F. argillicola* (*Kral



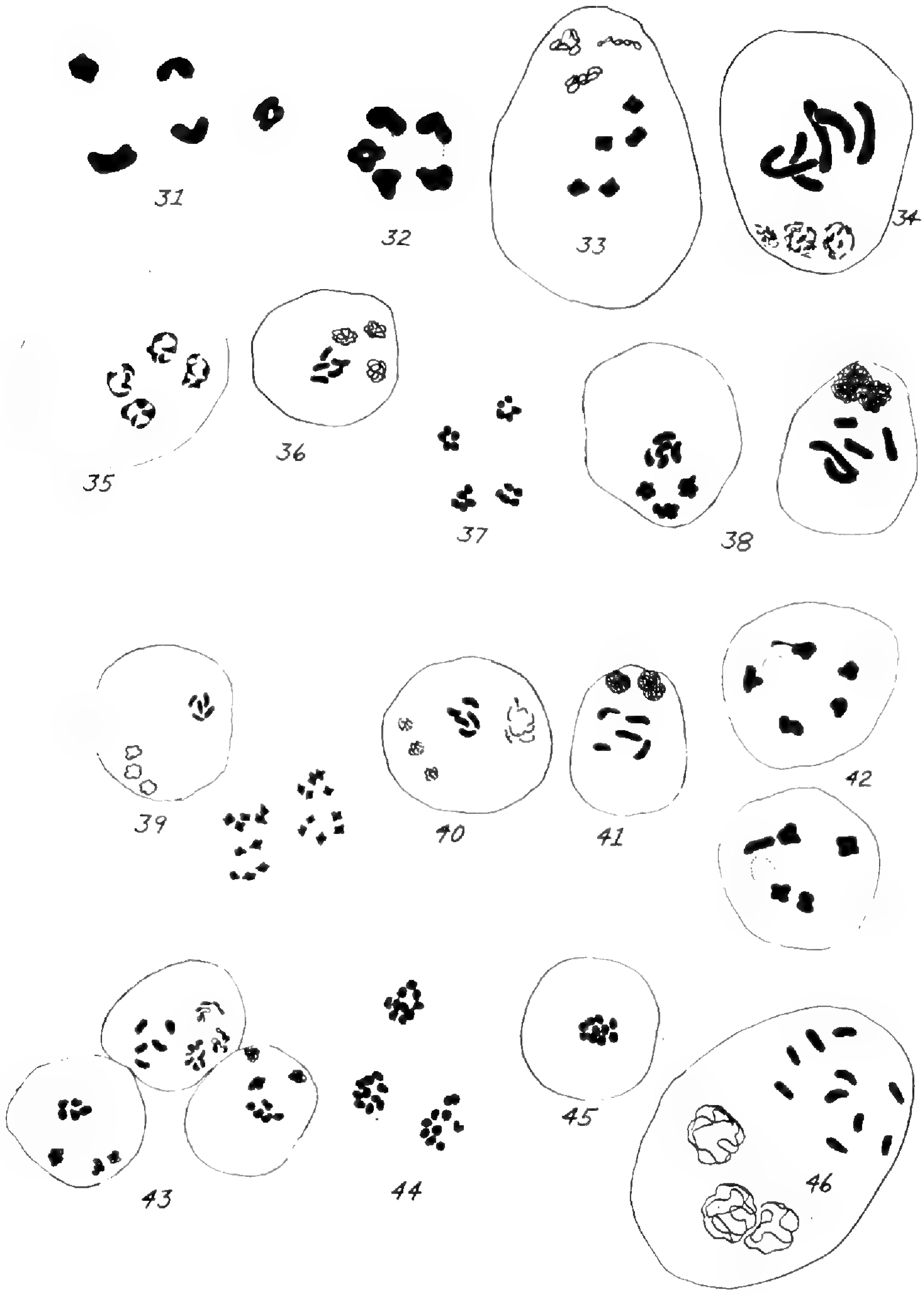
27631, 3rd division). 70. *F. puberula* var. *puberula* (*Kral 27471*, 3rd division). 71. *F. puberula* var. *puberula* (*Kral 18329*, prophase 1). 72. *F. puberula* var. *puberula* (*Kral 22089*, end of 2nd division). 73. *F. puberula* var. *puberula* (*Kral 27107*, 3rd division). 74. *F. puberula* var. *interior* (*Kral 28963*, metaphase 1). 75. *F. puberula* var. *interior* (*Kral 28927*, 3rd division). 76. *F. annua* (*Kral 27616*, prophase 1). 77. *F. annua* (*Kral 22601*, prophase 1). 78. *F. annua* (*Kral 22382*, 2nd division). 79. *F. caroliniana* x *F. puberula*? (*Kral 22920*, 3rd division). 80. *F. caroliniana* x *F. puberula*? (*Kral 22963*, 3rd division). 81. *F. caroliniana* x *F. puberula*? (*Kral 22861*, 3rd division). 82. *F. caroliniana* (*Kral



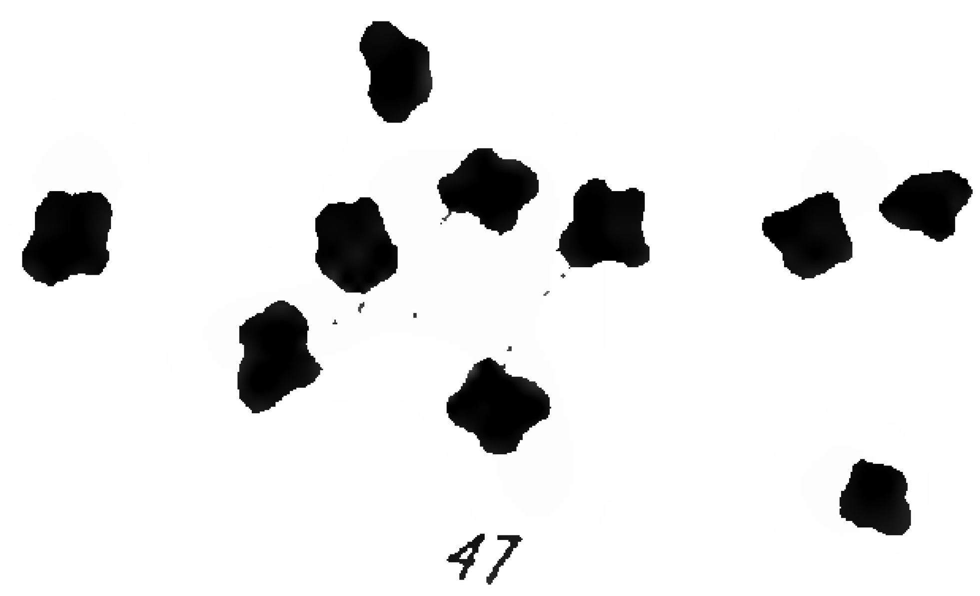
20490, prophase 1). 83. *F. caroliniana* (*Kral 22909*, 3rd division). 84. *F. caroliniana* (*Kral 27809*, 3rd division). 85. *F. caroliniana* (*Kral 27806*, 3rd division). 86. *F. caroliniana* (*Kral 22957*, late prophase 1). 87. *F. caroliniana* (*Kral 23214*, 3rd division). 88. *F. caroliniana* (*Kral 22469*, 3rd division). 89. *F. caroliniana* (*Kral 22868*, 3rd division). 90. *F. spathacea* (from specimens grown



from seed collected in Martin Co., Florida in the winter of 1963; 3rd division). 91. *F. tomentosa* (*Kral 18937*, prophase 1). 92. *F. tomentosa* (*Kral 27853*, 3rd division).

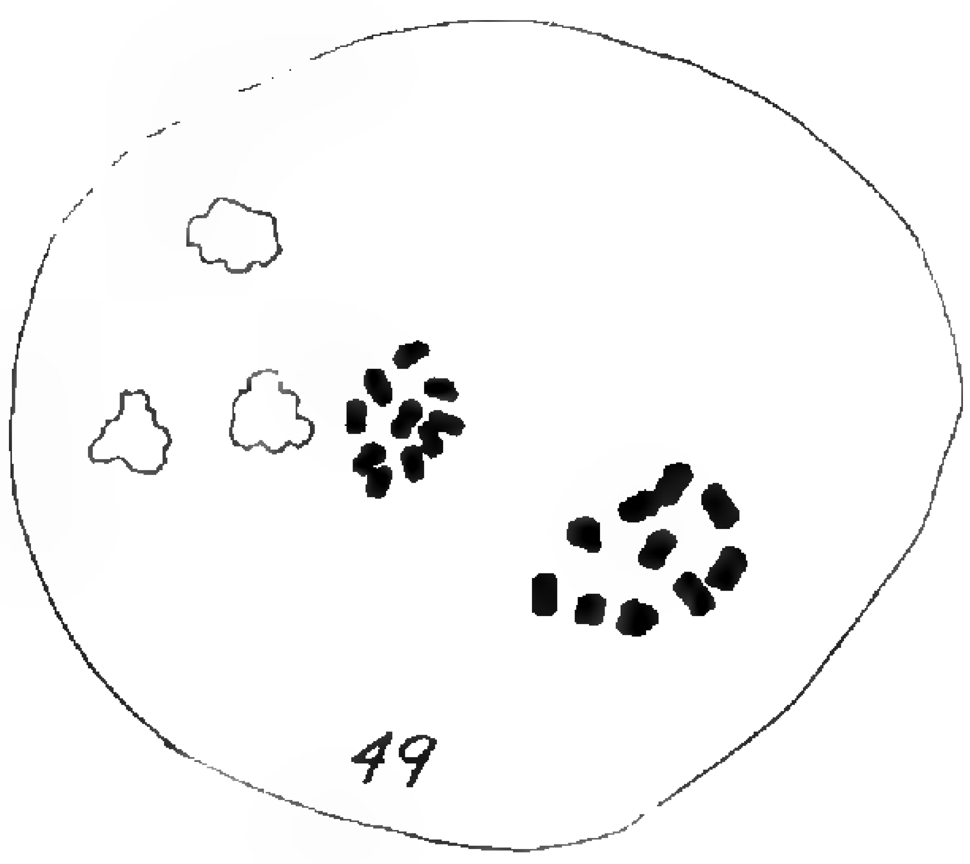


(Captions on pages 198-201.)



47

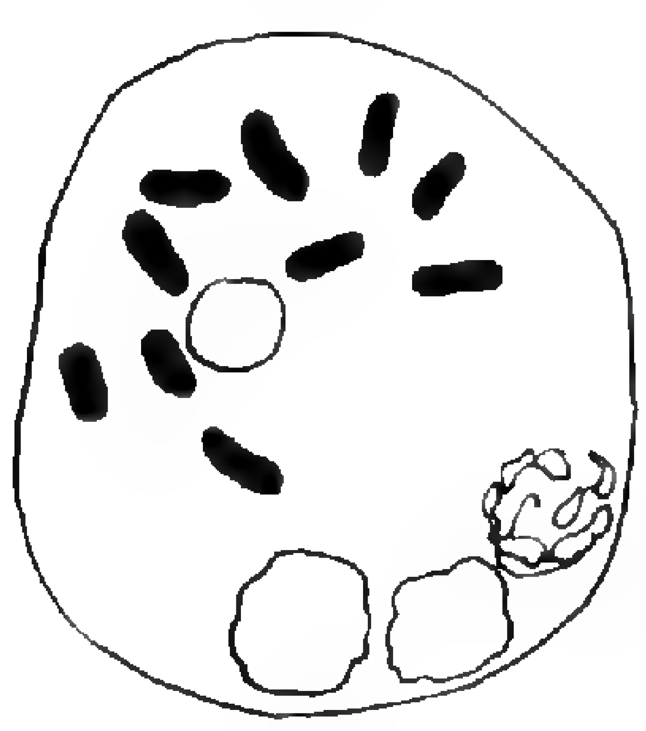
48



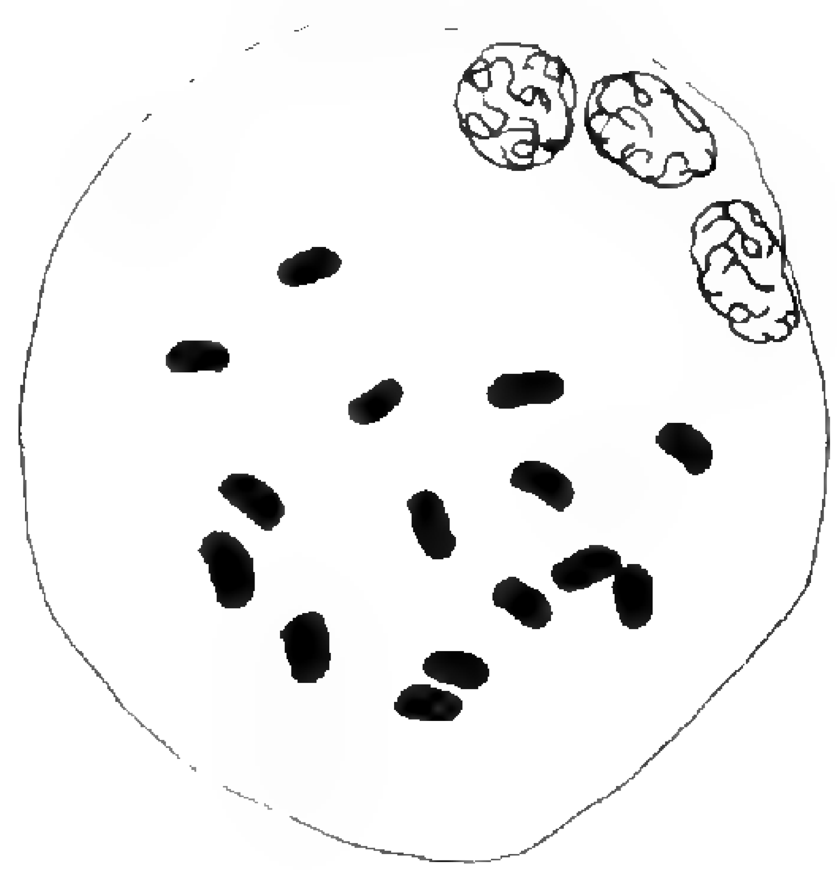
49

50

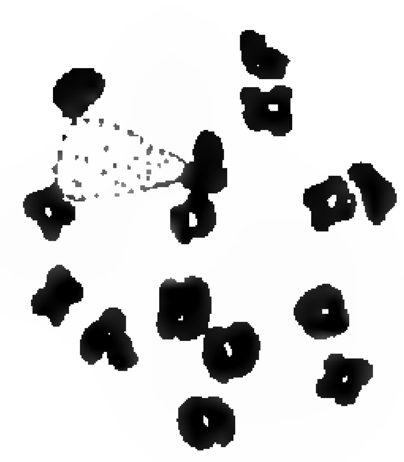
51



52

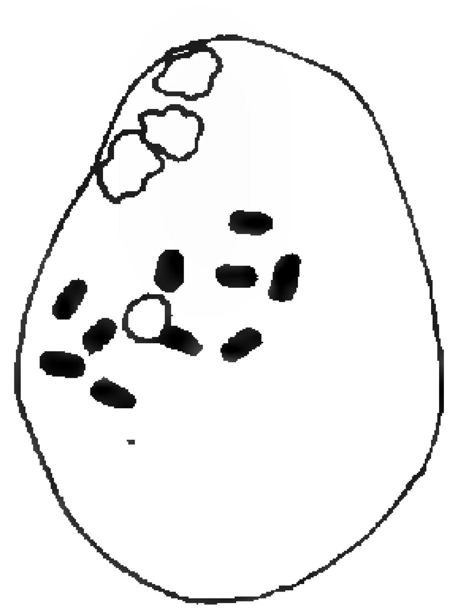


53

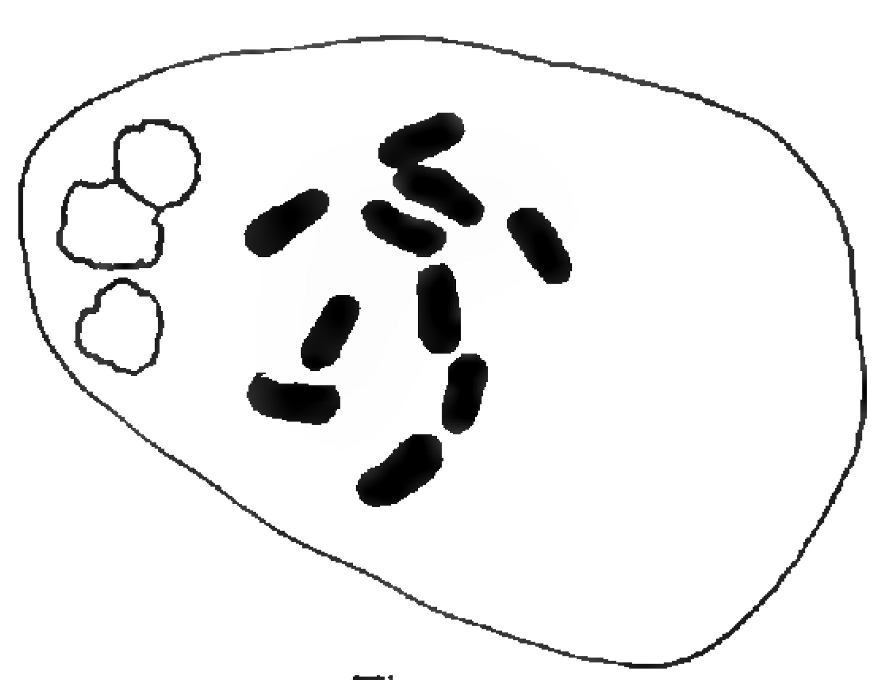


54

55



56



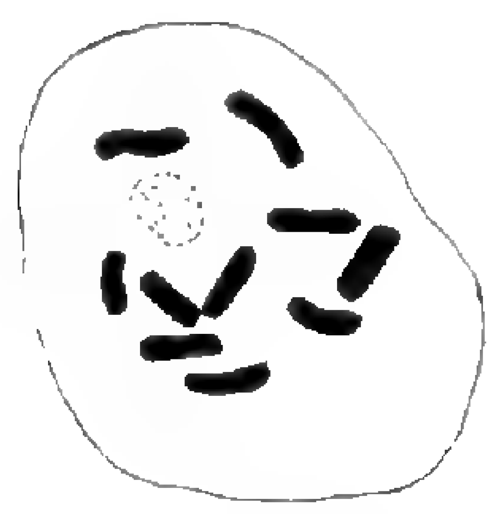
57

(Captions on pages 198-201.)

58

59

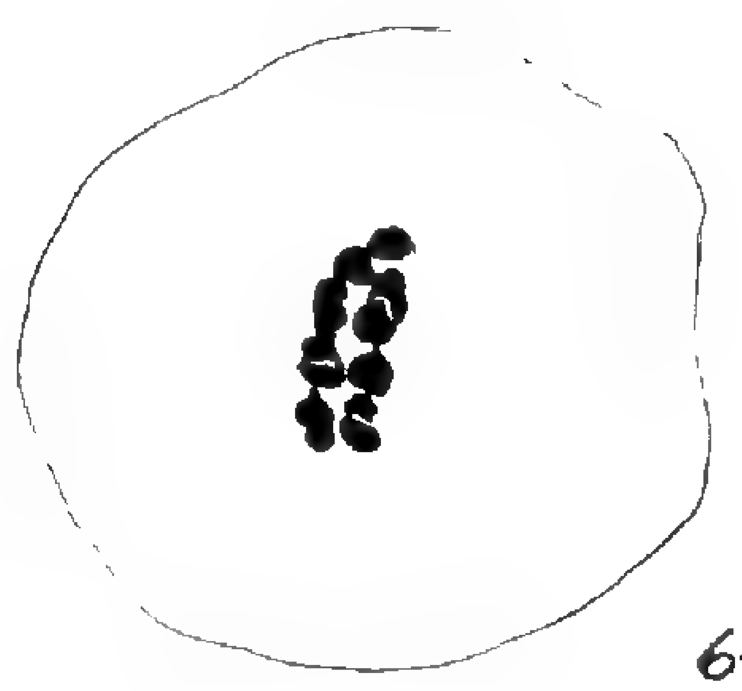
60



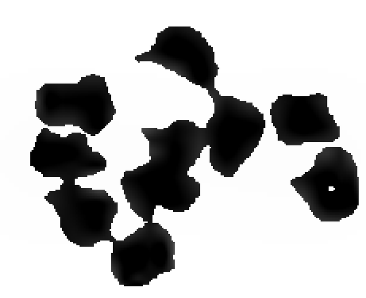
61

62

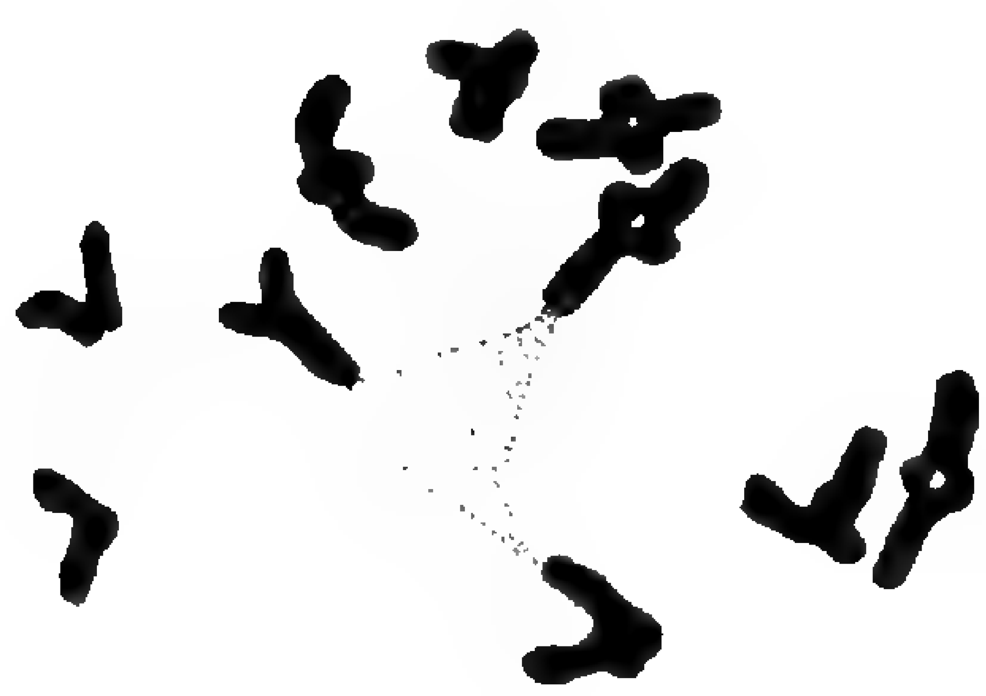
63



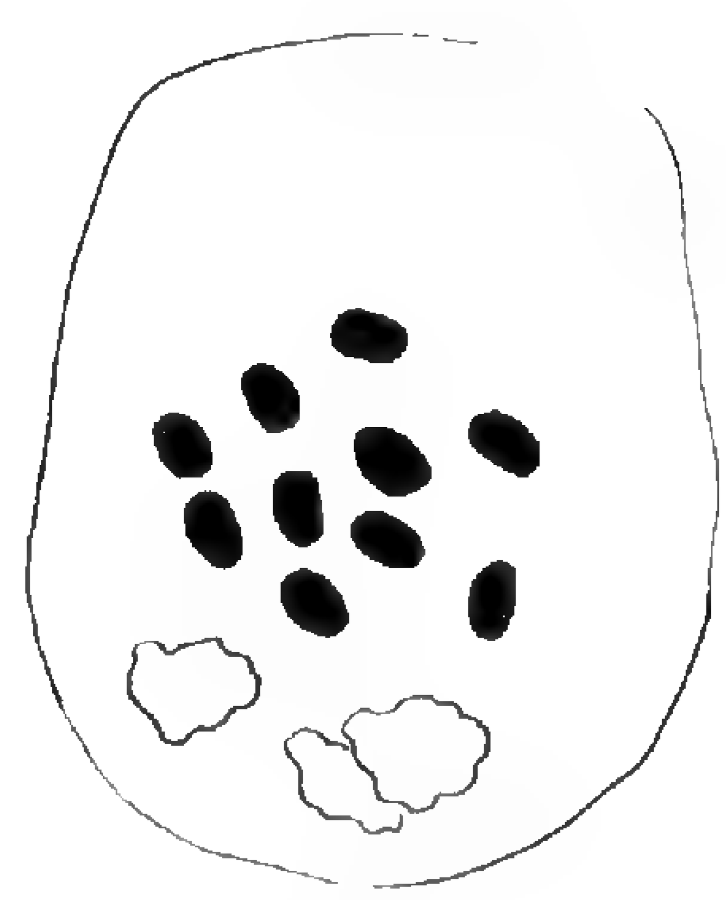
64



65

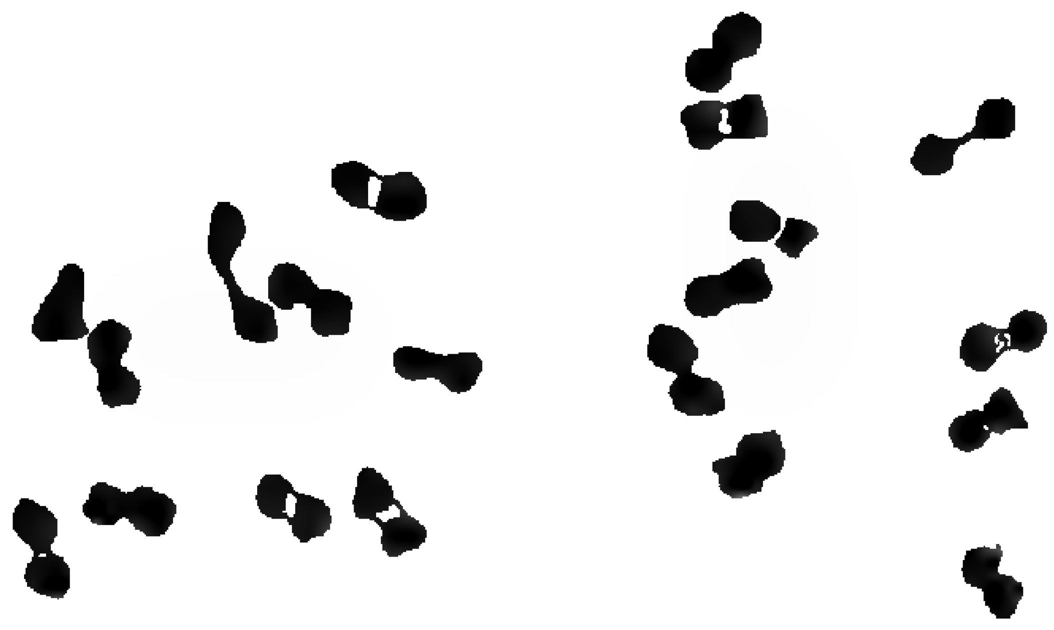


66



67

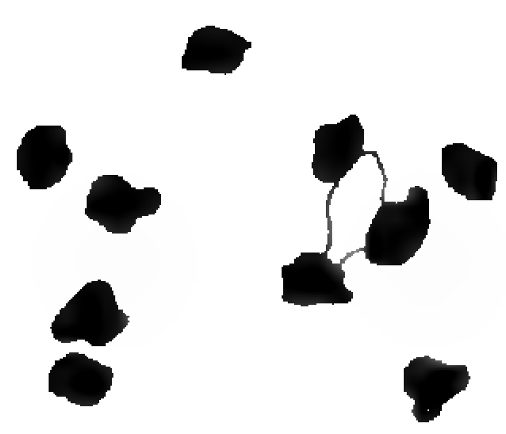
(Captions on pages 198-201.)



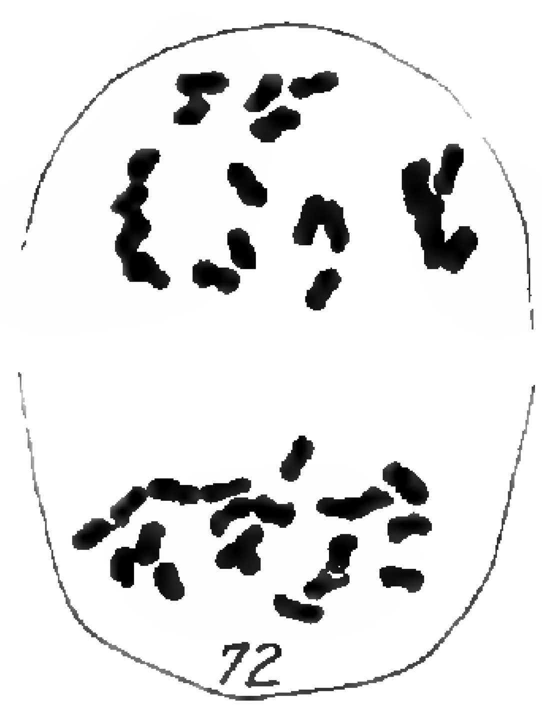
68

69

70



71



72

73

74

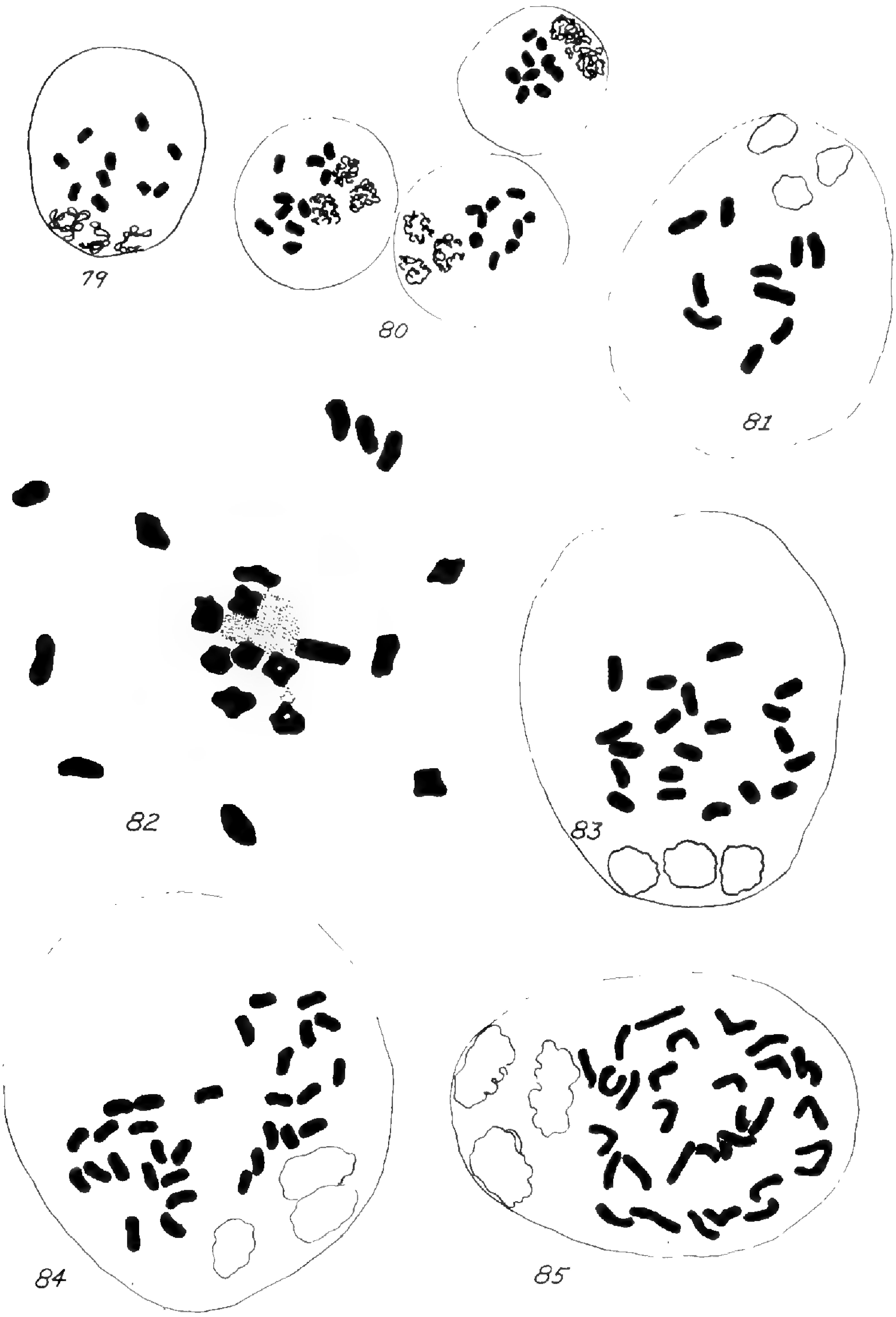
75

76

77

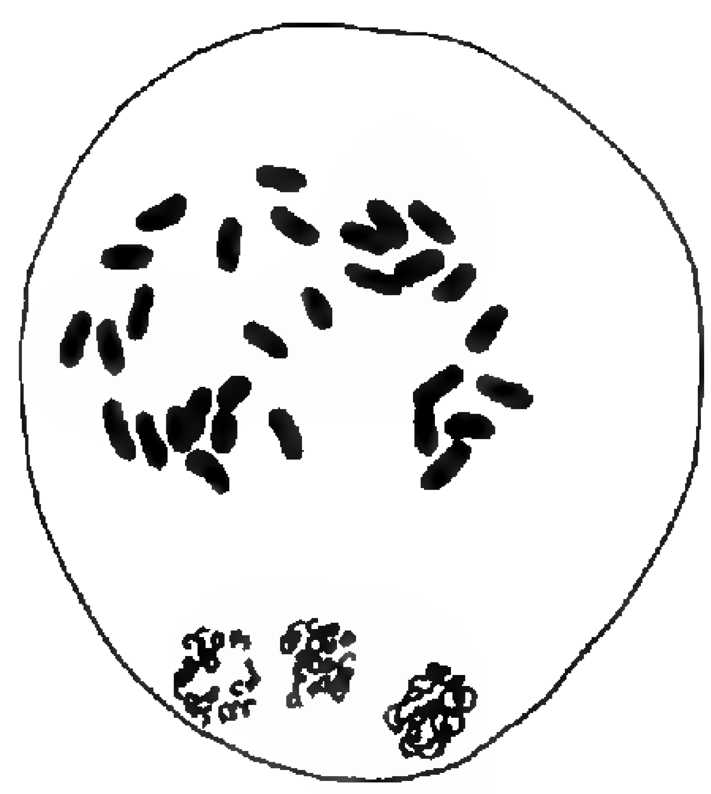
78

(Captions on pages 198-201.)

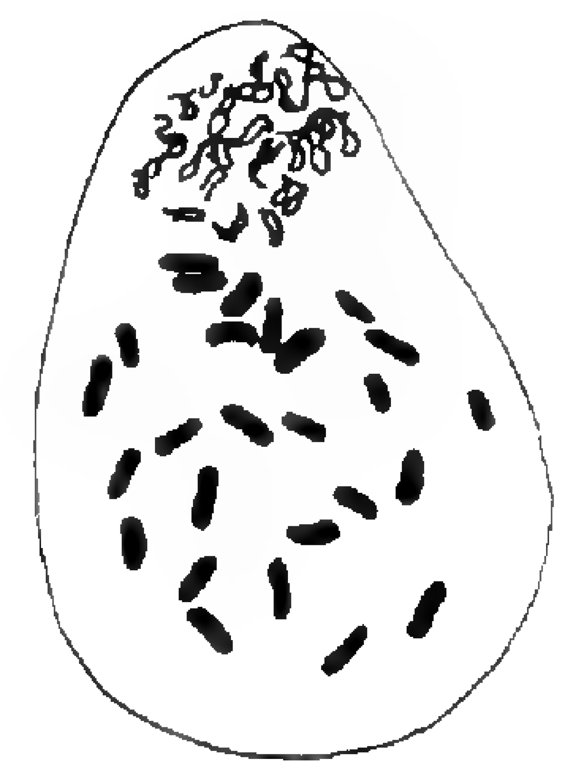


(Captions on pages 198-201.)

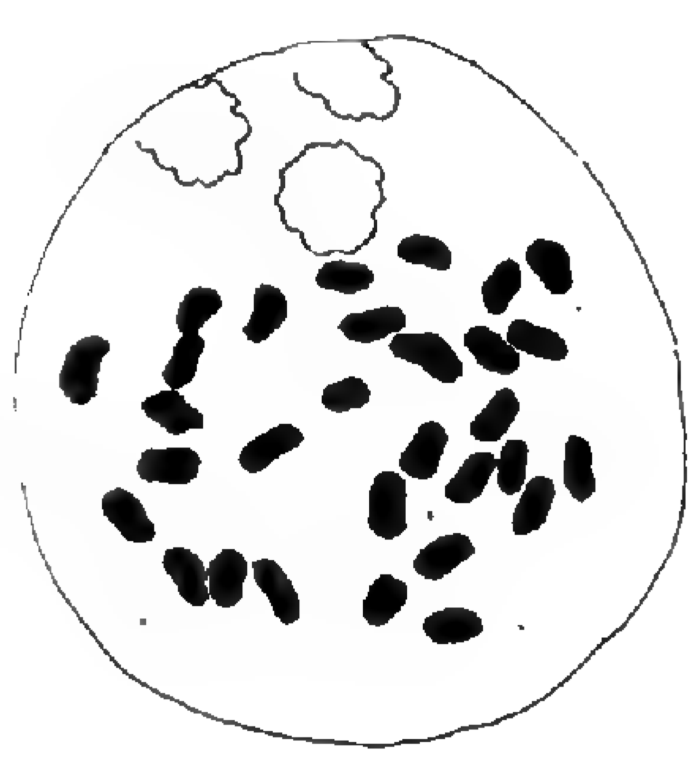
86



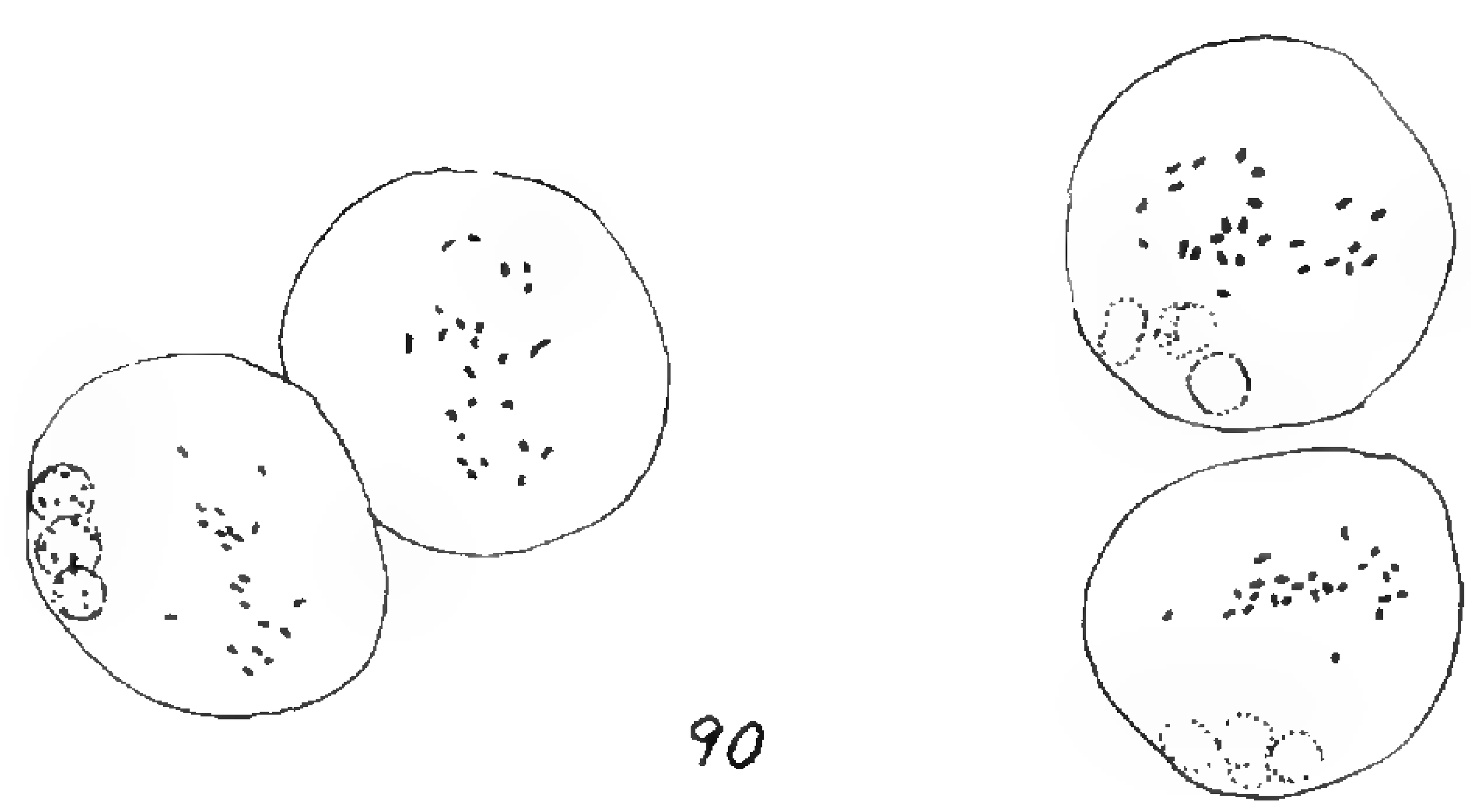
87



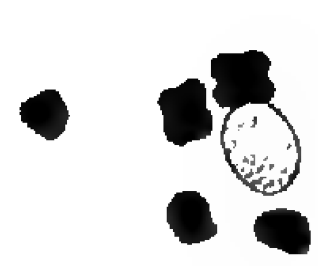
88



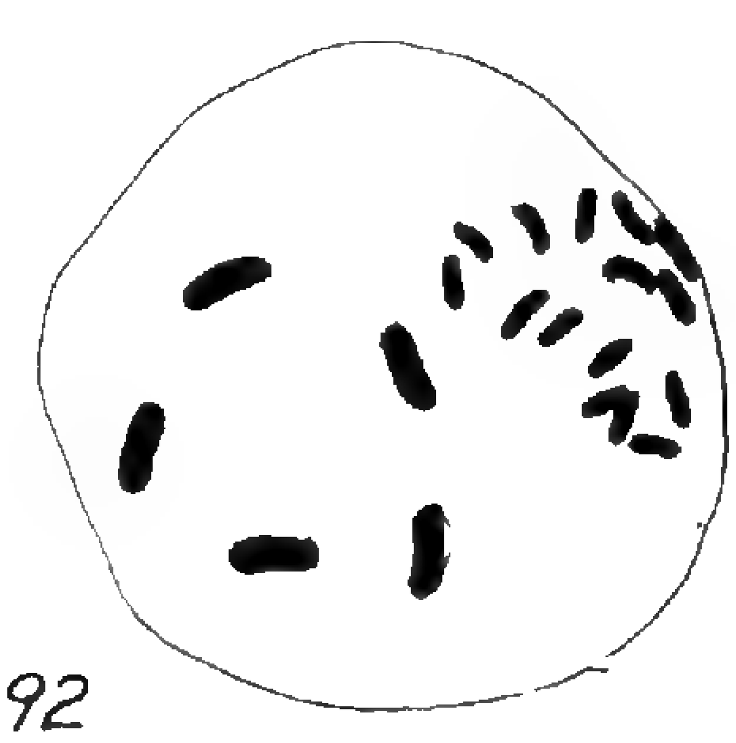
89



90



91



92

(Captions on pages 198-201.)

INDEX TO MAPS

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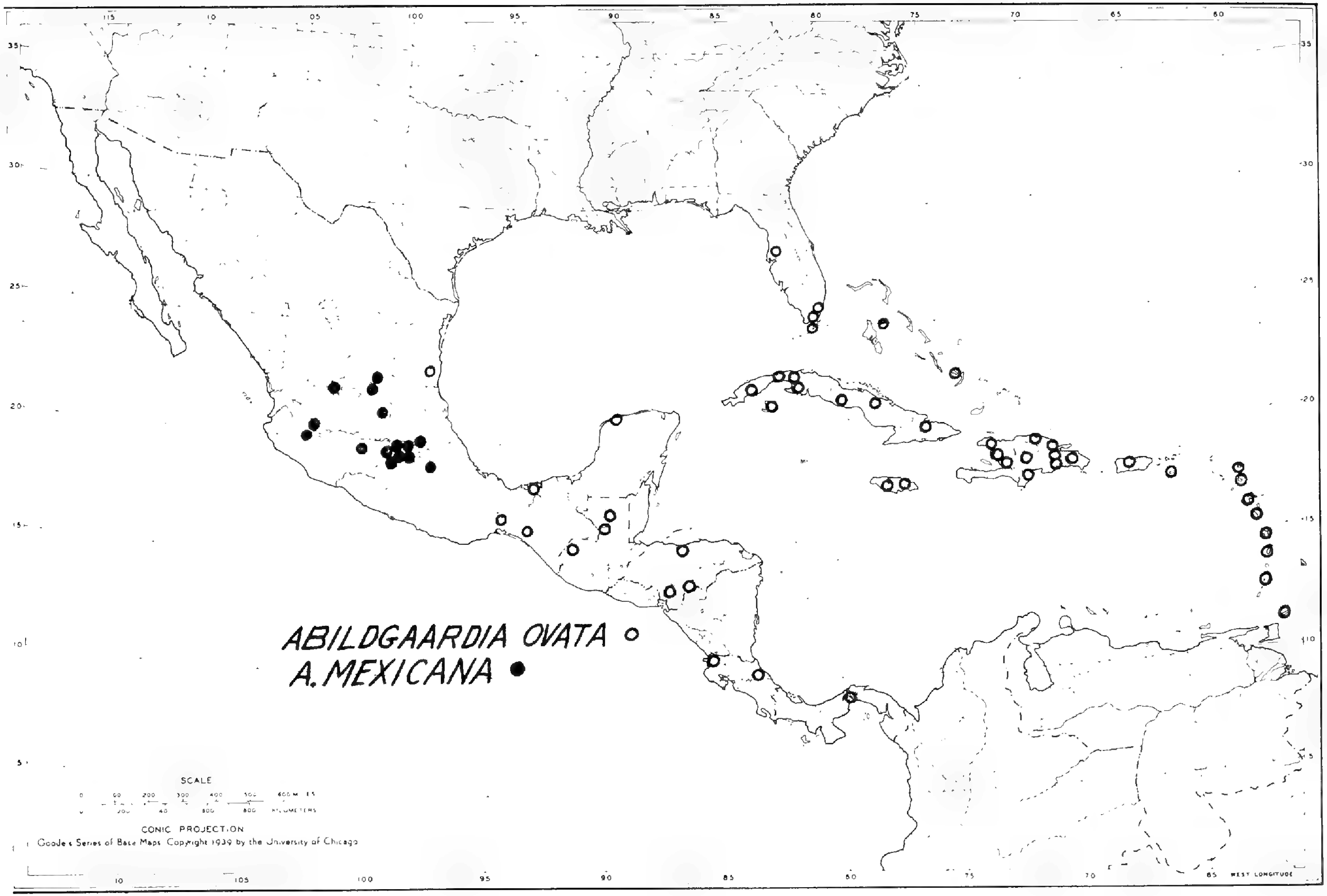
ABILDGAARDIA OVATA
A. MEXICANA
SCALE
CONIC PROJECTION
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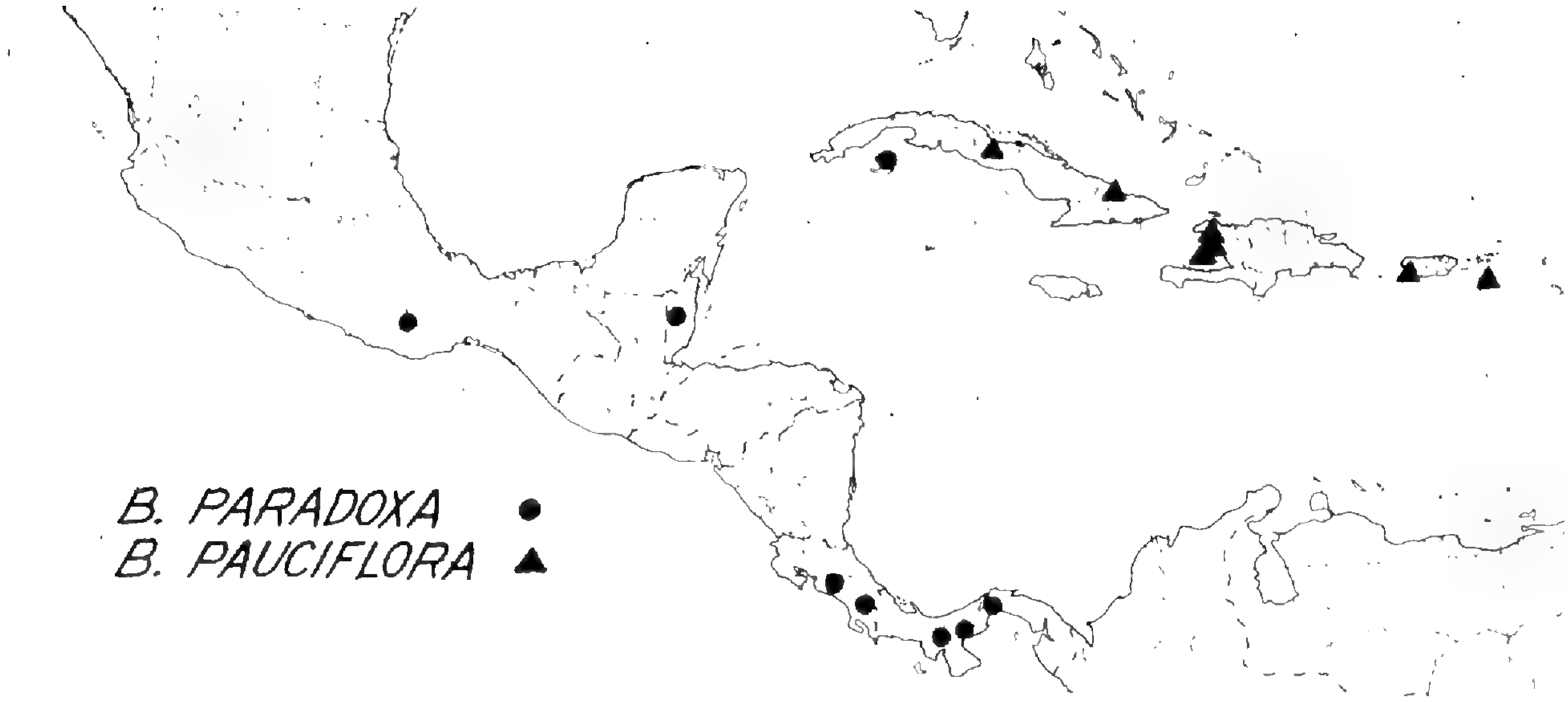
WEST LONGITUDE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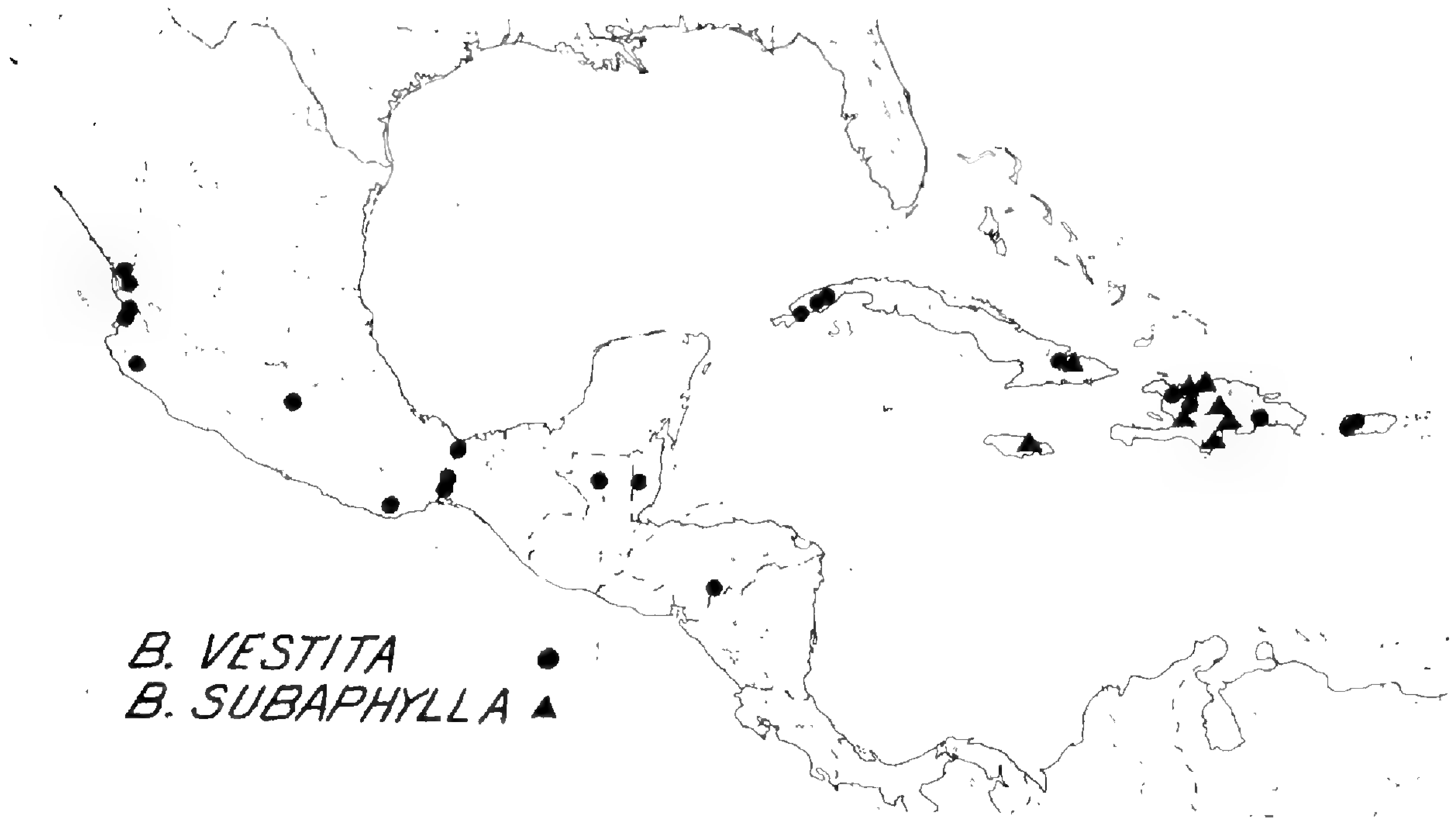
B. PAUCIFLORA ▲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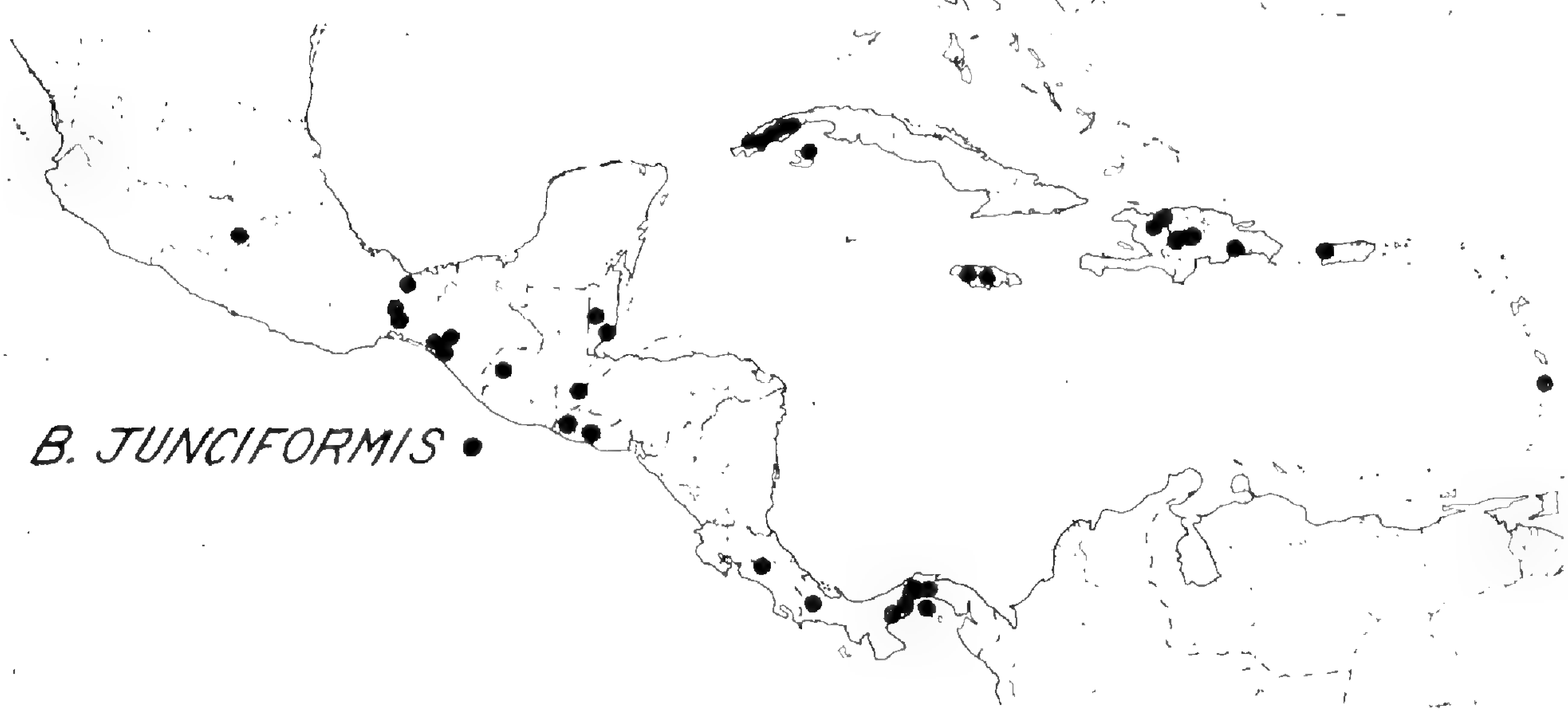
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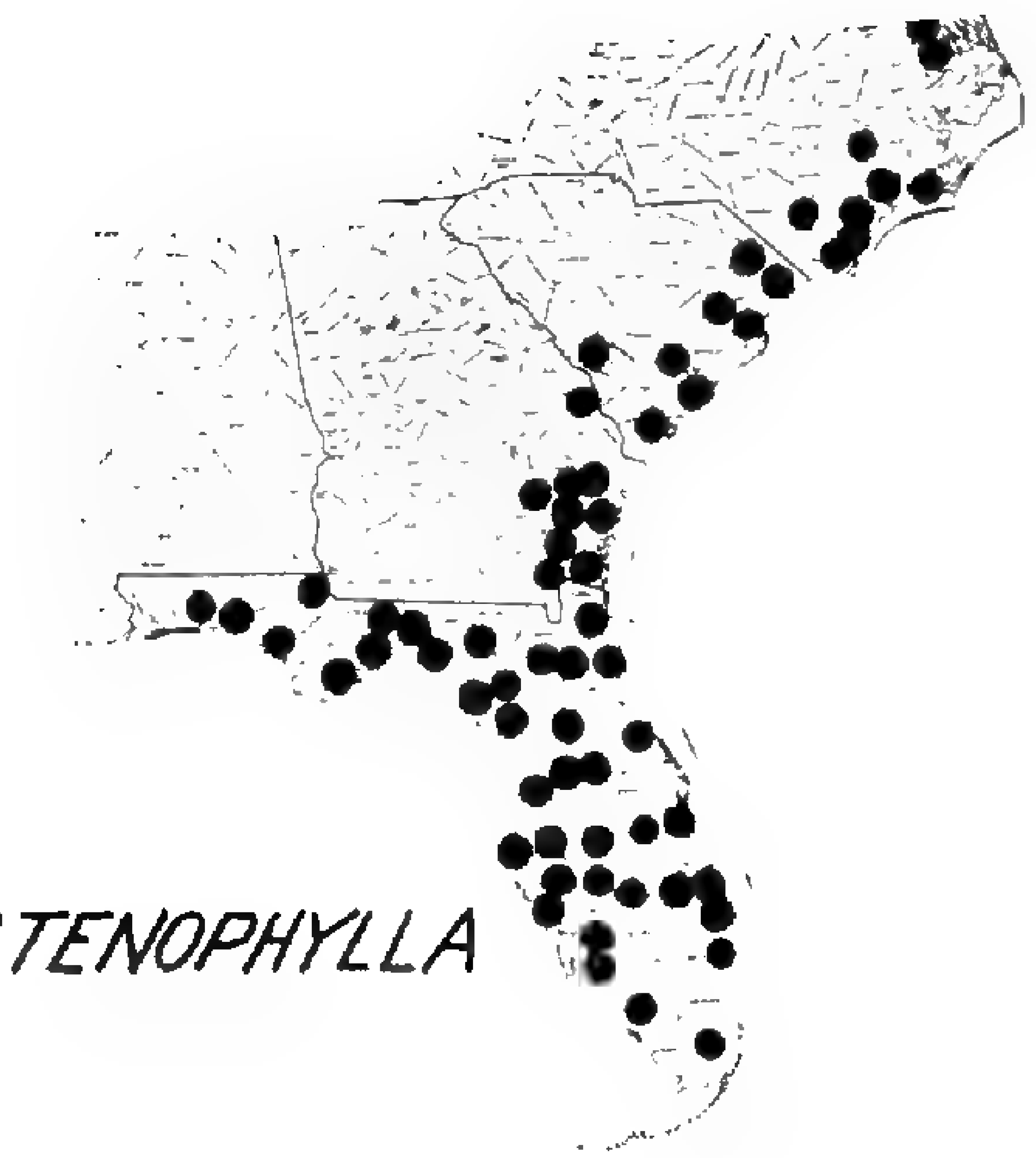

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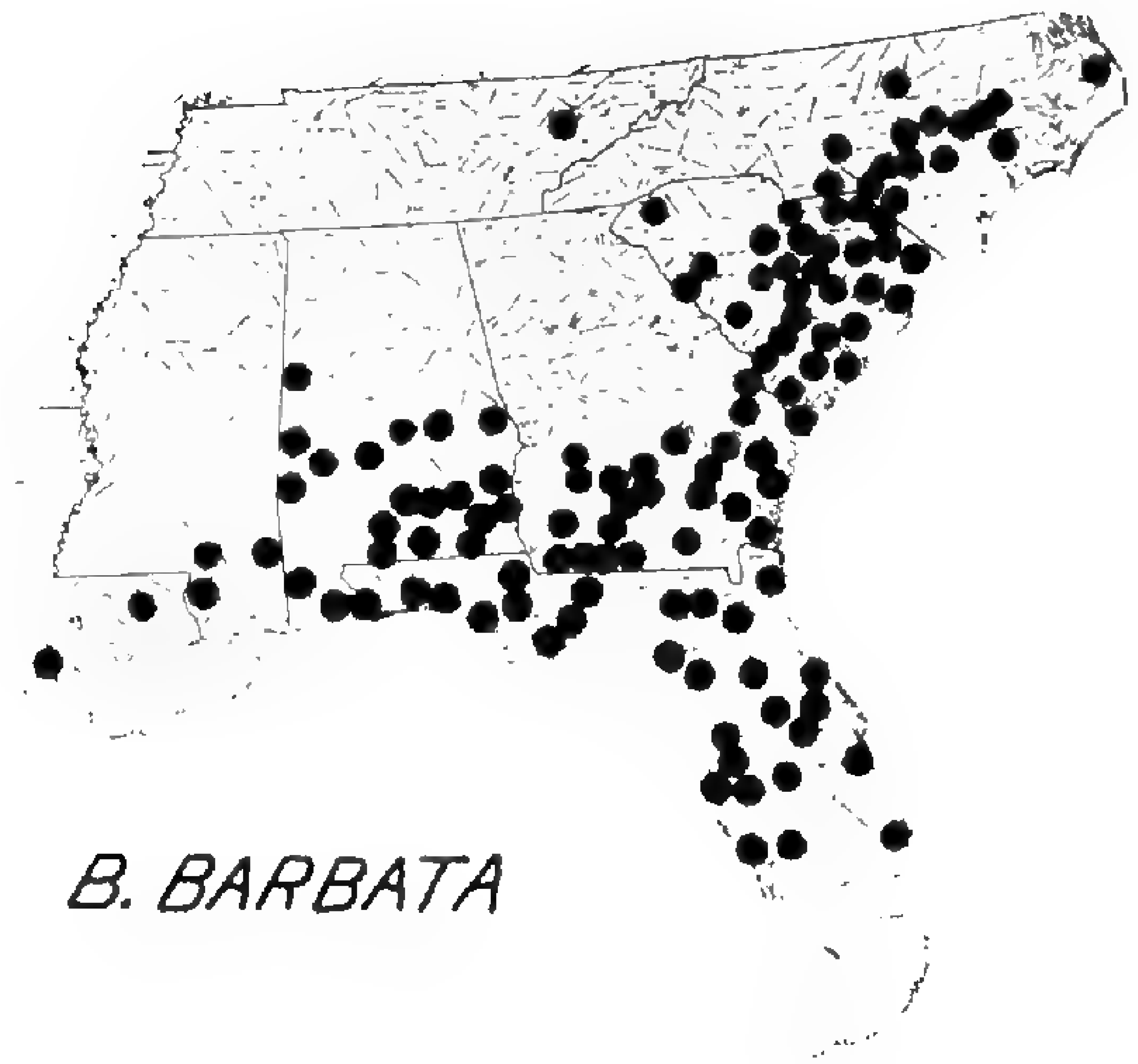

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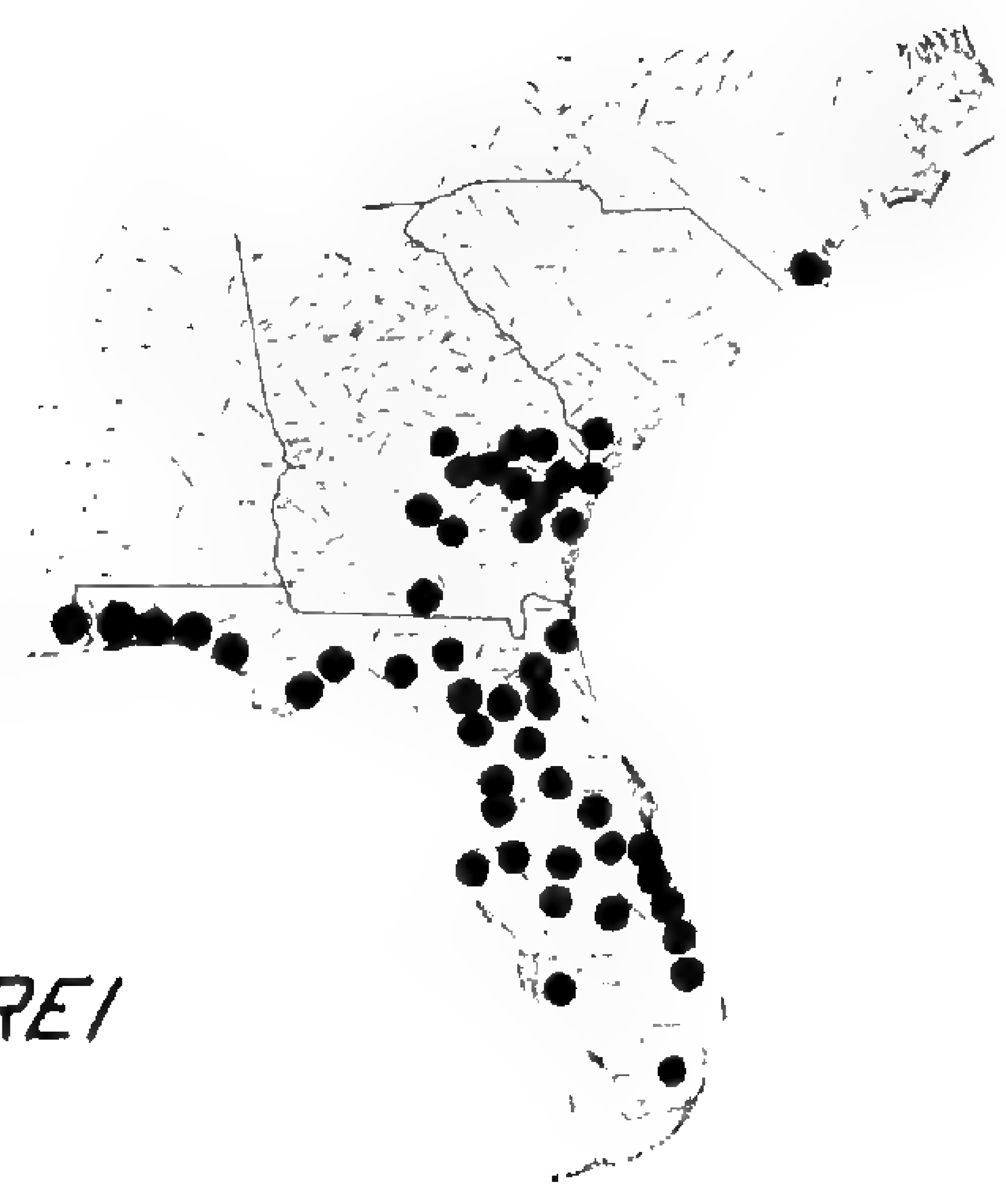

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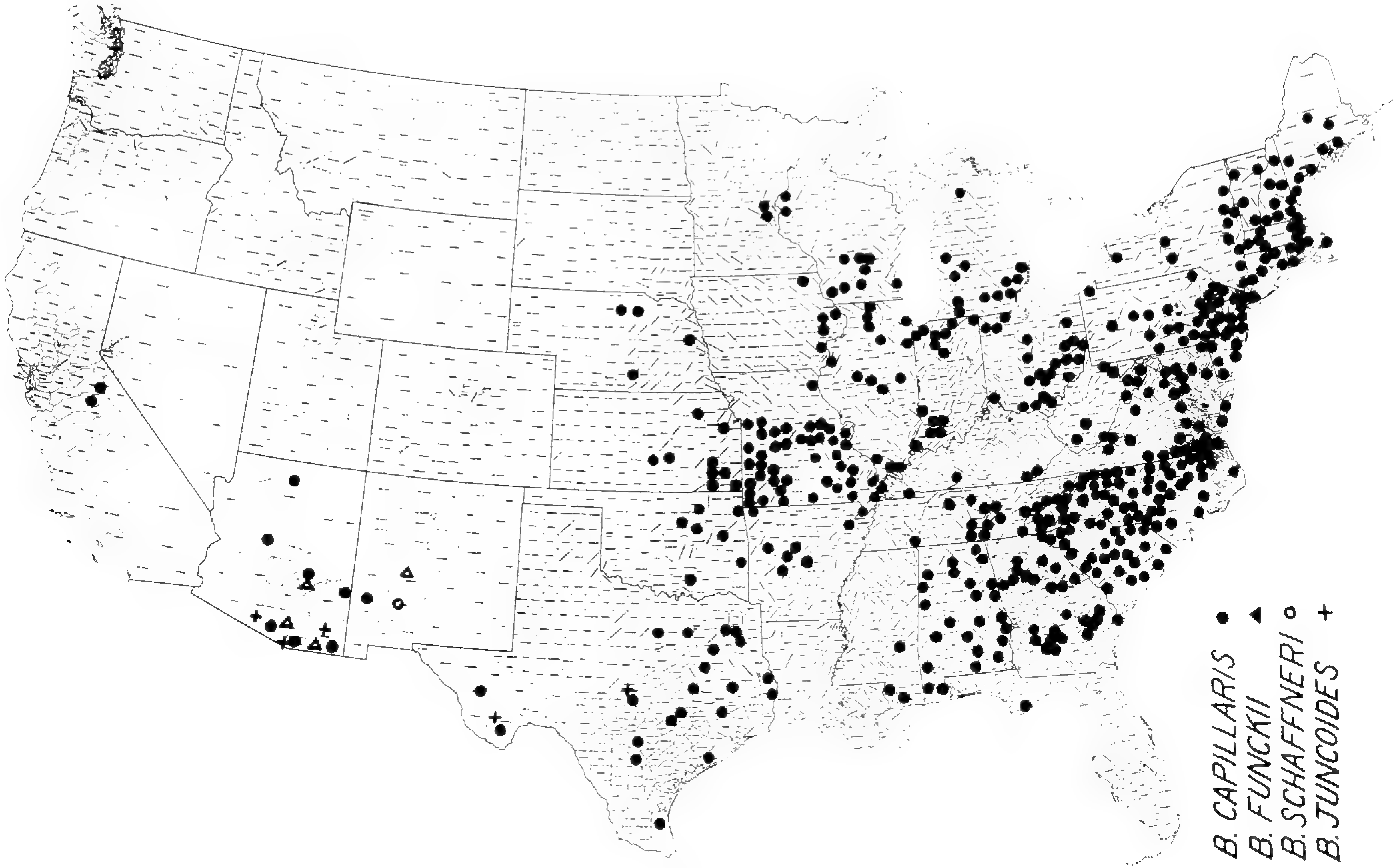
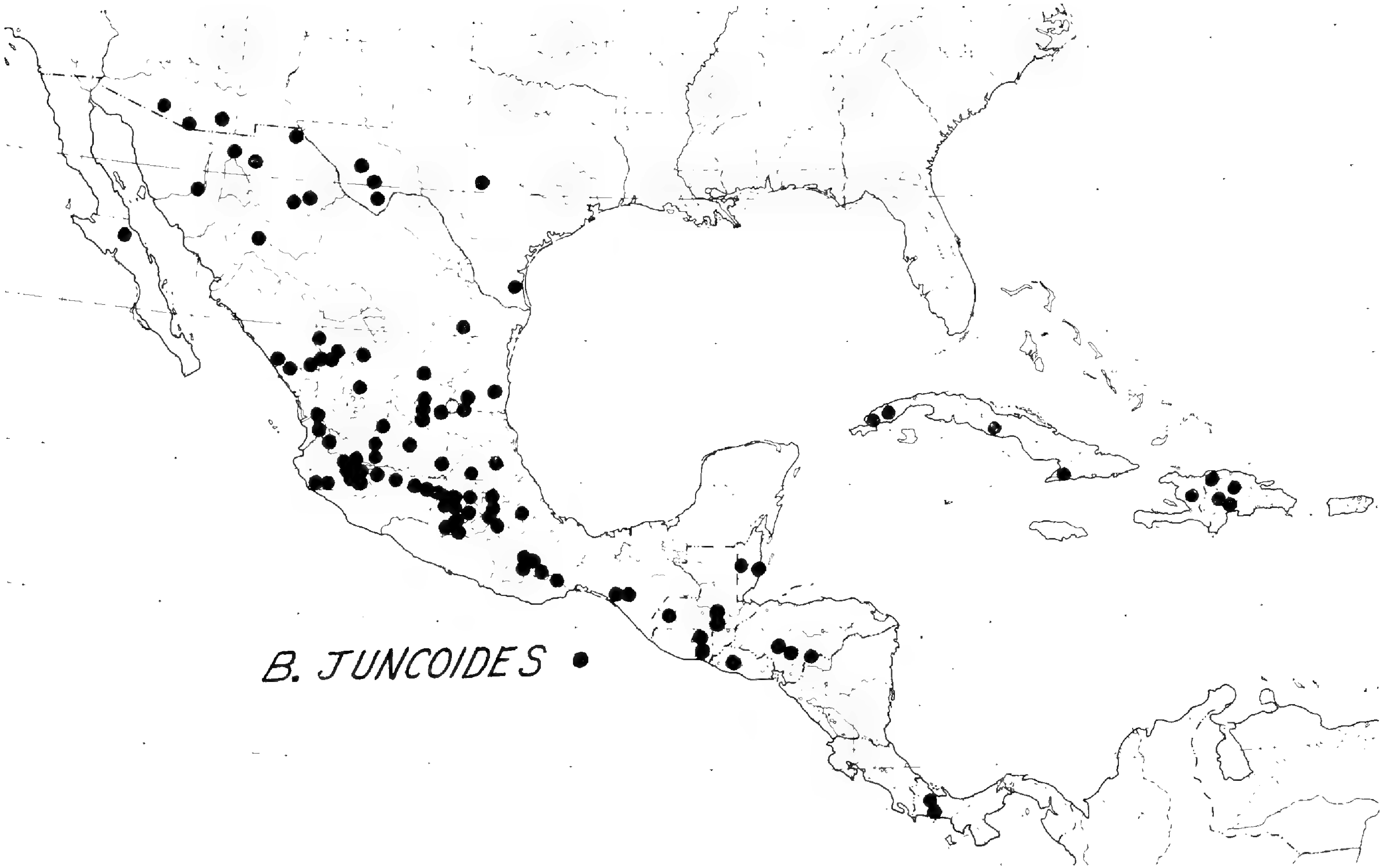

B. CAPILLARIS ●
B. FUNCKII ▲
B. SCHAFFNERI o
B. JUNCOIDES +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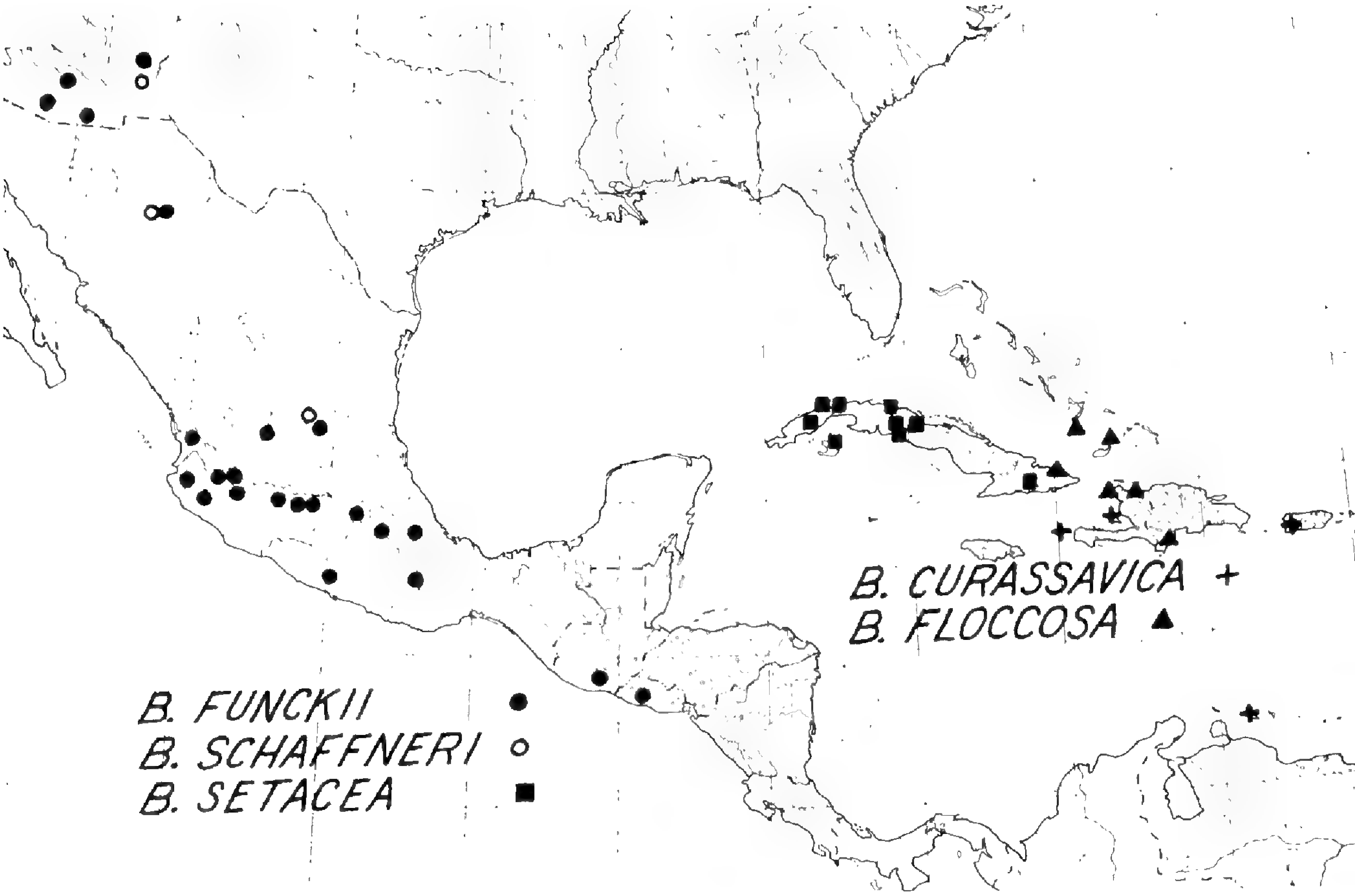
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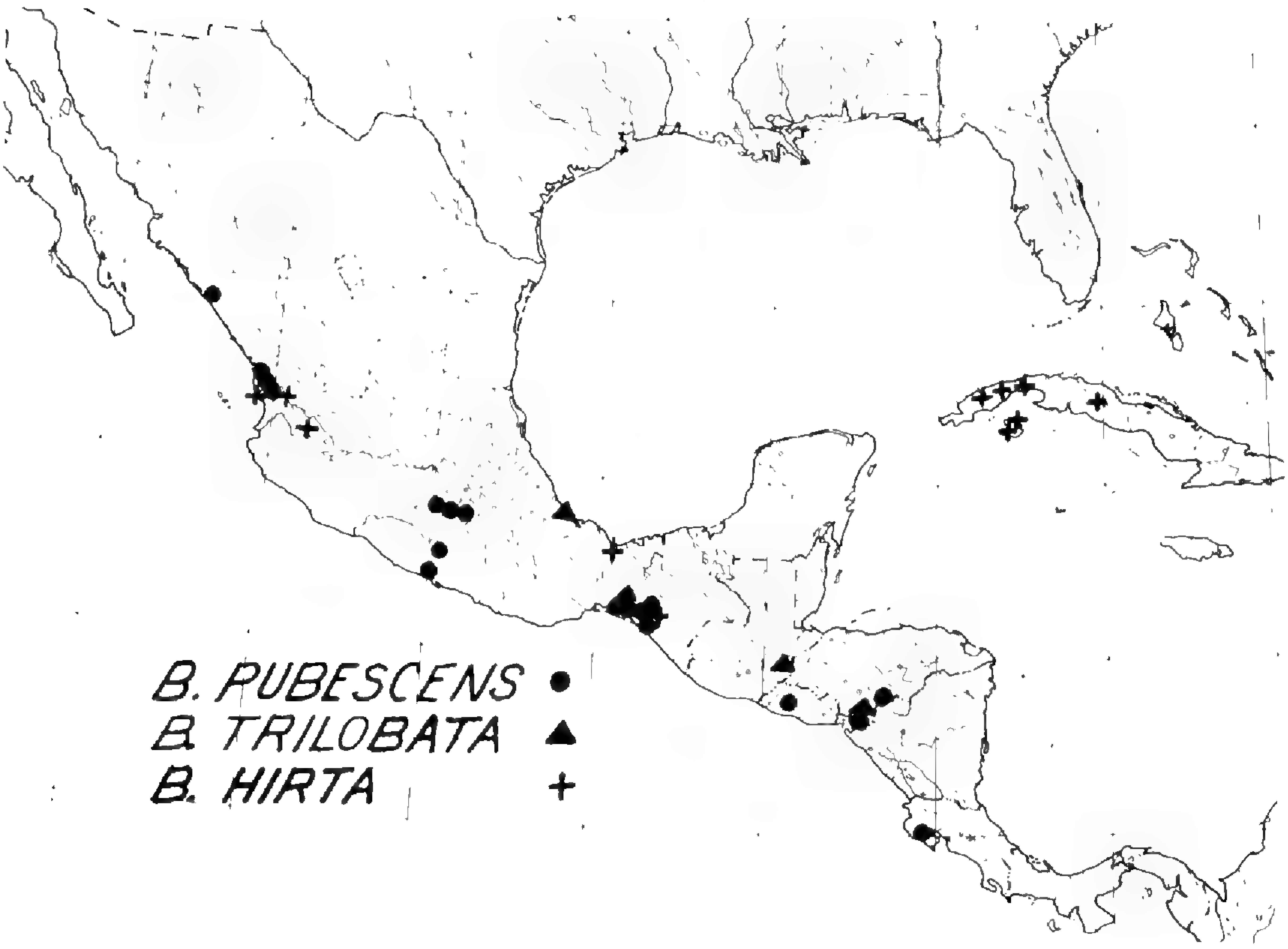
B. FLOCCOSA ▲
B. FUNCKII ●
B. SCHAFFNERI ○
B. SETACEA ■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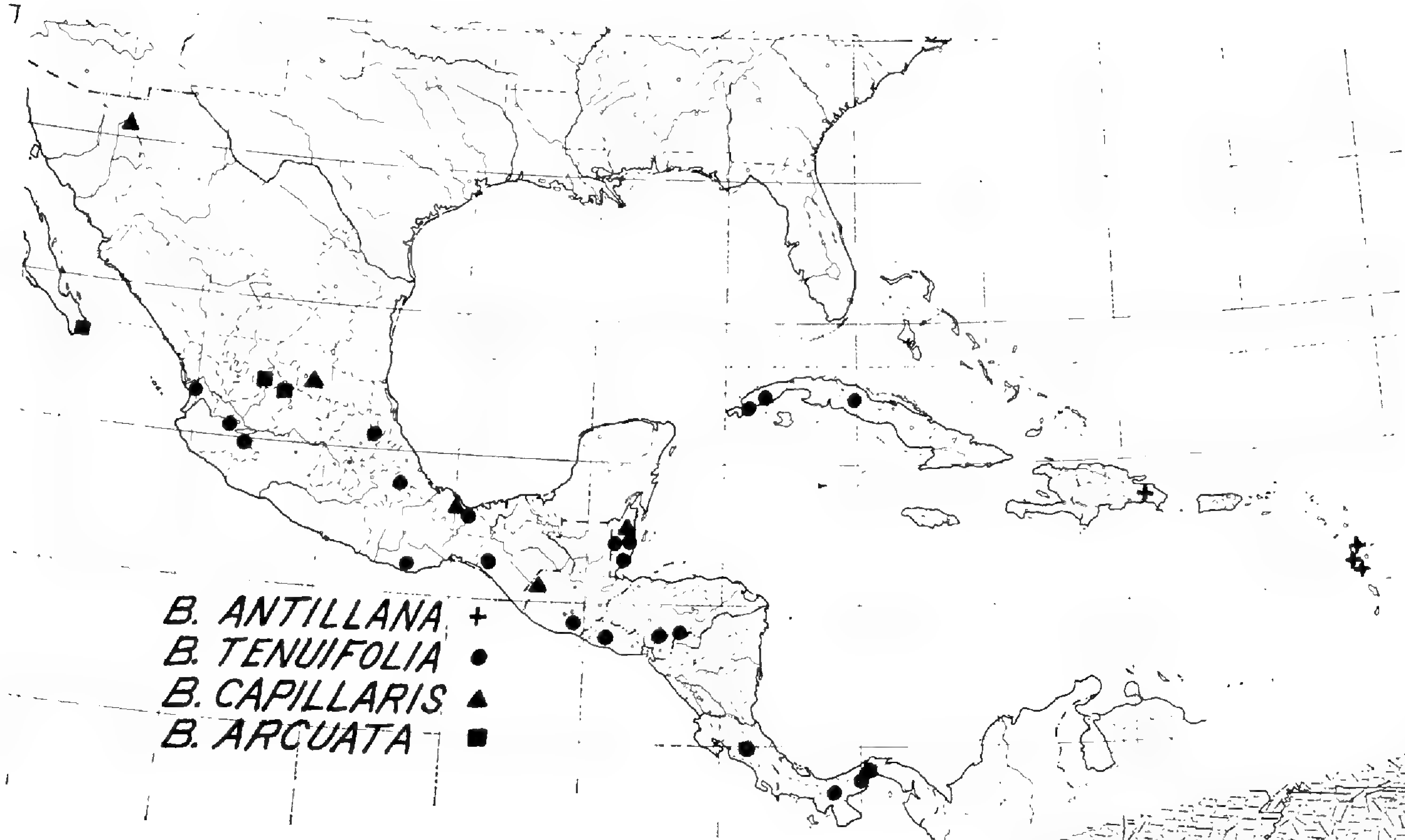
B. TRILOBATA ▲
B. HIRTA +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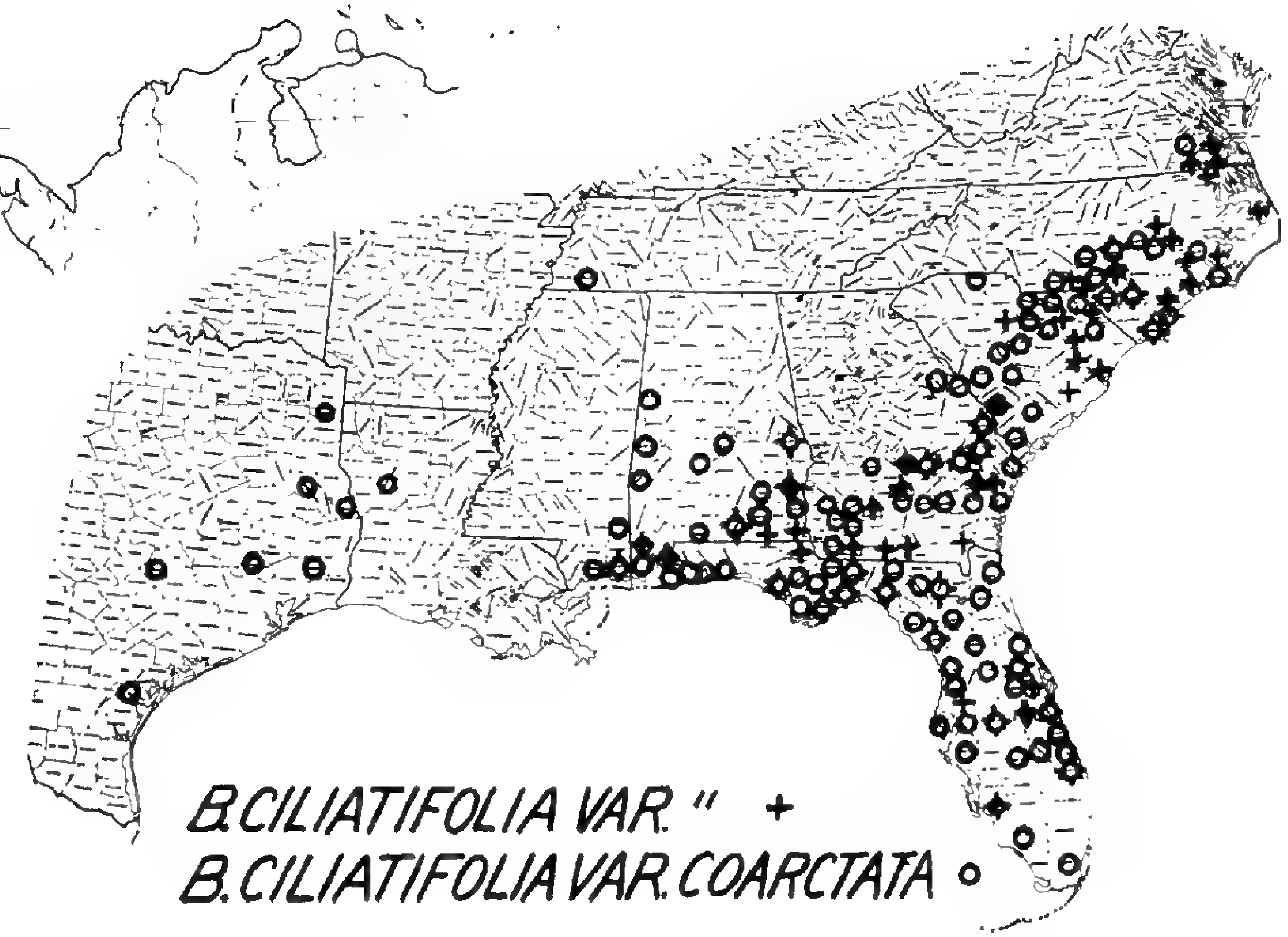
B. TENUIFOLIA ●
B. CAPILLARIS ▲
B. ARCUATA ■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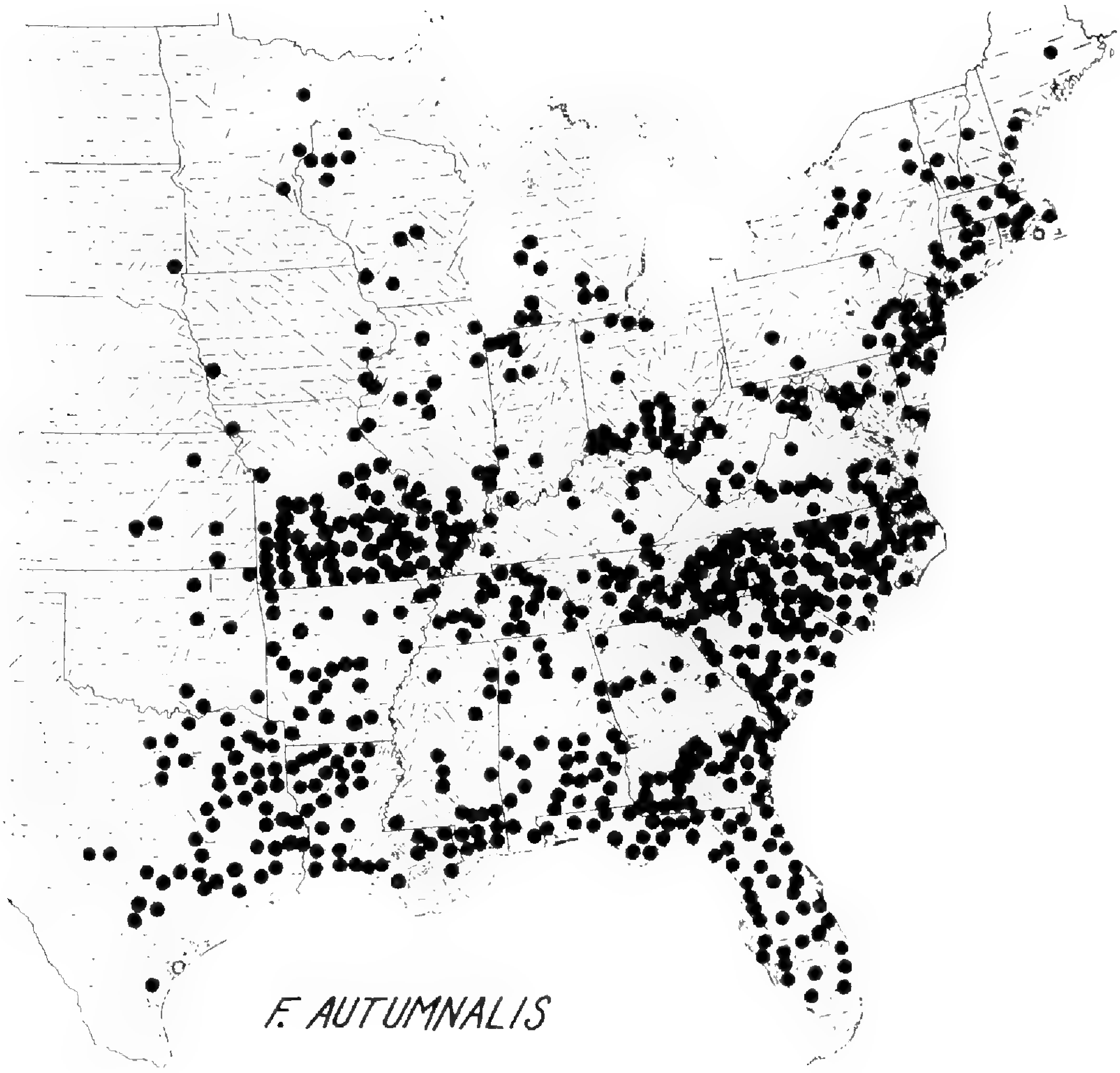
B.CILIATIFOLIA VAR. COARCTATA ○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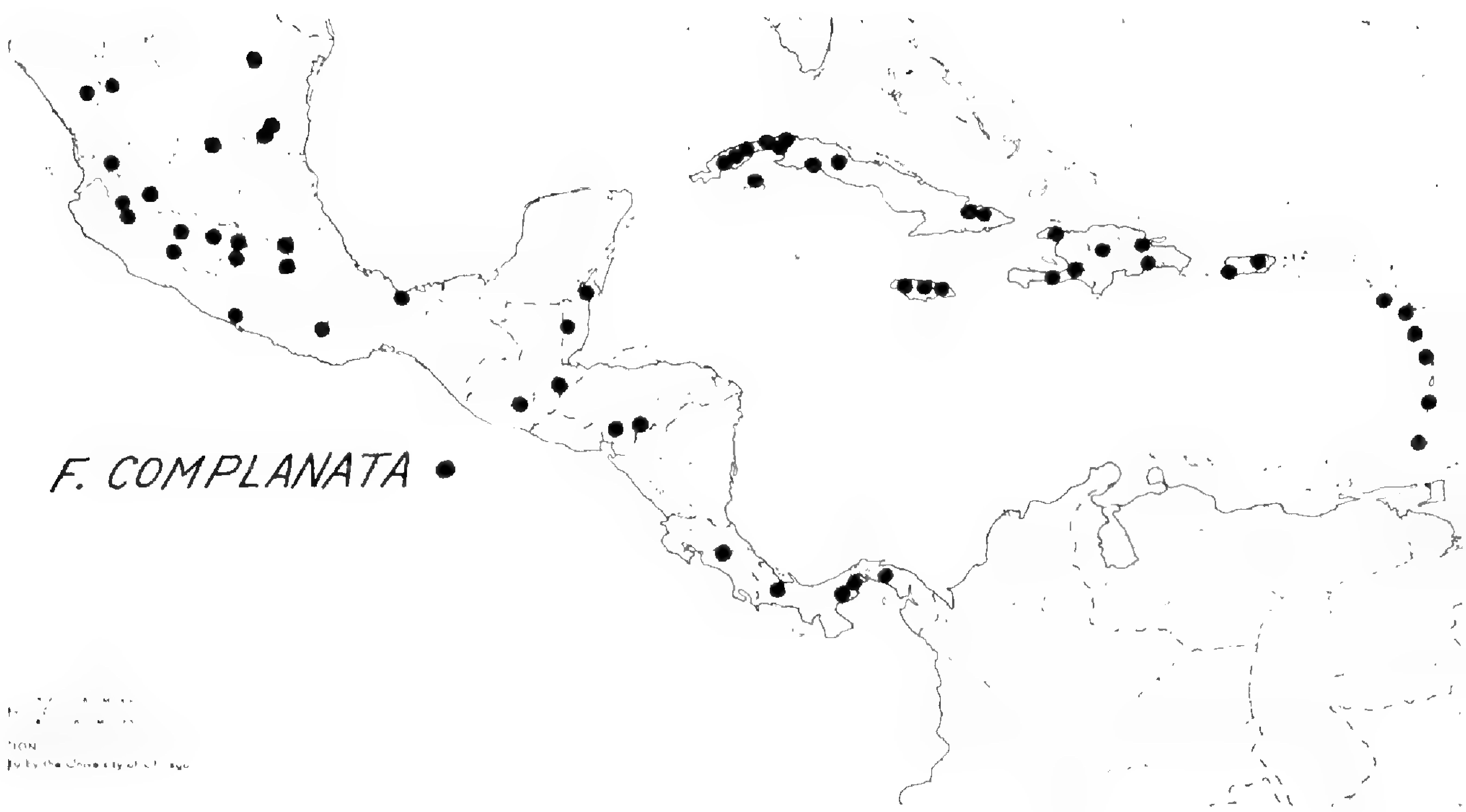
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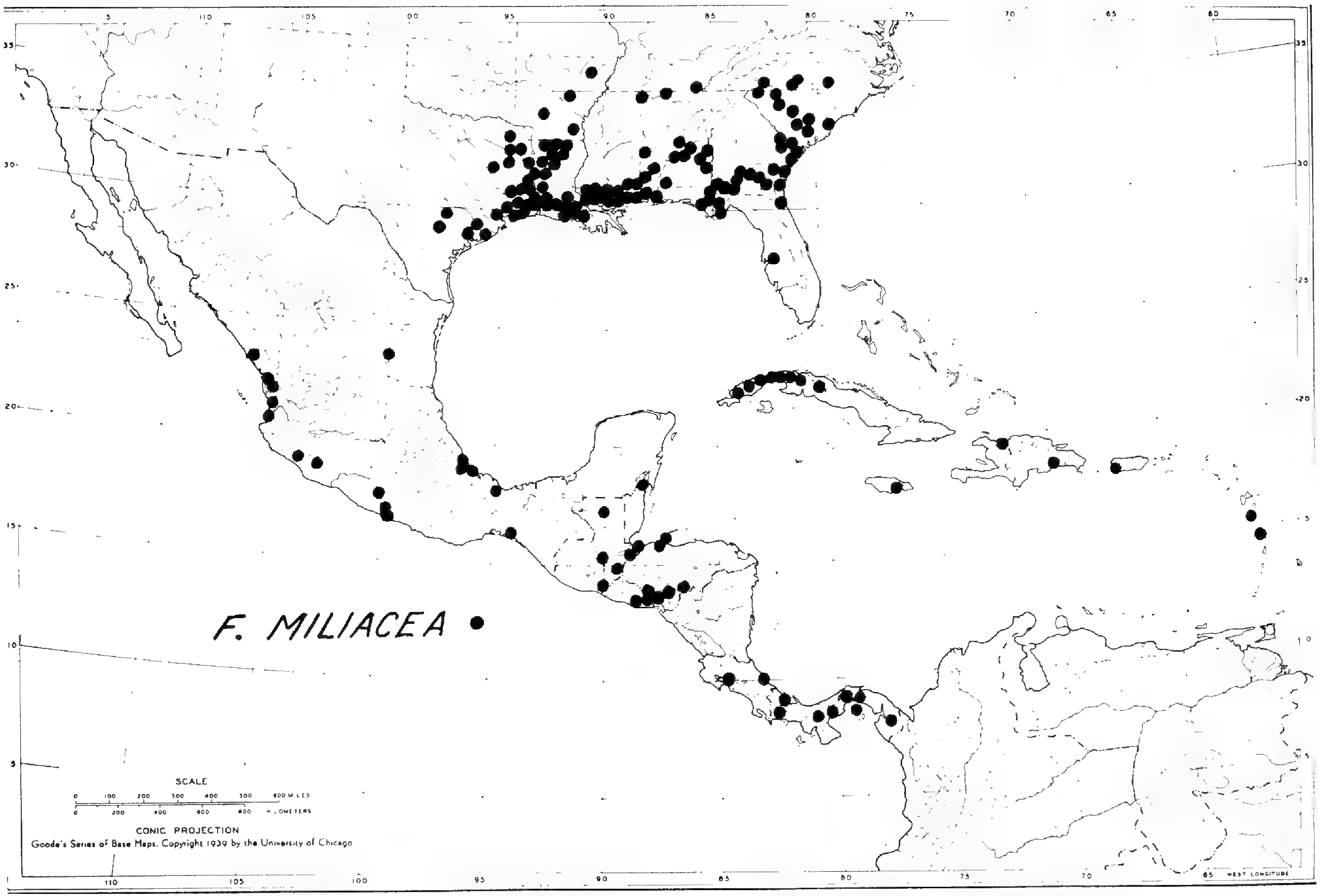
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SCALE
CONIC PROJECTION
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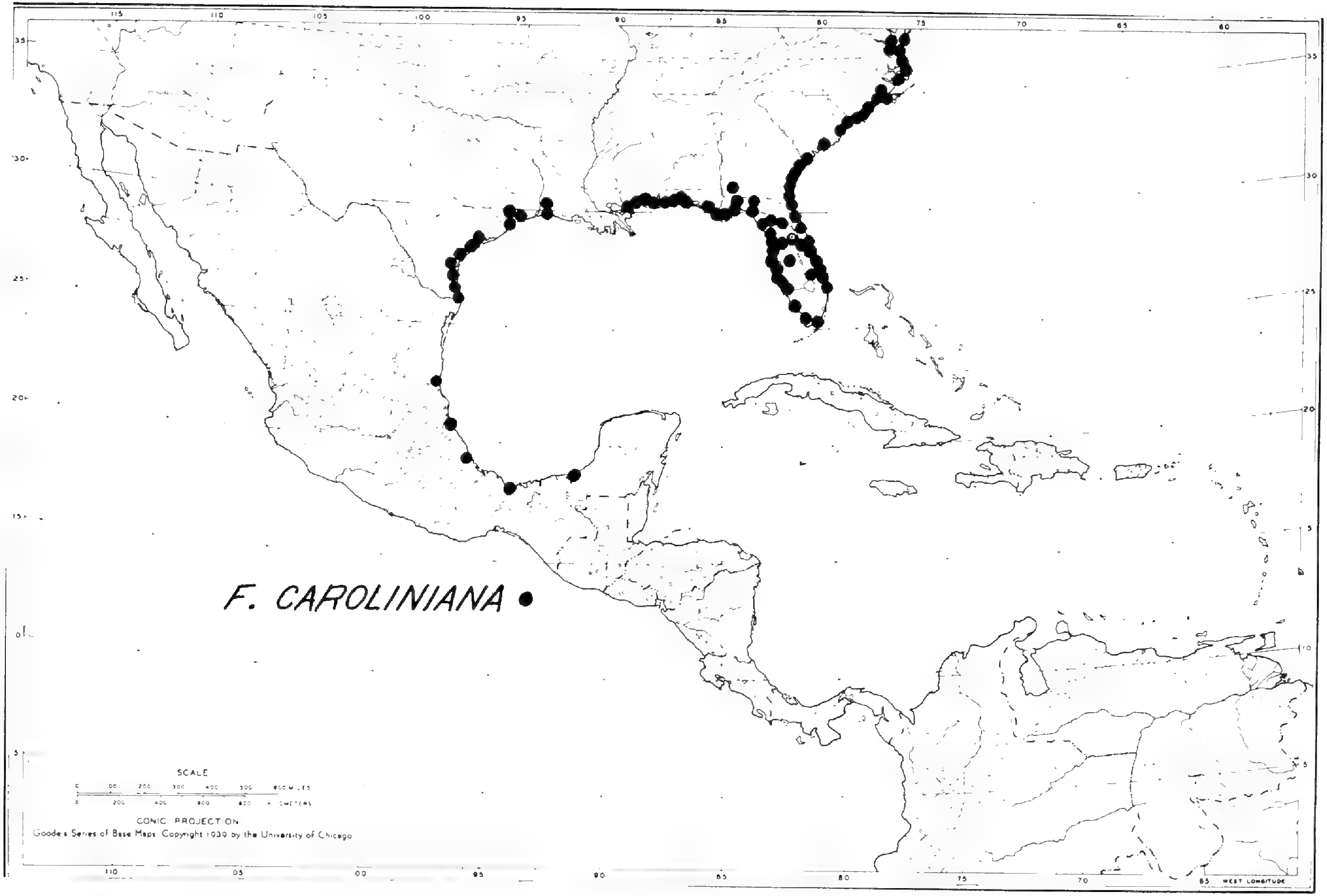
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SCALE
CONIC PROJECTION
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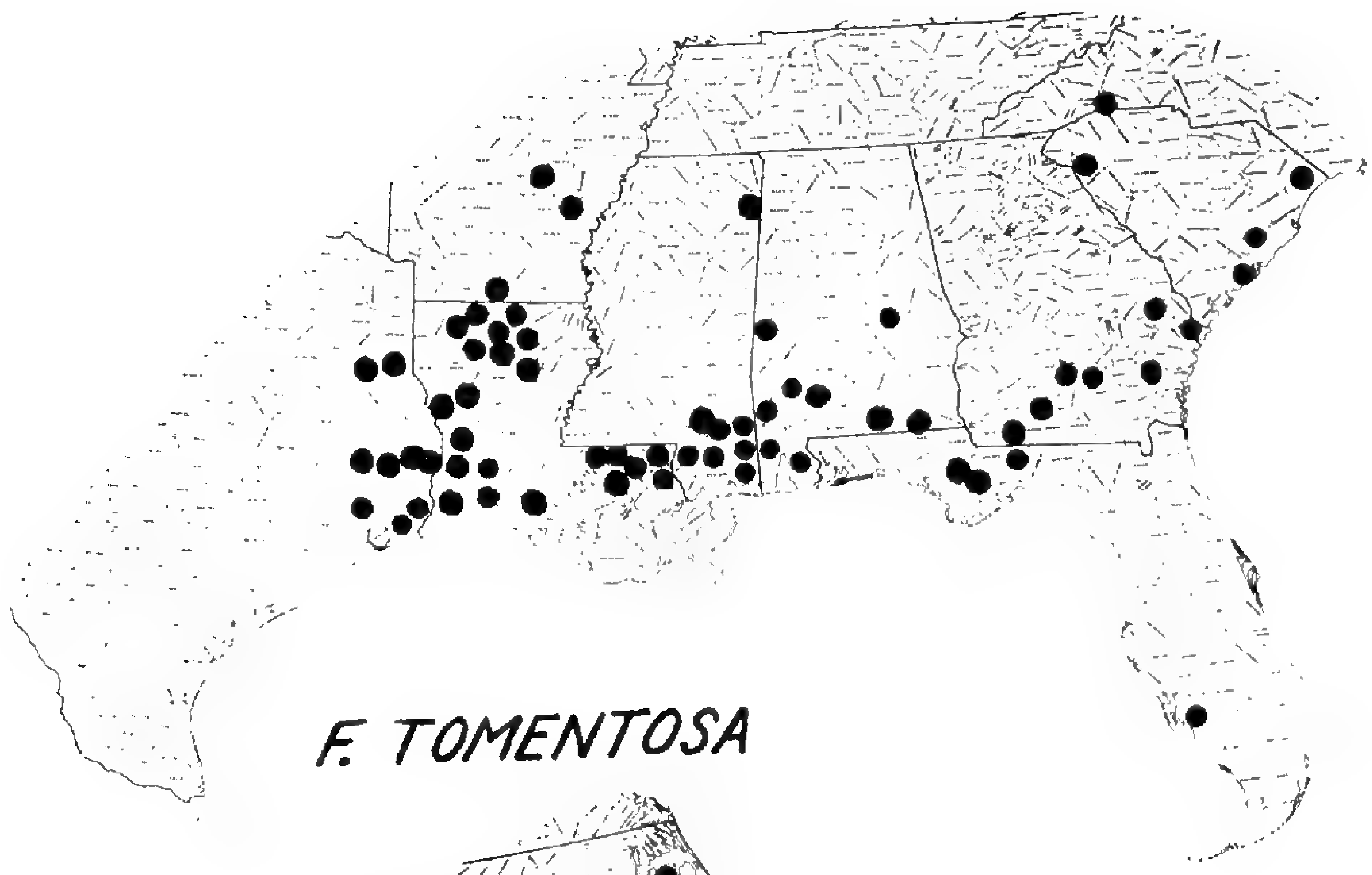

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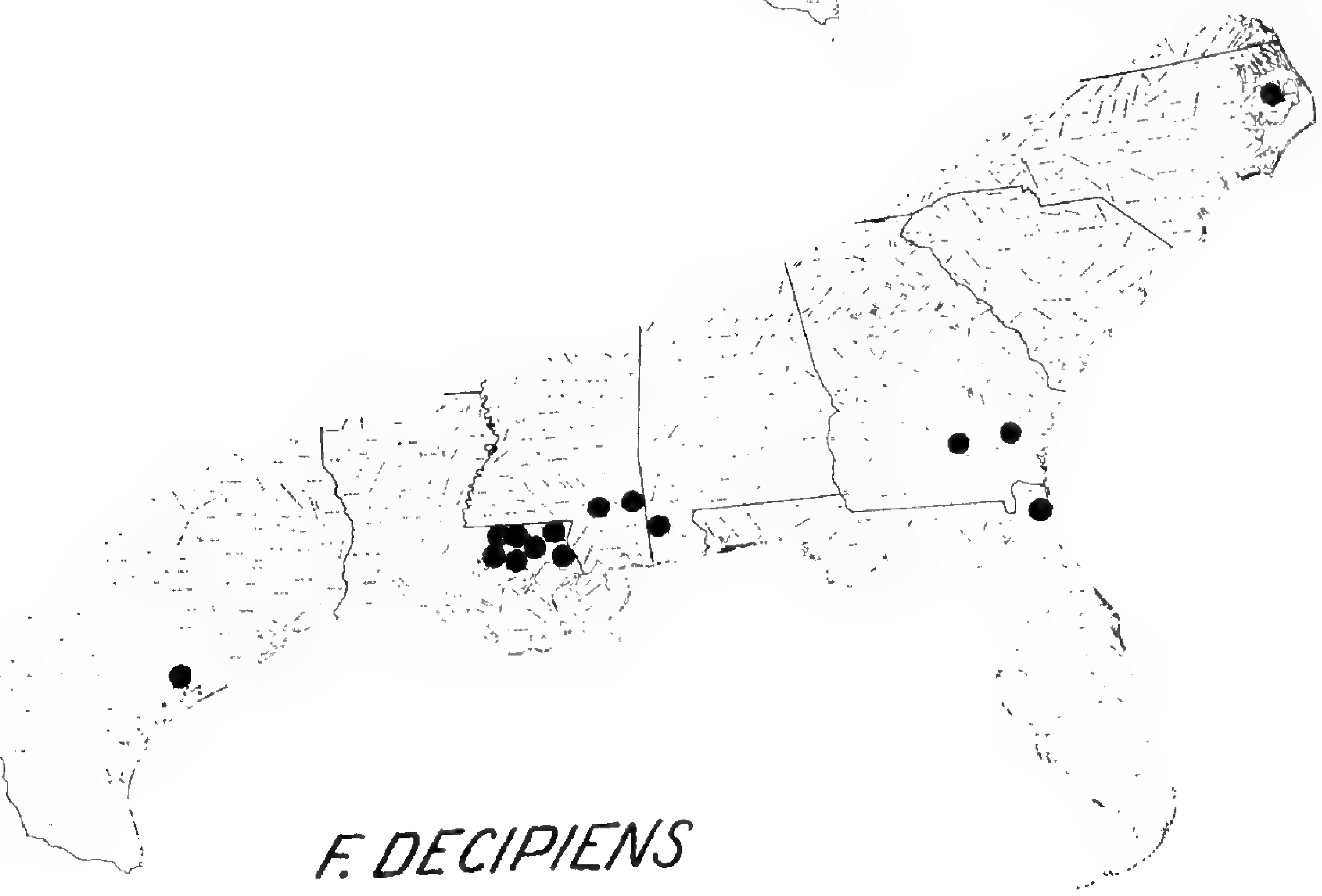

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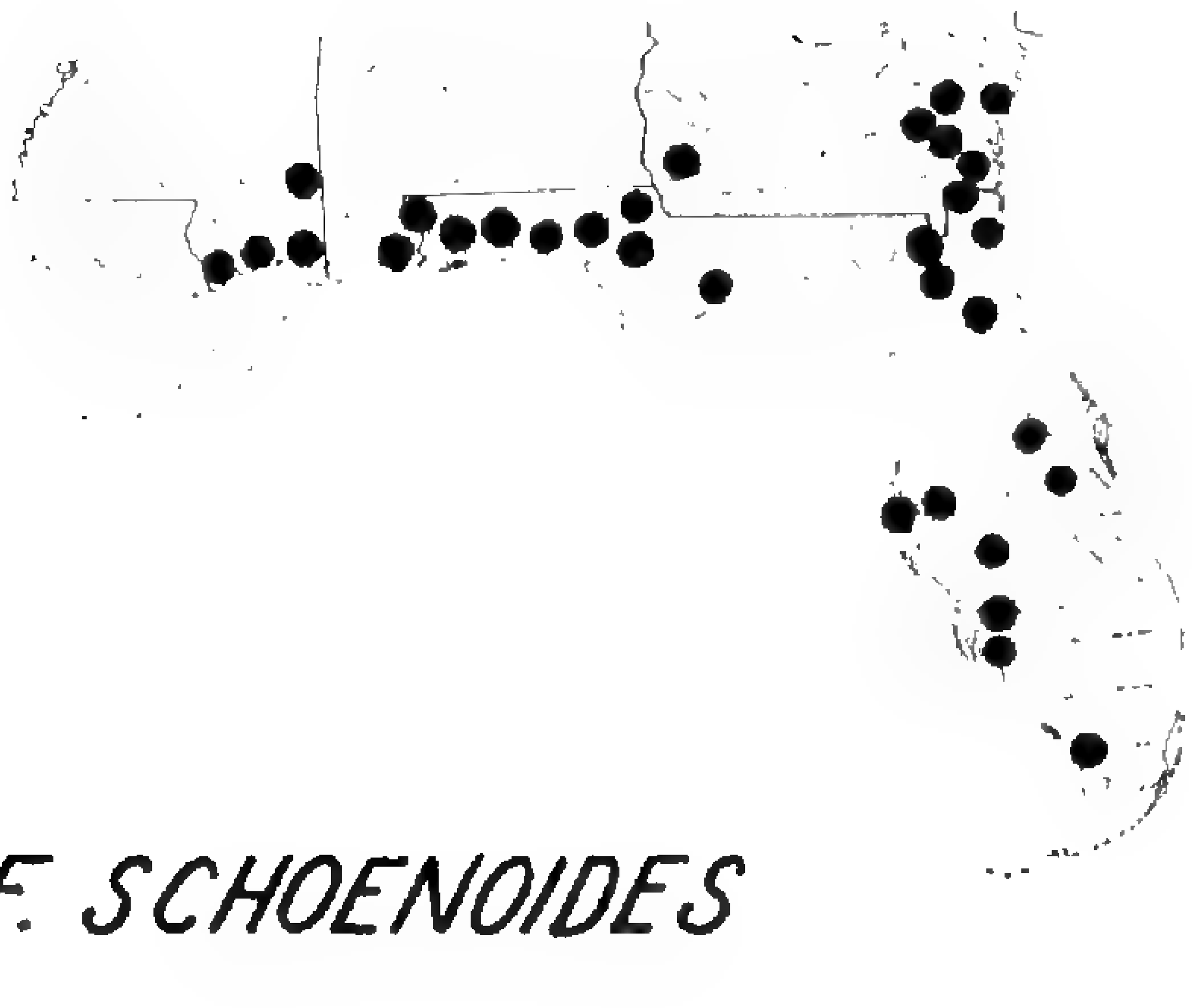

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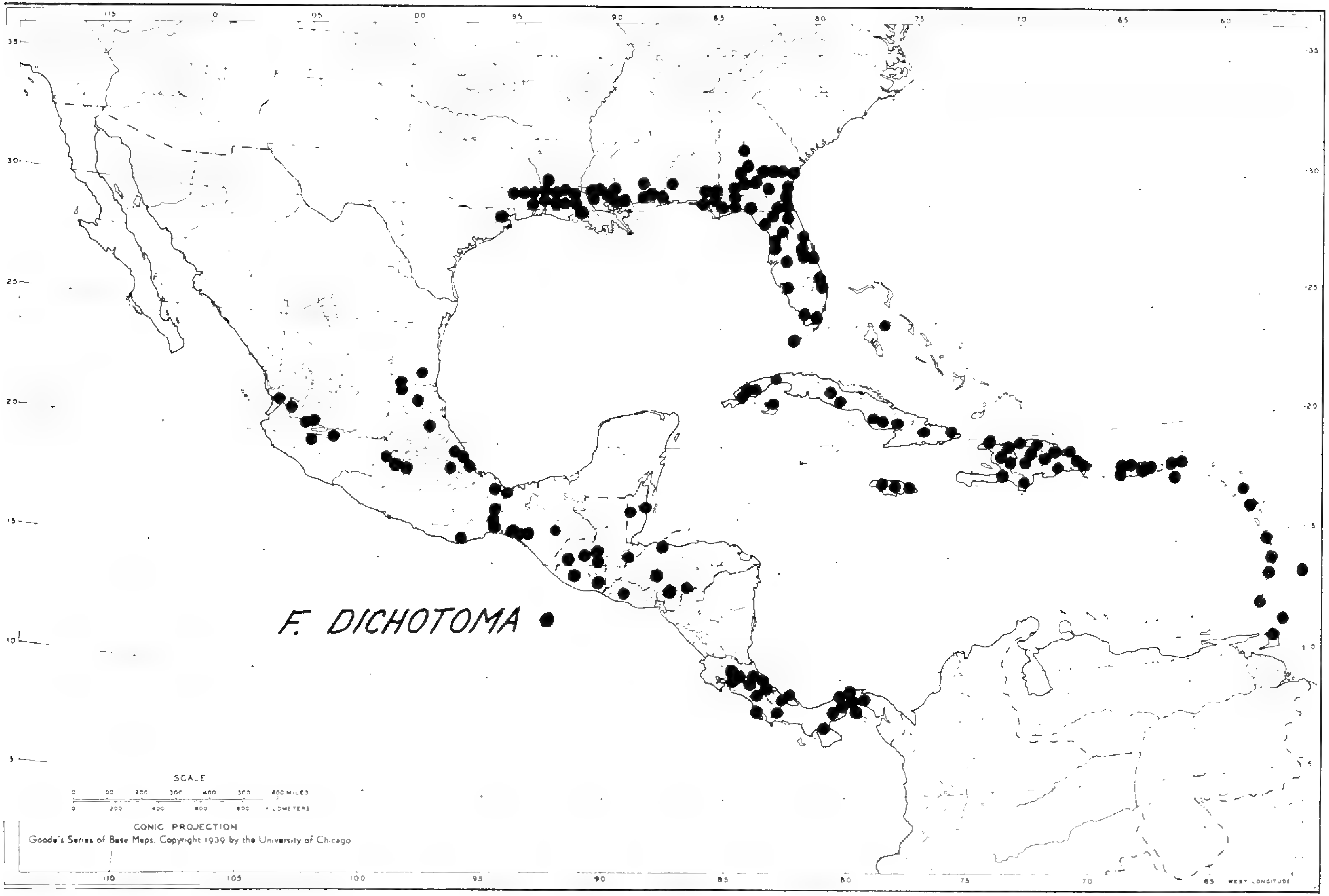
F. DICHOTOMA
SCALE
MILES
KILOMETERS
CONIC PROJECTION
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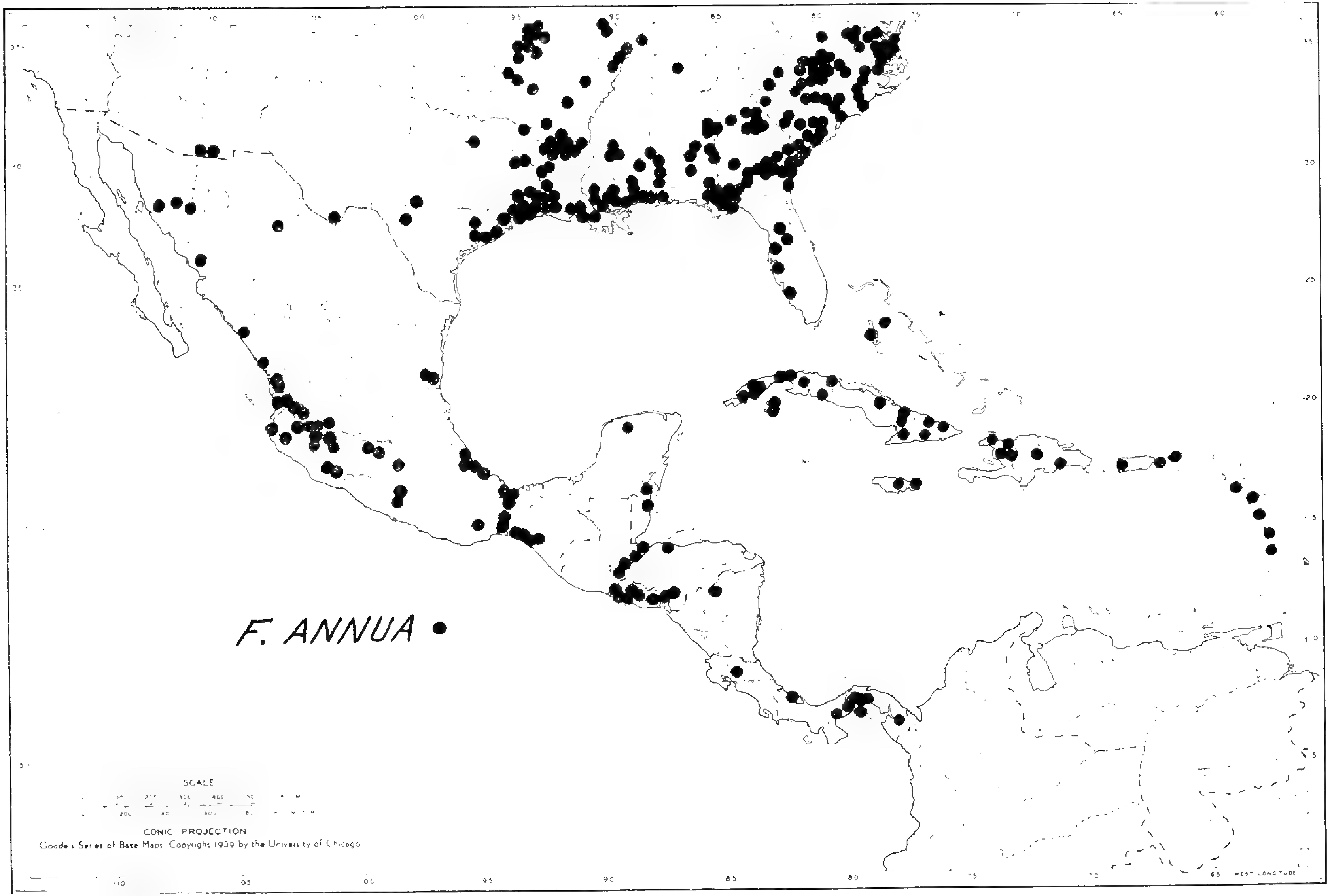
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CONIC PROJECTION
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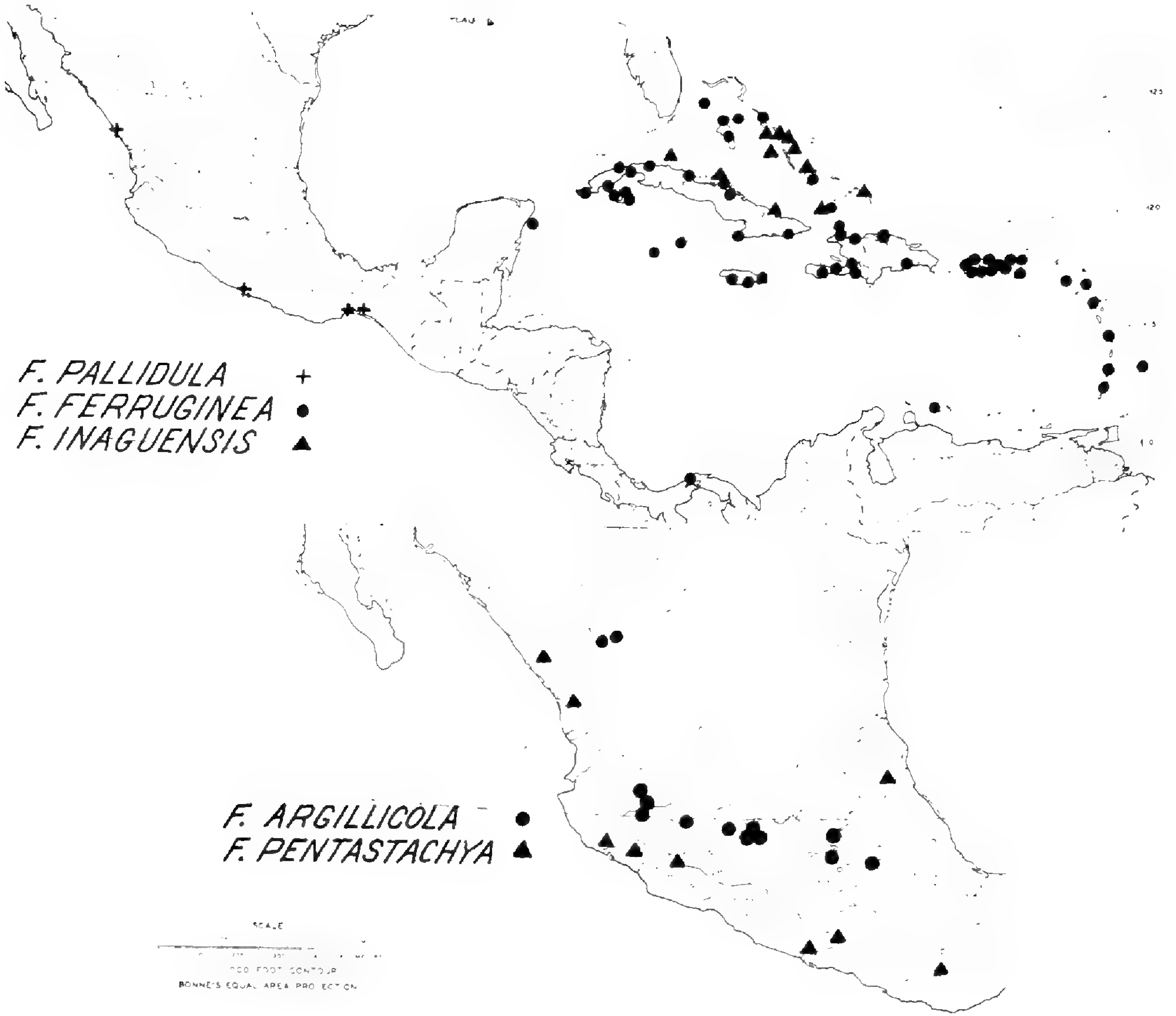
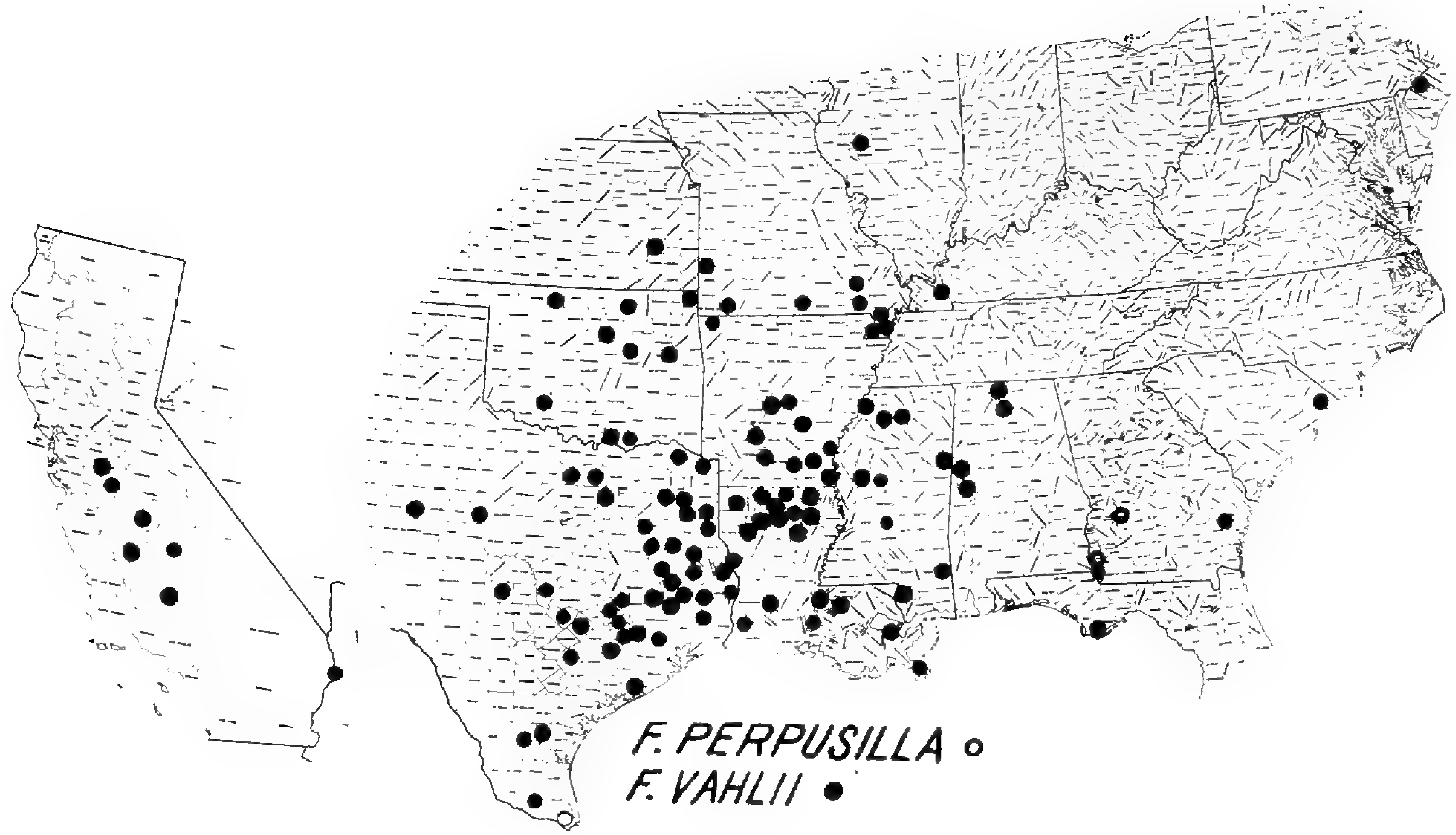
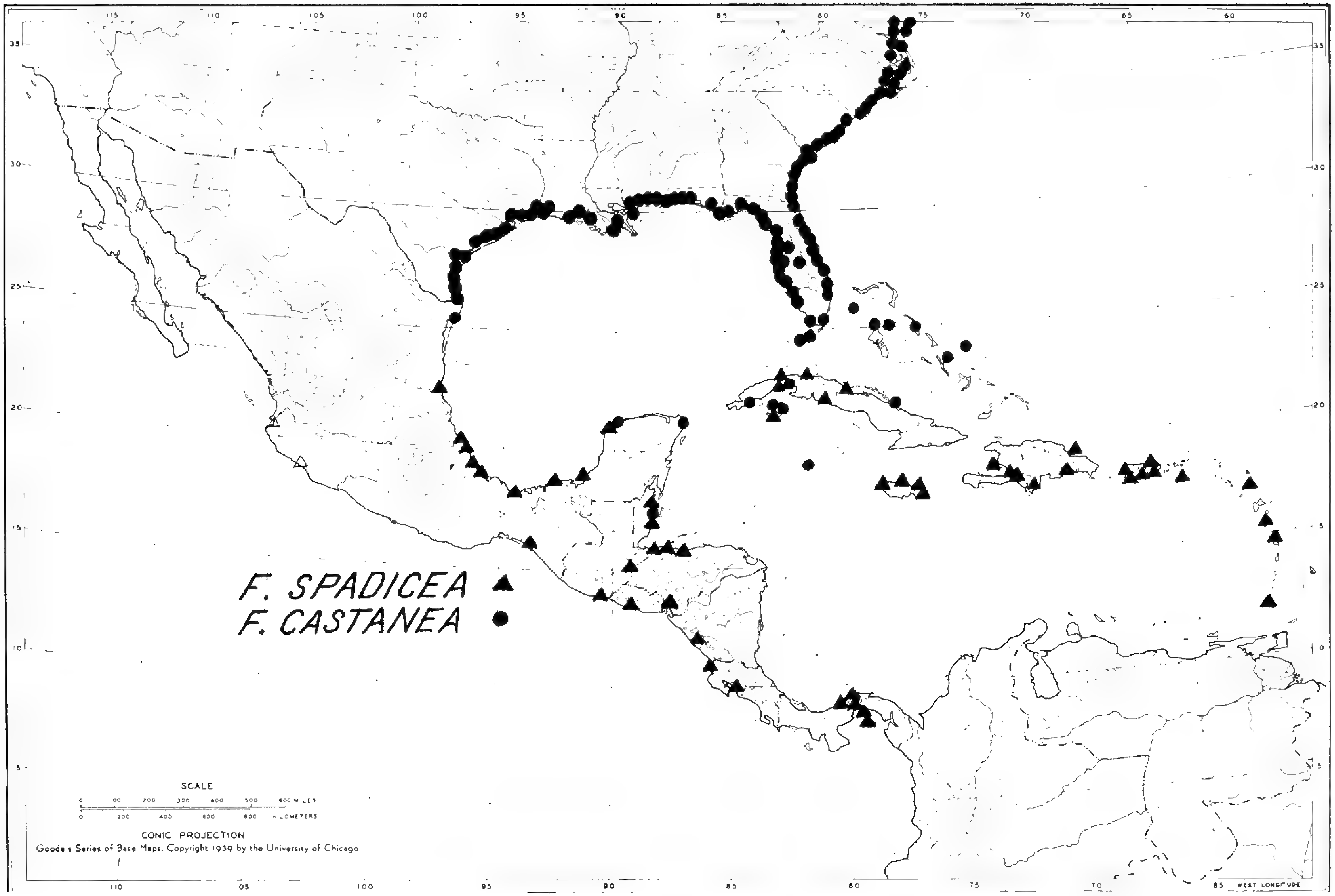

F. PALLIDULA +
F. FERRUGINEA ●
F. INAGUENSIS ▲
F. ARGILLICOLA ●
F. PENTASTACHYA ▲
SCALE


F. PERPUSILLA o
F. VAHLII ●


F. SPATHACEA


F. SPADICEA
F. CASTANEA
SCALE
CONIC PROJECTION
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F. THERMALIS
F. PUBERULA
F. PUBERULA VAR. INTERIOR

PARTIAL INDEX

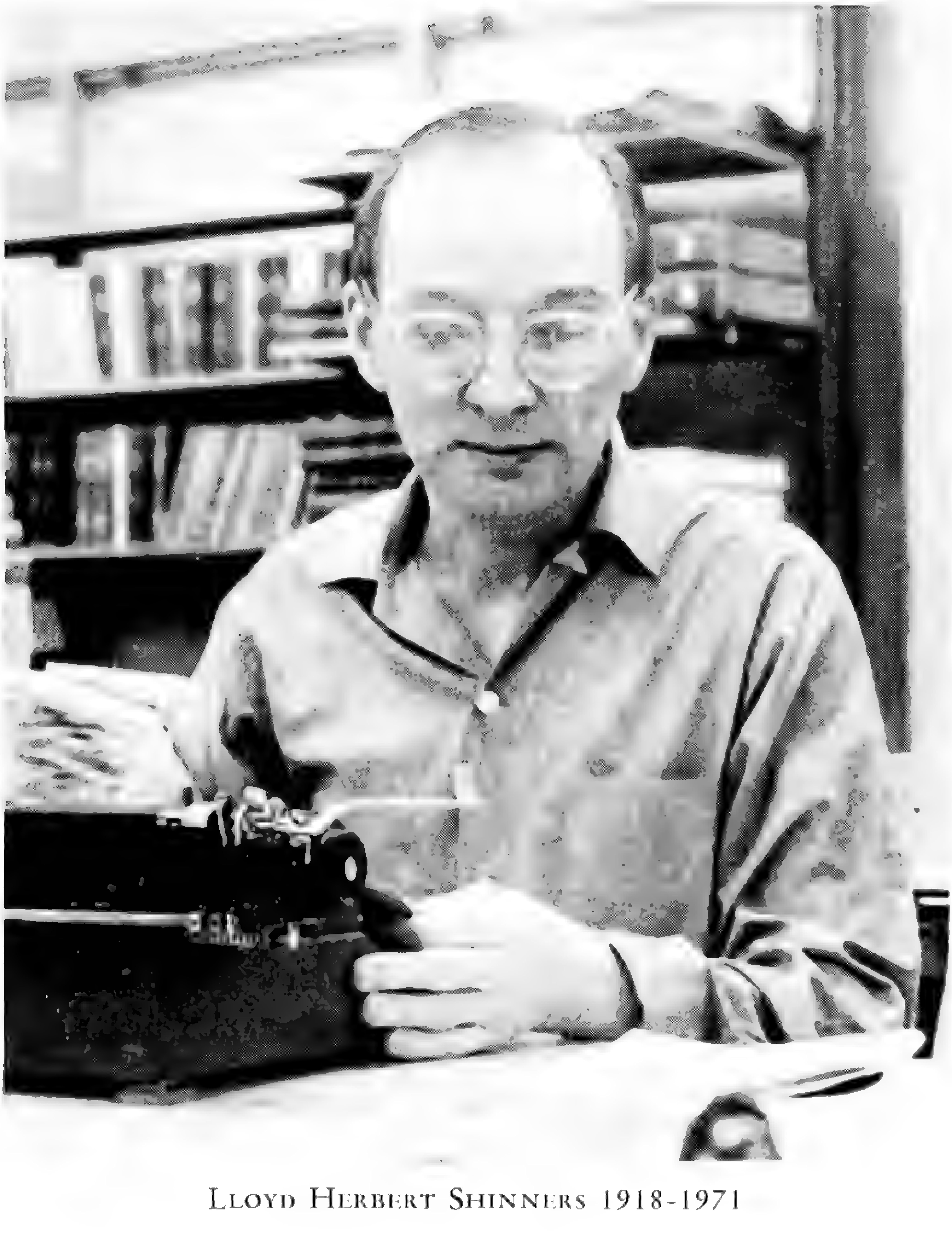
Only names of accepted taxa are included below. Page numbers are for main text discussion and for illustration(s). Those marked with an asterisk* are newly published. Names of **Fimbristylis** species in parentheses are only briefly noted in text but not described in detail, though illustrated. Maps are indexed separately on page 208. Chromosome counts are summarized on pages 64-69; captions for all chromosome figures are on pages 198-201.

SIDA CONTRIBUTIONS TO BOTANY

VOLUME 4 NUMBER 3 JULY 1971

CONTENTS

SIDA, founded by Lloyd H. Shinners, is privately published by Wm. F. Mahler, SMU Herbarium, Dallas, Texas 75222, U.S.A. Subscription price $8 (U.S.) per volume; parts issued at irregular intervals.



Lloyd Herbert Shinners 1918-1971

LLOYD HERBERT SHINNERS 1918-1971

WM. F. MAHLER[1]
Herbarium and Department of Biology,
Southern Methodist University, Dallas, Texas 75222

Lloyd Herbert Shinners was born at Blue Sky (Peace River country), Alberta, Canada on 22 September 1918, and moved with his parents to Wisconsin at an early age where he attended the public shools in Milwaukee. As valedictorian of his high school class, he received a scholarship and attended the University of Wisconsin where he obtained the B.A. (1940), M.A. (1941), and Ph.D. (1943).

He accepted a position as research assistant in systematic botany at SMU in 1945. He became a member of the academic faculty in 1947 (Assistant Professor, 1947; Associate Professor, 1955; Professor, 1960), Acting Director of the Herbarium in 1948, and Director of the Herbarium in 1949.

His life was devoted to taxonomic botany and his major goals were achieved within his lifetime. The chief goal was to make the S.M.U. Herbarium the largest and finest in the South and Southwest. His principal concern in the last few years was to keep the S.M.U. Herbarium and its taxonomic library in that position. The S.M.U. Herbarium grew from ca. 20,000 to 340,000 specimens in the 23 years it was under his direction. The top priority of the herbarium activities was to mount and file plant specimens so others could borrow them for study. When I came to the SMU Herbarium in 1968, this top priority was quite apparent for he was mounting an average of 10,000 sheets per year himself in addition to his other numerous activities. Herbarium loans ranked high in the unofficial list of priorities and in the last few years, over 5,000 sheets per year were loaned to other institutions for research purposes.

The taxonomic library is ranked between 12th and 15th in the nation and the best in the South and Southwest (south of the Missouri Botanical Garden, east of Berkeley, California to Chapel Hill, N.C.). His diligence and persistence in obtaining a good buy on a book was often rewarded only after years of searching book catalogues. He was proud of the taxonomic library and its position within the herbarium where the literature is readily available when one needs it. His knowledge of seven languages enabled him to operate this facet very efficiently.

In addition to the curatorial duties, his research activities resulted in over 250 single author publications ranging from short nomenclatural notes to his book, "Spring Flora of the Dallas-Fort Worth Area." Plans are

[1] I would like to thank his sister, Mrs. Helen Koresh (800 Western Ave., Cedarburg, Wisconsin, 53012), for providing the photograph.

being made to publish a complete bibliography in the future. When he had difficulty in publishing a lengthy and somewhat controversial manuscript, he founded his own botanical journal, "Sida, Contributions to Botany," and that manuscript was the first article in the new journal. He wanted to have at least one controversial paper per volume even though it was not always possible. When papers were turned down by other journals because of political reasons, etc., he would delight in publishing them. Very few, however, were submitted and published for these reasons. Priorities were also established with nomenclatural papers taking the highest rank.

Until I came to SMU, I regarded him as more of an "armchair botanist"—one of his many postcard signatures, for he seldom signed his name—than as a field botanist in spite of his high collection numbers. The necessity of field work was emphasized and I soon realized that he spent more time in the field than any other botanist I had ever known. In the last few years, he averaged at least 5 days per month in the field studying distribution, various species complexes, as well as general collecting. Some individuals have regarded his knowledge of plants as "intuition" which he would jokingly comment that they, too, could have this "intuition" if they would only study the plants in the field. An attempt to become a citizen of the United States evolved into a major ordeal and, thus, he remained a Canadian citizen living within the United States, unable to travel and collect plants outside of its boundaries.

Money was a necessity that he used for purchasing private herbaria, taxonomic literature and plant collections, to finance field trips, subsidize authors not able to pay page costs, for photocopying journal articles, entertaining visitors, etc. The source of the money was of no particular concern—the meager herbarium budget, his personal salary, gifts, or the Dallas Teachers Credit Union; if he did not have the money, he borrowed it.

My association with him the past three years compels me to comment upon an item which has been a constant source of irritation or amusement depending upon the origin—the personality of L. H. Shinners. He was one of the most congenial individuals I have ever had the pleasure of working with or for in any business or academic capacity. He was a soft-spoken person, never raising his voice regardless of how perturbed he might be, who always had time to discuss any item that you presented him with and who usually gave you a detailed history of the origin, etc., of the subject matter. Arguments were nil; he stated his viewpoints and listened to mine and the "discussion" ended unless references were sought in conjunction with nomenclatural topics, etc. Responsibilities assigned to me, such as student help, etc., were wholly mine and he stated often, "I'll sign whatever you bring me" in regard to papers requiring his signature as Director. He eliminated or ignored all paper work which did not contribute directly to the objectives of the Herbarium. He was very conscious of public relations and tried to reflect a good image for the SMU Herbarium.

In evaluating his abilities as an administrator, he would rank extremely high in efficiency. His ability to avoid busy-work associated with administrative duties was incredible. One example was his use of postcards which enabled him to carry a heavy correspondence load with less effort, comparatively speaking (no duplicate letters to be retained for filing, no forms for loans, exchanges, etc.). Herbarium records were extensive but a pen and note cards were used in the place of typed forms so common (occupy less space and easier to handle for preparation of annual report). It was noted by the lawyer of his estate that the same operation in any normal business would have required a herbarium assistant, secretary, typist, and accountant. Yet, one man who was in ill-health for many years and nearly blind at the time of death, performed all of these functions.

His diabetic condition, which plagued him for many years, contributed to a gradual decline in his health. After a short illness and hospitalization, he died on the evening of 16 February 1971 at the Presbyterian Hospital, Dallas, Texas.

LEGUMES OF THE UNITED STATES: III. SCHRANKIA[1]

DUANE ISELY
Department of Botany and Plant Pathology, Iowa State University
Ames, Iowa 50010

The objectives and format of these publications have previously been presented (Isely, 1969). Accessions of *Schrankia* from the following herbaria were studied during preparation of this paper: New York Botanical Garden (NY), Iowa State University (ISC), University of Texas (TEX), New Mexico State University (NMC), University of Arizona (ARIZ), University of Southwestern Louisiana (LAF), Mississippi State University (MISSA), Florida State University (FSU), and the University of South Florida (USF). Selected materials and (or) types have been studied courtesy of the following: Southern Methodist University (SMU), Gray Herbarium (GH), Missouri Botanical Garden (MO), Lundell Herbarium (LL), U.S. National Museum (US), and the Philadelphia Academy of Natural Sciences (PH). My thanks to the institutions and herbarium curators.

SCHRANKIA Willd.

Prickly, sprawling or ascending to subscandent, herbaceous (in U.S.) perennials. Stems tetragonal to ribbed-terete. Prickles internodal, mostly curved, widened to base, thinly or closely dispersed on stems, leaf petioles and rachises, peduncles and fruits. Leaves eglandular, twice-pinnate, usually sensitive. Pinnae (1)2—8. Leaflets several, small, mostly 2—5 mm long, nearly symmetric, with a midvein, with or without secondary venation. Stipules subulate, 2—6(10) mm in length. Peduncles axillary, 1—3, often approximating leaves. Flowers perfect or uppermost staminate, in bright to pale pink heads. Calyx campanulate, reduced. Corolla cylindric, ca 3 mm long, the tube longer than lobes. Stamens ca 10. Pods oblong, usually quadrangular and beaked, conspicuously prickly (rarely smooth); margins broad, separating from valves at maturity.

Primarily Mexico and the southern U.S.; scantily to South America, one species extending northward in the U.S. Introduced in Old World tropics. Possibly 15 species.

Chromosome number X = 13, based on six species.

Schrankia is a small, coherent group of undoubted evolutionary unity. A *Mimosa* derivative, it is characterized not only by its non-segmented

[1] Journal Paper No. J-6443 of the Iowa Agricultural and Home Economics Experiment Station, Ames, Iowa. Project 1814. The facilities of the Iowa State Herbarium supported by the Science and Humanities Research Institute were used in the preparation of this paper. This research is funded by the National Science Foundation, Grant GB-7342.

tetragonal pods in which the sutures in most species are broadened to approximately the width of the valves, but by its moderately consistent aspect and habit.

Chromosome base numbers of 13 are common to *Schrankia* and *Mimosa* as well as many other mimosoids. Of *Schrankia* species reported all are diploids except *S. leptocarpa* DC., a tetraploid (Frahm-Leliveld, 1957). A determination of $2n = 24$ for *S. microphylla* (Atchison, 1949) is anomalous, as Turner and Fearing (1960) have previously noted.

I present a review of U.S. *Schrankia* with less than unqualified satisfaction. The amorphous nature of the taxa, and my knowledge that alternative interpretations may have merit lead to disquietude. A leisurely study of the genus in its entirety might—perhaps with expansion of methods—render taxonomic decisions less conjectural. But there has been such a study: *Schrankia* is the subject of a recent, unpublished, monographic investigation (Beard, 1963). The Beard manuscript contains much useful information concerning *Schrankia*. It includes several postulates which, on basis of my geographically limited studies, I cannot properly evaluate. However, it is necessary to take issue with the major premises.

Beard abandons *Schrankia*, submerging it under *Mimosa*. Furthermore, he reduces the genus to one species, *Mimosa quadrivalvis* L. He says "Absolutely no character has been found that can be said to be peculiar to *Schrankia* apart from *Mimosa* L. emend. Benth. It is concluded that to maintain *Schrankia* Willd. as a genus distinct from *Mimosa* L. while subscribing to the broad concept of the latter genus as maintained by most recent botanists publishing in the group is indefensible, and therefore *Schrankia* Willd. must be recombined with *Mimosa* L."

Reserving philosophical response to the Beard proposition, I comment only in a pragmatic vein: (1) The characters of *Schrankia* are congruent to the degree that the genus is more easily recognized—even by the uninitiated—than most mimosoid genera. (2) Were Beard's viewpoint of generic delimitation taken up for the Mimosoideae as a whole, the subfamily (family of many authors) would probably have to be reduced to 1 or 2 genera. I doubt that this would be practical or reasonable.

Beard's second prescript is that *Schrankia in toto* represents a single species. Perhaps my presentation recognizes too many species (e.g., *S. hystricina*, a geographic variant of *nuttallii*; *S. latidens*, an element of a polymorphic Mexican complex). But I find Beard's position somewhat extreme. Both Beard and I indeed have observed that several of the subordinate taxa are "messy." Beard mentions intermediates between geographically contiguous taxa (but the number of such cited is very small in proportion to the total number of sheets seen). Many taxa lacking compatibility barriers betray such sins. Their "virtue" has been dependent on ecological or geographic isolation; but many such isolations have been eliminated or reduced by man's subjugation of the world.

The most useful regional summary of *Schrankia* is that of Turner (1959) for the state of Texas. As to the species that he treats, my interpretations differ only in detail; I suspect that certain of my premises derive from Turner.

SCHRANKIA Willd. Sp. Pl. 4: 1041. 1806! nom. cons. non *Schrankia* Gmelin 1791. Type species: *Schrankia aculeata* Willd. nom. illeg. = *Mimosa quadrivalvis* L.

LEPTOGLOTTIS DC. Mem. Leg. 451. 1827!

MORONGIA Britt. Mem. Torr. Bot. Club 5: 191. 1894!

I follow the choice of type species designated in the Nomina Generica Conservanda (Lanjouw, 1966): *Schrankia aculeata* Willd. Literature contains the spelling variant "*Schranckia.*" Perhaps this has been derived from a change made by DeCandolle (loc. cit.). In any event, Willdenow named the genus for a man by the name of Schrank and employed the spelling *Schrankia.*

DeCandolle was uncertain of the relationships of his *Leptoglottis* to *Desmanthus* and *Schrankia* and described the genus "provisoirement." Beard (1963), with technical correctness, takes the position that the name was not validly published at that time and attributes publication to Standley (1925). The problem is academic except as it bears on the authorship of *S. nuttallii* (which see).

KEY TO SPECIES

1. Leaflets with evident lateral venation beneath.
    2. Florida species; leaflets not or slightly cuspidate . . . . *Schrankia uncinata*
    2. Central States species; leaflets shortly cuspidate.
        3. Pod 2—4(5) cm long, not beaked; flower buds often with protruding bracts; peduncles 5—10 cm long; southeastern Texas and adjacent Louisiana . . . .*S. hystricina*
        3. Pod 4—10 cm long, beaked or pointed; flower buds with bracts concealed; peduncles 2—8(10) cm long; widely distributed, Texas to South Dakota . . . . *S. nuttallii*
1. Leaflets with only midvein evident.
    4. Species of Louisiana to Carolinas and Florida; pinnae usually 6—8 pairs except in peninsular Florida . . . . *S. microphylla*
    4. Species of Texas to New Mexico; pinnae mostly 2—5 pairs except in western Texas.
        5. Stems evidently puberulent (infrequently glabrate in New Mexico); pinnae 4—7(8) pairs; pods tetragonal; western Texas and adjacent New Mexico . . . . *S. occidentalis*
        5. Stems glabrous or very finely puberulent; pinnae (2) 3—5 pairs; pods compressed (central Texas) or tetragonal (eastern Texas).
            6. Pod laterally compressed, 4—5 mm wide; pinnae 3—5(6) pairs; petiole usually shorter than rachis; stems rarely quadrangular,

often exceeding 2 mm in diameter; central Texas, east to Frio, Travis, and Dallas Co's. . . . . *S. roemeriana*

6. Pod tetragonal, 2—3(4) mm wide; pinnae 2—4(5) pairs; petiole usually exceeding rachis; stems frequently quadrangular above and less than 2 mm in diameter; eastern and southern Texas—northwest margin of range through Zavala, Comal, and Robertson Co's. . . . . *S. latidens*

SCHRANKIA HYSTRICINA (Britt. & Rose) Standl.

Southeastern Texas (Matagorda Co. north to Shelby Co., west to Brazos Co.) and adjacent southwestern Louisiana. Pine woodlands, coastal grassland; disturbed areas, roadside, etc.; moist, sandy soils. Locally frequent. (March) April—June.

Chromosome number 2n = 26 (Turner and Beaman, 1953)

This taxon seems to be *Schrankia nuttallii* except as to total size, the usually elongate peduncles, the large heads, and sometimes exserted floral bracts, and the short, very prickly pods. Plants possessing most of these characters occupy a discrete geographical area wherein they essentially replace *S. nuttallii.* Character correlation is somewhat loose-knit: *viz,* a few specimens beyond the range of *S. hystricina* have unusually prickly pods, but these (the pods) are longer than those of *hystricina*; not all *hystricina* possess the distinguishing bracts; some material without unusually long peduncles possesses the characteristic *S. hystricina* pods; vigorous *S. nuttallii* may have long peduncles. B. L. Turner has commented (personal correspondence): "It [*S. hystricina*] is a much larger plant than *S. nuttallii.* To my knowledge it does not grow with *nuttallii,* occupying a wetter habitat. It acts like a species."

I define *S. hystricina* on the basis of pod-range correlation but am inclined to the view that the case for specific rank may be moot.

The pods range from brick-shaped-tetragonal to as flat as those of *S. roemeriana.* This variance may, in part, represent a function of maturity —the sutures widening after the valves.

Schrankia hystricina (Britt. & Rose) Standl. Field Mus. Publ. Bot. 8:13. 1930! *Leptoglottis HYSTRICINA* Small ex Britt. & Rose N. Am. Fl. 23:139. 1928! Type NY! Isotypes MO! and US! Hall 170.

Hall 170 at both NY and MO is heterogeneous, probably representing more than one gathering. Among this material, I have designated a type which is congruent with the description of *S. hystricina.*

SCHRANKIA LATIDENS (Small) Schum.

Eastern and southern Texas. Mexico. Ranging from oak woodlands in northern part of range to grassland and thorn scrub in south; mostly sandy or gravelly soils, often semiweedy along roadsides and disturbed areas. (March) April—July (Sept.)

Chromosome number 2n = 26 (Turner and Fearing, 1960).

Schrankia latidens represents the northern outlier of an extensive Mexican complex which possesses relatively few pinnae, nonreticulate leaflets and usually angular stems. I have taken the position that the U.S. representatives and some of the Mexican phenotypes represent elements of a single species. I do not know whether the complex in entirety should be best considered one or several species. It has not been easy to garner interpretive satisfaction from Beard (1963) who includes *S. latidens* under *Mimosa quadrivalvis* subspecies *quadrivalvis*, variety *quadrivalvis*, ecotype 4 (I am neither accepting nor publishing this combination.).

Thus, *Schrankia latidens* of the present treatment is approximately traditional except that material of the eastern Texas oak woods region formerly assigned to *S. microphylla* (e.g., Turner, 1959) is herein regarded as the northern phase of *latidens*. I distinguish *S. latidens* from *S. microphylla* of the eastern coastal plain on a combined geographic-morphological basis: (1) They are geographically disjunct. (2) *S. microphylla* possesses mostly (4)6—8(11) pairs of pinnae and 9—12 pairs of leaflets; the stems are angular-terete to infrequently nearly quadrangular. *S. latidens* has 2—4(5) pairs of pinnae and 5—9 pairs of leaflets; the stems, particularly in the southern part of the range, are frequently distinctly quadrangular.

Schrankia microphylla excluded, Texas *Schrankia* with nonreticulate leaflets then includes three closely related species. *S. occidentalis* is reasonably distinct on the basis both of range and morphological characters. *S. latidens* and *S. roemeriana* possibly represent an intergradient complex: *S. latidens*, eastern and coastal plain sands, and *S. roemeriana*, interior, limestone. Their differentiation is discussed under the latter species. After extraction of *S. roemeriana*, the heterogeneous residue is then *S. latidens*. I recognize this material is not all of a type, but I can neither presently justify several species as some authors have done, nor accept the opposite extreme advocated by Beard (1963).

The pods of *Schrankia latidens* are diverse in degree of prickliness, length, and width. Their form ranges from stubby (ca 4 cm), and heavily prickly, to narrowly linear (to 16 cm in length), somewhat sinuous, and lightly prickly.

Leptoglottis halliana Britt. & Rose, as to description, is *S. latidens* minus prickles on the pods. Beard (per annotations) has marked certain specimens with long, slender pods as *S. halliana*.[2] Some of these specimens have almost unarmed pods; some are quite prickly. Possibly (as in *S. microphylla*) pod variance has biological significance; however, the proportion of specimens with "good" pods is so low that correlation with other characters or range is difficult to study.

Schrankia latidens of the southern coastal plain includes populations of vigorous plants that possess 3—4 pinnae, and have larger heads than

[2] Beard employed two annotation "systems" during his work. His use of *Schrankia* binomials seems mostly post 1963.

"typical" *S. latidens*. They resemble, in these ways, *S. roemeriana* of the interior. But the pods when present are not those of *S. roemeriana*. Beard (annotations) has taken up *S. nelsonii* (Britt. & Rose) for some of this material.

One collection, Cory, 9/27/44, Aransas Co., Texas (FSU) is a reduced latidens-like "thing." The stems are filamentous-slender and obscurely prickly, and the leaves bear only 1—2 pinnae at the ends of long petioles; the moderately prickly pods are narrow-linear and well beaked. Except for the pod beak, this gathering matches the description and type of the Mexican *Schrankia potosina* (Britt. & Rose) Standl. and it has been marked by Hermann "first record outside Mexico." Beard has annotated a few Mexican sheets as *Schrankia potosina*; they are vegetatively as above but possess short, heavy, scarcely beaked pods. In view of the total range of variance within this complex I refer *S. potosina* to *S. latidens*.

Schrankia latidens (Small) Schum. Bot. Jahresb. 29:540. 1903! *Morongia LATIDENS* Small Bull. N.Y. Bot. Gard. 2:98. 1901! Type NY! Isotype US! Heller 1779. *Leptoglottis latidens* (Small) Britt. & Rose N. Am. Fl. 23:142. 1928!

Schrankia aculeata var? Benth. Trans. Linn. Soc. Lond. 30:441. 1875! *Leptoglottis BERLANDIERI* Britt. in Britt. & Rose N. Am. Fl. 23:144. 1928! Type NY! Isotype MO! and GH! Berlandier 2513. *Schrankia berlandieri* (Britt.) Standl. Field Mus. Publ. Bot. 11:159. 1936!

Leptoglottis HALLIANA Britt. & Rose N. Am. Fl. 23:141. 1928! Type NY! Isotypes MO! US! GH! Hall 171. *Schrankia halliana* (Britt. & Rose) Standl. Field Mus. Publ. Bot. 8:13. 1930!

Leptoglottis POTOSINA Britt. & Rose N. Am. Fl. 23:143. 1928! Type US! Isotype GH! Purpus 5177. *Schrankia potosina* (Britt. & Rose) Standl. Field Mus. Publ. Bot. 11:159. 1936!

Leptoglottis NELSONII Britt. & Rose N. Am. Fl. 23:142. 1928! Type US! Isotype GH! Nelson 6230.

As indicated in the taxonomic discussion, I have not been able to reach a firm decision concerning the relationships of *Schrankia latidens* and its Mexican allies. My circumscription (a provincial one), includes U.S. and Mexican elements which I can refer to one species with considerable confidence. But the complex to which this species belongs includes several older names—herein excluded: *Mimosa quadrivalvis* L. (1753), *Schrankia aculeata* Willd. (1806), *S. mexicana* Raf. (1836), and *S. subinermis* Wats. (1882). The critical earlier epithets boil down to one; *aculeata* is an illegitimate substitute for *quadrivalvis*. *Schrankia quadrivalvis* (L.) Merrill is probably the correct name for this entire group in the event it is considered a single species.

The type (NY) of *Morongia latidens* Small is a vigorous plant with short, long-beaked, heavily prickly pods. A designated isotype (MO!) bearing the same collection number as the type at NY must be excluded. It is *S. roemeriana*! *Leptoglottis berlandieri* (based on the same collection as

Bentham's *S. aculeata* var?) possesses but weakly prickly pods. *Leptoglottis halliana* per description is *latidens* with very slender, long-beaked pods that are nearly unarmed. There are three specimens at NY of Hall 171. Only one of them bears smooth pods; I consider it the type. Duplicates at GH and US are likewise diverse in pod characters. The types of *Leptoglottis nelsonii* and *potosina* represent Mexican forms which I believe clearly fall within *S. latidens*.

SCHRANKIA MICROPHYLLA (Dryand.) Standl.

Southern and southeastern coastal plain; southernmost Virginia, Florida, to eastern Louisiana. Openings or margins of pine or hardwood woodlands, in Florida with turkey oak and pine-palmetto; disturbed, eroded or burnt-over areas, roadsides, sandy to loam soils. (April) May—June or in southern Florida essentially all year.

Chromosome number 2n = 16 (Atchison, 1949)

Schrankia microphylla and *S. nuttallii* represent the major complexes of this genus in the United States, the former primarily of the southeastern, the latter of the central states.

In broad scope, *S. microphylla* is reasonably consistent morphologically. Populations and individual plants differ primarily in degree of prickliness, vigor, presence or absence of puberulence, and shape and prickliness of the pods. Pubescence variation has some geographic orientation and may be of significance taxonomically: e.g., most Florida populations are glabrous; most Alabama and Carolina, puberulent; and most Louisiana, puberulent. I have had little opportunity to attempt interpretation of pod variation because so few specimens possess fruit.

My circumscription of *S. microphylla* includes two variants convenient to discuss by name even though I am not according them taxonomic rank. They are as follows:

BRACHYCARPA variant (var. *brachycarpa* Chapm.; *S. chapmani* Britt. & Rose)

Louisiana, Florida, to North Carolina. Habitat as var. *microphylla*.

Extreme forms of *brachycarpa* are distinctive. They have short pods (mostly 3—5 cm long) which are intensely prickly; the prickles are much widened toward the base; the pods possess little or no beak. This entity has been given specific rank by Small (1933) and Britton and Rose (1928). But one encounters intermediates toward the *microphylla* pod (for example, excessively prickly pods which are, however, elongate, beaked or not). I find no other exomorphic characters correlating with the distinctive pod (thus no way of telling if flowering material will possess the *brachycarpa* pod), and *brachycarpa* seems to have no discernible distributional patterning, being sporadic throughout the range of the species. The genetic complex resulting in this pod type occurs likewise in the *S. nuttallii* group as *S. hystricina* but, in this instance, with geographic orientation.

I am presently considering *brachycarpa* as a recurrent phenotype within *microphylla* populations.

ANGUSTISILIQUA variant [*Schrankia angustisiliqua* (Britt. & Rose) Hermann]

Florida. Pinelands, pine-palmetto, disturbed areas. March—May or all year.

Schrankia microphylla is progressively less robust as one proceeds southward in Florida. The extreme forms, in southern Florida, where they make up most of the *microphylla* populations, possess filiform, usually square, glabrous stems; the pinnae are usually 4—5 pairs; the leaflets are small, not exceeding 2 mm; flower heads are 1 cm or less in diameter; and the pods are slender, but moderately prickly.

The *angustisiliqua* variant thus differs from typical *microphylla* in a number of features. But its irregularly clinal nature seems to defeat any merit in according it taxonomic recognition.

Schrankia microphylla (Dryand.) MacBride Contr. Gray Herb. 59:9. 1919! *Mimosa MICROPHYLLA* Dryand. in J. E. Smith Insects Georgia 2:123. 1797! *Morongia microphylla* (Dryand.) Britt. ex Britt. & Brown Ill. Fl. ed. 2, 2:334. 1913! *Leptoglottis microphylla* (Dryand.) Britt. & Rose N. Am. Fl. 23:142. 1928! *Schrankia microphylla* (Dryand.) Standl. Field Mus. Publ. Bot. 8:13. 1930!

Mimosa HORRIDULA Michx. Fl. Bor. Am. 2:254. 1803! Photo of type (from P) ISC! *Schrankia horridula* (Michx.) Chapm. Fl. South. US. ed. 2. 683. 1892! *Morongia horridula* (Michx.) Heller Cat. N. Am. Pl. 5. 1898!

Schrankia ANGUSTATA T. & G. Fl. N. Am. 1:400. 1840! *Morongia angustata* (T. & G.) Britt. Mem. Torr. Bot. Club 5:191. 1894!

Schrankia angustata BRACHYCARPA Chapm. Fl. South. U.S. 116. 1860! non *S. brachycarpa* Benth. 1840! *Leptoglottis chapmanii* Small ex Britt & Rose N. Am. Fl. 23:141. 1928! *Schrankia chapmanii* (Small ex Britt. & Rose) Hermann Jour. Wash. Acad. Sci. 38:237. 1948!

Schrankia horridula var. *ANGULARIS* Chapm. Fl. South. US. ed. 3. 127. 1897! Type US! Chapman "Fence rows near Rome, Georgia . . . var. *angularis*" (Chapman handwriting). *Morongia horridula angularis* (Chapm.) Heller Cat. N. Am. Pl. 5. 1898!

Leptoglottis ANGUSTISILIQUA Britt. & Rose N. Am. Fl. 23:143. 1928! Type US! Small & Mosier 6349. *Schrankia angustisiliqua* (Britt. & Rose) Hermann Jour. Wash. Acad. Sci. 38:237. 1948!

As to concept:

Mimosa intsia sensu Walt. Fl. Carol. 252. 1788! "*M. intsia* Walt." auct. pl. non *M. intsia* L. 1753!

The first binomial traditionally referred to this species is "*Mimosa intsia* Walt." (1788, loc. cit.). But *Mimosa intsia* of Walter was not proposed as a new name; it is simply a misapplication of the Linnaean *Mimosa intsia* as MacBride (1919) noted some years ago.[3]

The identity of *M. intsia* sensu Walt. with *M. microphylla* is reasonable but unequivocal demonstration has been lacking. Britten (1920) reported Walter's plant as *S. microphylla* but his dubiousness concerning the mutual discernibility of *S. uncinata* (*nuttallii*) and *microphylla* ("I can see no sufficient differences between them") essentially nullifies his observation. Dr. N. K. B. Robson has kindly responded to an inquiry to the British Museum as follows (personal correspondence): "The specimen of *Mimosa intsia* is on p. 73 of the Walter volume. From a comparison with material in our main collection, it seems that the Walter specimen does belong to *Schrankia microphylla*." But combinations based on "*Mimosa intsia* Walt." [*Schrankia intsia* (Walt.) Trelease ex Branner and Coville, 1891; *Leptoglottis intsia* (Walt.) Rydb., 1894] are largely *Schrankia nuttallii* as to concept.

Mimosa microphylla Dryand. is clearly identified by the plate. Some authors attribute this species to Solander. The Solander case is presented by Britten (1920). I have accepted the credit line in the original publication as appropriate identification of authorship. I have previously discussed the identity of *M. horridula* Michx. (Isely, 1957). Torrey & Gray's description of *S. angustata* indicates their concept to lie largely (if not entirely) within the circumscription of *S. microphylla*. They cite three specimens. I have seen two gatherings (both *S. microphylla*) at GH which probably represent part of the original material; but label data does not coincide with the published citations.

The description of *Leptoglottis angustisiliqua* Britt. & Rose suggests that the original material might have been *S. uncinata*. The type, however, is the slender-podded, tenuous, Florida form of *S. microphylla*. Britton and Rose state "Pinelands of Florida, and in Texas." The nature of Texas material is conjectural, possibly *S. latidens*.

The only Chapman sheet I have seen marked as *Schrankia angustata* var. *brachycarpa* is US! "S fl. Florida." It is reasonably consistent with the description except that the slender, strongly prickly pods scarcely deserve the epithet *brachycarpa*.

SCHRANKIA NUTTALLII (Britt. & Rose) Standl.

Illinois, South Dakota, Texas, Louisiana. Prairies, open woodlands, clearings, roadsides and other disturbed sites, usually sandy or rocky soil, frequent and often abundant. April (south)—July (north).

Chromosome number 2n = 26 (Turner and Beaman, 1960)

This *Schrankia*, the most widely distributed species, extends further

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[3] Walter complicated matters for posterity by providing no citations to previous authors. But most of his new species are in italics—which *M. intsia* is not. Also, his diagnosis is almost identical with that of the Linnaean *M. intsia*.

north in the U.S. than any other mimosoid—*Desmanthus illinoensis* and the introduced *Albizia julibrissin* are the closest competitors. It is an inhabitant of grasslands and of the contiguous wooded provinces. It has been reported from several of the southeastern states, presumably because of erroneous determinations of *S. microphylla* or *S. uncinata*. *S. hystricina*, southern Louisiana, is probably a geographical segregate of *S. uncinata*, but the pods are so different that I am retaining it as a species.

Leptoglottis nuttallii DC ex Britt. & Rose. Fl. N. Am. 23: 139. 1928! *Leptoglottis NUTTALLII* DC. Mem. Leg. 451. 1827! nom. invalid. Presumed fragment of type NY! Nuttall "Hab . . . territorio Arkansano." *Schrankia nuttallii* (Britt. & Rose) Standl. Field Mus. Publ. Bot. 8:13. 1930!

Leptoglottis MIMOSOIDES Small ex Britt. & Rose N. Am. Fl. 23: 109. 1928! Type NY! Ruth 13.

As to concept:

Schrankia intsia (Walt.) Trelease ex Branner & Coville. Plants Ark. 178. 1891! *Leptoglottis intsia* (L.) Rydb. Bot. Surv. Neb. 3: 33. 1894! neque *M. intsia* L. 1753!; neque *M. intsia* sensu Walt. 1788!

Schrankia uncinata auct. pl. non Willd. 1806! *Leptoglottis uncinata* (Willd.) Rydb. Fl. Nebr. 21: 31. 1895!

Neither the DeCandolle description nor the fragmentary isotype seen provide an unequivocal distinction between *S. hystricina* (Britt. & Rose) Standl. and *S. nuttallii* DC. The cited collection, a Nuttall sheet "Hab . . . in Americae borealis territorie Arkansano (V.S. in herb. Mercier.)," is not represented in the DeCandolle herbarium (microfiche examination). The unavailability of the original specimen is noted by Beard (1963). I render the conventional determination: that the material is probably of the widely distributed species rather than its local derivative.

See *Schrankia uncinata* for typification of that specific epithet.

Leptoglottis mimosoides is characterized on the basis of flattened pods; those of the type are indeed somewhat less than quadrangular and perhaps the plant possesses some degree of genetic intermediacy with *S. roemeriana*. The NY type is designated "RR embankment 5 miles from Fort Worth." Two MO "isotype" sheets possess the same collection number but "Valley of the Trinity, 6 miles from Fort Worth, June 10, Aug. 5, 1912." They probably represent another gathering. A US "type" apparently constitutes yet a third collection.

Beard (1963) rejects *Leptoglottis nuttallii* of DC. 1827, and attributes the name to DC. ex Britt. & Rose N. Am. Fl. 23: 139. 1928. He reasons that DeCandolle published the genus *Leptoglottis* "provisoirement," and since the single species *L. nuttallii* was presented following a combined generic-specific diagnosis, it was not validly published. Although there was no uncertainty in DeCandolle's viewpoint of the new species: "il s'est presénté à moi une belle espèce de Mimosée," (his indecision related only to the generic relationships of his plant.), Beard's position is correct.[4] Valid publication of *L. nuttallii* seems not to have occurred until 1928 (Britton & Rose, loc. cit.). Thus, *L. nuttallii* is thrown into priority competition with the century later but simultaneously published *L. mimosoides* Small ex Britt. & Rose (loc. cit.). Beard (loc. cit.) seems to be the first individual to have chosen one of these epithets (*nuttallii*) relegating the other (*mimosoides*) to taxonomic synonymy.[5]

SCHRANKIA OCCIDENTALIS (W. & S.) Standl.

Eastern New Mexico and western Texas. Sandy soils, dunes to roadsides. April—June (Sept.).

Chromosome number 2n = 24 or 26 (Turner and Beaman, 1953; Turner and Fearing, 1960).

This, the westernmost species of *Schrankia*, can usually be easily determined by its distribution and slender, coarsely prickly pods. I cannot credit MacBride's assertion that "*Morongia occidentalis* . . . seems to merely be a pubescent state of *S. roemeriana*." MacBride must have had only flowering and immature fruiting material available.

A sand dune form (Winkler Co., Texas) is distinctive being almost unarmed and glabrate; the leaves possess 6—9 pairs pinnae to 20 pairs of tiny (ca 2 mm long) leaflets.

Schrankia occidentalis (W. & S.) Standl. Field Mus. Publ. Bot. 8:13. 1930! *Morongia OCCIDENTALIS* Wooten & Standley Contr. U.S. Natl. Herb. 16:135. 1913! Type US! Isotypes MO! GH! Fisher, Nara Visa, New Mexico. July 4, 1911. *Leptoglottis occidentalis* (W. & S.) Britt. & Rose N. Am. Fl. 23:140. 1928!

SCHRANKIA ROEMERIANA (Scheele) Blankinship

Northcentral Texas south to Frio Co. Rocky limestone soils; prairies, or with mesquite and oak; roadsides. April—July.

Chromosome number 2n = 26 (Turner and Fearing, 1960).

Schrankia roemeriana replaces *S. latidens* to the north and west of the latter; *S. roemeriana* is primarily of limestone soils, *latidens* of sands. The two are marginally sympatric, and I cannot always distinguish non fruiting material. In general, *S. roemeriana* is more robust, has larger leaves with more pinnae, proportionally shorter petioles, larger flowering heads, and rarely square stems. I have the impression that southern material of *S. roemeriana* adjacent to *S. latidens* tends to have fewer pinnae and

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[4] "A name of a taxon below the rank of genus is not validly published unless the name of the genus or species to which it is assigned is validly published at the same time or was validly published previously." (Lanjouw, 1966; Article 43).

[5] Cory and Parks Cat. Fl. Tex. 60. 1937 took up *S. nuttallii* but cited only *S. uncinata* auth as synonym. Other authors who have treated Texas *Schrankia* (e.g. Turner, Shinners, Gould, Reeves and Bain) designated the species *S. uncinata*.

leaflets than gatherings further north. But the range of variation is considerable in both species and includes robust phenotypes well within the *latidens* range (assigned to that species).

Do the two species blend biologically? From limited fruiting material, I have little evidence that they do. This is the major reason I have maintained them as distinct species. Pod shape in both species is variable but generally distinctive. Some pods of *roemeriana* lack the ideal compressed form; "stubby" types show up in *latidens* as in *microphylla* in the eastern part of the country. With only one exception, "aberrant" fruiting specimens are not from areas that suggest genetic influence from the other species. The exception is from Frio Co. where *S. roemeriana* and *latidens* overlap. There, the pod characters of one collection (Tharp and Turner 3457) suggest a blend of the two kinds.

Schrankia roemeriana (Scheele) Blankinship Rept. Mo. Bot. Gard. 18:168. 1907! *Mimosa ROEMERIANA* Scheele Linnaea 21:456. 1848! *Morongia roemeriana* (Scheele) Heller Contr. Herb. Frank & Marsh Coll. 1:44. 1895! *Leptoglottis roemeriana* (Scheele) Britt. & Rose N. Am. Fl. 23:140. 1928!

Schrankia PLATYCARPA Gray Bost. Jour. Nat. Hist. 6:183. 1850! Type GH! Isotypes MO! US! Lindheimer 384.

Leptoglottis reverchonii Britt. & Rose N. Am. Fl. 23:140. 1928! Type NY! Reverchon, Calcareous prairies. Dallas, Texas 1877.

I have not seen the original material of Scheele's *M. roemeriana*. The locality "Propre Neubraunfels," in light of known ranges of Texas *Schrankia*, specifies this species. Several Lindheimer specimens designated as from the type locality are *S. roemeriana*.

Gray's superflous *S. platycarpa* was described in full knowledge of Scheele's *M. roemeriana* because "that blundering and unscrupulous propounder of species had not seen the legumes." (Gray's isotype at US possesses no fruit.)

Leptoglottis reverchonii is said to differ from *S. roemeriana* in that the "legume is scarcely beaked; its valves long-prickly." The pods of the type specimen are, within the total range of *M. roemeriana*, scarcely unusual.

SCHRANKIA UNCINATA Willd.

Central peninsular Florida (south on west side to Lee Co.), north in eastern Florida to southernmost Georgia. Pinelands, sandy disturbed areas, white sand scrub, open turkey oak woodlands. Dec.—Sept.

Some material of this species is difficult to sharply discern from *S. microphylla* by any characters save leaf venation, yet I suspect it may be more closely related to the noncontiguous *S. nuttallii*. The leaves possess fewer pinnae than typical *S. microphylla*, and usually larger leaflets than the sympatric *angustisiliqua* variant of *S. microphylla*. A more robust habit, relatively few, broad-based prickles, and shorter peduncles are often—but not invariably—characteristics of *S. uncinata.*

Schrankia UNCINATA Willd. Sp. Pl. 4:1043. 1806! Photo of type (from B) ISC! Herb. Willdenow 19099 "*Schrankia uncinata.*" *Morongia uncinata* (Willd.) Britt. Mem. Torr. Bot. Club 5:191. 1894! *Leptoglottis uncinata* (Willd.) Rydb. Fl. Nebr. 21:31. 1895! quoad basionym.

Schrankia FLORIDANA Chapm. Fl. South. US. ed. 2. 683. 1892! Presumed fragment of type NY! Manatee, Florida. *Morongia floridana* (Chapm.) Small ex Britt. & Rose N. Am. Fl. 23:139. 1928!

Torrey & Gray (1840) took up the binomial *S. uncinata* Willd. for the widely distributed species of the central United States and the name was so employed for nearly a century. Standley (1930) presumably noting that most of Willdenow's citations ultimately traced to *S. microphylla*, assigned the name to that species. In 1957, I examined a photograph of the Willdenow original material and leaflet fragments; the leaflets were evidently nerved and the Willdenow description consistent with the specimen. I properly dismissed reference to *S. microphylla* but less wisely allowed the name to revert to its traditional connotation. Beard (1963) has presented a detailed exposition of the identity of the Willdenow material and refers it to the Florida entity. I accept his conclusions.

Chapman's description of *S. floridana* (sandy barrens, southern Florida) specifies that the leaflets are reticulate beneath. A putative fragment of type material at NY represents a couple of leaves and a flower head with the annotation: "from type specimen." Presumably types of Chapman's 1892 Supplement species are at US; but I have been unable to find a specimen pertinent to this binomial.

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A MONOGRAPH OF THE GENUS CONOPHOLIS (OROBANCHACEAE)[1]

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The Orobanchaceae consist of about 15 genera, four of which are native to the conterminous United States. One of these, *Conopholis*, is the subject of this revision. Two of the remaining three, *Epifagus* and *Orobanche*, are sympatric with *Conopholis*. From these, *Conopholis* can be separated by its chasmogamous flowers—those of *Epifagus* being, in large part, cleistogamous—and by its exserted stamens—those of *Orobanche* being included.

Conopholis, a genus of plants parasitic upon the roots of *Quercus*, is confined to North and Central America and is composed of two major populations, one in eastern United States and adjacent Canada, and one in western United States, Mexico, and Central America. This bicentric pattern is found also in several other genera in North America, among them *Platanus*, *Juglans*, and *Liquidambar*.

Although five species of *Conopholis* have been described from different geographical areas, no comprehensive taxonomic study of the genus has been published. Uncertainty as to the number of species in the genus can be noted in standard works, e.g., Fernald (1950) accepted only one species, Beck-Mannagetta (1930) accepted two species, Small (1933) credited the genus with three species, and Gleason (1952) believed there to be four species. For these reasons, I felt the genus was in need of revision.

Unlike certain other members of the Orobanchaceae, *Conopholis* is of little or no economic importance. Although the plants are parasitic upon oaks, they seemingly do little harm to the host. Evidently no animal is known to feed upon the plants.

Conclusions presented in this thesis are based upon limited field study (in Florida, Georgia, Texas, and New Mexico) and upon a study of approximately 1350 herbarium specimens from the following 36 herbaria: ARIZ, ASC, AUA, C, DAO, DUKE, F, FSU, GA, GH, ILL, IND, KY, LAF, LL, MAINE, MEXU, MICH, MO, NEBC, NHA, NY, OS, PAC, PH, SMU, TAES, TEX, UC, UNM, US, VDB, VPI, VT, WIS, and WVA (abbreviations according to Lanjouw and Stafleu, 1964). In order to conserve space, a list of specimens examined is not included in this paper. I shall be happy to send a mimeographed copy of exsiccata to anyone who requests it.

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REVIEW OF LITERATURE

The genus *Conopholis*, established by Wallroth (1825), was based upon a Linnaean species, *Orobanche americana*, described in 1767. Since that time four other specific names have been added to the genus. Liebmann (1847) described two species from Mexico, *C. alpina* and *C. sylvatica*. *Conopholis alpina*, described from Chinautla, District Tinzutlan, Puebla, was said to be distinguishable from *C. americana* by its calyx being unibracteolate, divided anteriorly almost to the base, and not divided posteriorly; by its corolla being twice as long as the calyx, with its upper lip reflexed and entire, and the lobes of the upper lip not longer than the lower lip, and with the lobes of the lower lip short, lanceolate, and entire; by its stamens being much exserted; by its style being angular, reflexed, and hardly longer than the stamens; and by its capsule being apiculate (not having a long curved beak) and shorter than the bracts. *Conopholis sylvatica*, described from Totutla and the Hacienda de Mirador, Veracruz, was said to differ from *C. americana* by its slenderer stem; by its smaller calyx being split to the middle anteriorly and bidentate posteriorly; and by its slenderer corolla being twice as long as the calyx, the lobes of the lower lip being shorter and more obtuse.

Watson (1883) described *C. mexicana* from the Sierra Madre, south of Saltillo, and from Soledad, Coahuila. It was said to be distinguishable from *C. americana* by its longer and more rigid lanceolate acuminate scales, by its less deeply toothed calyx, and by its larger corolla.

Finally, *C. panamensis* was described by Woodson (Woodson and Seibert, 1938) from Chiriquí, Panama. It was said to be distinguishable from both *C. americana* and *C. mexicana* by its barely bilabiate calyx with rather shallow, broadly obtuse lobes.

Wilson (1898) studied *C. americana* morphologically and anatomically. Although her paper is one of the major sources of vegetative anatomical data on the genus, it is sadly lacking in depth. It covers many facets of the genus but goes into detail on none. Doak (1929) gave additional data on the structure of the gall.

Percival (1931) studied *C. americana* to determine the nature and development of the connection between the parasite and its host. He included several anatomical and morphological features of the species, as well as some ecological data.

A detailed study of seed development in *C. americana* was made by B. Tiagi (1965). He pointed out several seed and embryological characters unique in the Orobanchaceae to *Conopholis*.

Nelson (1919), Clute (1919), and Jennings (1920) published brief notes concerning the rarity of *Conopholis* in parts of northeastern United States.

MORPHOLOGY

Habit. The *Conopholis* plant consists of several to many erect flowering stalks and buds arising from a gall on an oak root. The gall is produced by the root as a result of the presence of the parasite. Although roots are occasionally found to extend past the gall, the parasite normally prevents further growth of the root. The duration of the flowering stalk is undoubtedly annual, but according to Wilson (1898) and to my observation (of dead and living flowering stalks on the same gall at the beginning of the growing season), the gall is certainly perennial. Wilson suggested that the gall probably lives 4 to 5 years before any flowering stalks are produced. The duration of the buds is not known. They may remain dormant for 1 year or may be capable of rapid growth, maturing in one growing season.

Gall. The gall ("tubercle") is covered by a thick, coarse, porous, dark-brown bark and is composed of "innumerable granules of sclerenchyma" (Wilson, 1898). The *Conopholis* seed germinates in the soil near a young oak root (Percival, 1931). The young seedling parasitizes the oak root, causing it to produce massive amounts of tissue, thus forming the gall (Wilson, 1898). According to Doak (1920) and to Percival (1931), however, the gall is made up largely of *Conopholis* tissue. *Conopholis* flowering shoots are initiated within the gall, eventually breaking through its thick bark. Galls have been found ranging from 0.5 to 10 inches in diameter (Wilson, 1898; Boeshore, 1920).

Stem. The stem is erect, typically unbranched, usually terete, strongly grooved, and glabrous to slightly glandular pubescent. I have seen only one specimen with a branched stem: Kentucky, Bullitt Co., *Gunn 616*, 16 May 1966 (KY).

Leaves. The leaves, reduced to scales, are simple, sessile, exstipulate, and, at first, cream-colored but later turning brown and membranous. The lowest portion of the stem is densely covered with crowded leaves, while just above the stem base the leaves become more distant and much larger. Although they vary much in length and width, the upper leaves are taxonomically useful, usually maintaining, within a species, a fairly constant length: width ratio and a uniform shape and texture. The leaves may bear stalked or sessile glands or they may rarely be glabrous.

Inflorescence. The inflorescence is a crowded raceme composed of imbricate bracts, each subtending a flower. The denseness and thickness of the inflorescence are usually good taxonomic characters.

Bracts. Each flower is subtended by one bract that greatly resembles the leaves. The bracts are probably the structures most useful taxonomically. In *C. americana*, for example, the bract nearly or wholly surrounds the base of the flower, is usually very thin in texture, and maintains a low length: width ratio.

Flowers. The flowers are sympetalous, zygomorphic, perfect, and cream-colored and usually have one or two bractlets arising on the base of the calyx.

Calyx. The calyx is the most variable part of the plant. It is tubular and has acute to rounded teeth or lobes. Some *Conopholis* species have been described on the basis of calyx differences, but due to great variability, these differences cannot alone be used as criteria of taxonomic value. One or two bractlets arise on the base of the calyx.

Corolla. The corolla is tubular, sometimes reflexed distally, and two-lipped, with the upper lip external in the bud and notched or rarely three- to four-lobed, and the lower lip usually three-lobed, or rarely one- or two-lobed. The corolla persists for a while around the maturing capsule but eventually is split by the enlarging capsule and falls off. Corolla length is a good taxonomic character.

Androecium. Four stamens, all fertile, the lateral two sometimes connate, are usually present in each flower. Gray (1888) reported that a fifth stamen is occasionally present. My observations have not confirmed the presence of a fifth stamen. The stamens are epipetalous, arising on the corolla tube at a level just above the summit of the ovary, and are well exserted. The reflexed tip of each filament bears an anther with two thecae that dehisce longitudinally. The thecae of the anther are slightly divergent, basally attenuate, and glabrous to sparingly pilose.

Gynoecium. The gynoecium is superior, irregularly shaped, compound, four-carpellate, multiovulate, and unilocular. Traditionally the gynoecium of many Orobanchaceae, including *Conopholis,* has been interpreted as having two median carpels, each carpel bearing two placentae, these being displaced from the margin towards the median line of the carpel. According to this interpretation, each of the resulting four parietal placentae is the product of only one carpel. In contrast, Y. D. Tiagi (1962) interpreted the gynoecium of these Orobanchaceae as having *four* carpels, two median and two lateral, each carpel bearing two marginal placentae. According to him, the placentae of adjacent carpels are fused, and thus the ovary contains four parietal placentae, each placenta being the product of *two* carpels. I am accepting Tiagi's interpretation. The four carpels of *Conopholis* are equal; however, there is a deep groove over the midrib of the median carpels, and the lateral carpels lack midrib bundles (Y. D. Tiagi, personal correspondence). The ovules of *Conopholis* may be stalked or sessile and are variously shaped. This variation results from pressure exerted by the enlarging ovules. The pressure frequently results in their partial or complete fusion in pairs (B. Tiagi, 1965). Usually the ovules become inverted, but some, due to crowding, do not fully invert. The stigma is either depressed centrally or horizontally furrowed and is capitate on a long style that is often apically reflexed.

Fruit. The fruit of *Conopholis* is a two-valved, single-celled, many-seeded, dark brown to black capsule. According to B. Tiagi (1965), the capsule dehisces anteroposteriorly along the grooves that lie in line with midrib bundles of the median carpels. My observations indicate that dehiscence also may be irregular.

Seeds. The seeds of *Conopholis* are large relative to those of other Orobanchaceae. They are variously shaped: oval, triangular, quadrangular, or rhomboidal in outline, with rounded, or less often, sharp angles. The various shapes are due to the pressure exerted by the enlarging ovules (B. Tiagi, 1965). According to Martin (1946) the seeds of *Conopholis* are microembryonic, containing a small oval embryo surrounded by a massive endosperm. The color of the seeds varies from light to dark brown, with the testa usually being marked with darker brown to black lines forming a reticulum. The seeds are not taxonomically important because of their great variability.

CYTOLOGY AND ANATOMY

Chromosome number. The only report of a chromosome number for *Conopholis* is that of Lewis (1966), $n=20$ (± 1) for *C. americana*, the eastern species. My attempts to make chromosome counts of western *Conopholis* from root tip smears were unsuccessful due to failure to obtain seed germination.

Embryology. That *Conopholis* has several embryonic characters elsewhere unknown in the Orobanchaceae was shown by B. Tiagi (1965). Some of these are as follows.

The massive integument is composed mostly of about nine layers of cells; however, towards the funicle and chalaza it consists of more than 12 cell layers.

The nucellus is single-layered and ephemeral, disappearing by the time the embryo sac matures. As the nucellus degenerates, two or three layers of the integument surrounding the embryo become glandular. This tissue, consisting of uninucleate vacuolated cells, acts as the endothelium. In most Orobanchaceae, the endothelium is composed of a single cell layer; therefore, the well developed massive endothelial tissue is a remarkable feature of *Conopholis*.

In the seed the endothelium cells, after serving a nutritive function, become extremely thickened due to the deposition of hemicellulose, which may serve as an additional source of food for the embryo. Probably for this reason and also because the endosperm is surrounded by this protective coat of endothelium, the peripheral cells of the endosperm do not develop a cuticle. Without an intervening cuticle, they can then absorb nourishment directly from the endothelium at the time of germination.

Epidermal cells. The epidermal cells of the leaves of *Conopholis* are highly lignified and have thick, extremely pitted walls. Wilson (1898) reported that stomates are absent on the leaves of *Conopholis* but are present on the flowering stalk, but Boeshore (1920) found some misshapen and poorly developed stomates on the outer surface of the upper leaves. These appeared to be functionless or nearly so. Some had two elongated guard cells which had "slipped out of position" and showed a long orifice between them, while others had three or four loosely fitted guard cells. I have made but few slides of epidermal tissue. These have not contained any recognizable stomates or guard cells.

ECOLOGY

Habitat. Conopholis occurs under oak trees in moist mixed or deciduous forests, oak woodlands, and mixed montane forests. The number of plants parasitizing a host may vary from one to many, the latter forming almost matlike growths up to 20 feet across.

Pollination. Thus far, I have observed only one insect visiting a *Conopholis* flower, a bumblebee on *C. americana*, the eastern species: Georgia, Grady Co., *Haynes 2679*, 11 April 1968 (DUKE, GH, LAF, VDB). I have seen only one other specimen with insect visitation data: P. S. Martin observed bumblebees visiting *C. alpina* var. *alpina* flowers in central Mexico: Tamaulipas, *Martin 56*, 10 March 1953 (MICH).

I have found dehisced anthers in flower buds of herbarium specimens and of plants preserved in 50% methanol. A slide of pollen from dehisced anthers of a flower bud from a methanol-preserved plant revealed that about one-half of the pollen grains already had germinated. Perhaps *Conopholis* is not obligately insect pollinated but is, at least occasionally, self pollinated in the bud.

Parasitism. The question arises concerning the generic host-specificity of *Conopholis*. Is *Quercus* the sole host, or are plants of other genera parasitized? I have seen *Conopholis* specimens with data indicating that the plants grew under *Fagus, Pinus, Juniperus, Acer, Ulmus, Cornus, Juglans, Carya, Liquidambar,* or *Cupressus*. I myself have found *Conopholis* under *Tilia* and *Pinus*, but after digging up the parasitized root, I found that it would always lead to a *Quercus*. I believe that if the collectors of the specimens whose data suggest a non-*Quercus* host would have done the same, they would have found the host actually to be *Quercus*. Wilson (1898) and Boeshore (1920) both concluded that *Quercus* is the sole host.

According to literature and herbarium-label data, *Conopholis* parasitizes the following hosts: (1) *Conopholis americana: Quercus alba, Q. bicolor, Q. borealis, Q. falcata, Q. hemisphaerica, Q. marilandica, Q. nigra, Q. petrea* (cultivated in Copenhagen, Denmark), *Q. shumardii, Q. velutina,* and "Chestnut oak"; and (2) *Conopholis alpina: Q. gambellii, Q. grisea, Q. texana, Q. utahensis,* and "Grey oak."

SYSTEMATIC TREATMENT

,Five species of *Conopholis* have been described. However, the characters used to distinguish most of these are too variable to be significant taxonomically. I am recognizing but two species, one of them being divided into two varieties. These three taxa could perhaps have been treated as varieties of one species, but because of the reproductive isolation, the morphological distinctness, and the apparent host-specificity of the eastern and western populations, I prefer to treat them as two species.

The two species of *Conopholis* are allopatric. The range of *C. americana* is limited to the United States east of the Mississippi River and to southeastern Canada, whereas *C. alpina* is restricted to southwestern United

States, Mexico, and Central America. So far as is known, the two species approach no closer than about 800 miles to each other (Fig. 4, 5).

A possible explanation for the disjunct range of plants with a distribution similar to *Conopholis* is offered by Sharp (1966). He postulates that much of the present Mexican vegetation had its origin in the circumboreal flora that existed in northern Asia and northern North America during the Cretaceous. Many species of this flora [probably including *Conopholis*] migrated southward into the United States and Mexico during the Cretaceous and Tertiary. The rigorous climate of the Tertiary and Pleistocene subsequently extinguished most of them throughout North America. A few survived in the southeastern United States and many more in Mexico and Central America.

The two species of *Conopholis* are morphologically distinct. No single character can be relied upon to determine all specimens encountered, but when several characters are collectively considered, a specimen in question can easily be referred to the corrct taxon. At a glance I was able to determine to species 90% of all *Conopholis* specimens seen by me. After examining the remaining specimens with a microscope, I had no problem determining them.

So far as is known, the host plants are different species of *Quercus*. Apparently only two of the many North American oaks occur sympatrically with both species of *Conopholis*. These are *Q. virginiana* and *Q. muhlenbergii*, neither of which is known to be a host of *Conopholis*. Possibly one of the species could parasitize the hosts of the other, but such a condition has yet to be demonstrated.

Much cytological, anatomical, and biochemical work needs to be done on the genus. Then perhaps the monographer will see a need to consider the various taxa as varieties of one species, but hopefully this work will support my conclusions.

CONOPHOLIS Wallroth, Orob. Gen. Diask. 78. 1825.

Low, glabrous or sparsely to densely glandular-pubescent, cream, yellow-brown, brown, or black simple or rarely branched herbs, fleshy at first but becoming brittle, the flowering stems arising from a dark brown to black gall. Leaves scale-like, sessile, with invisible to plainly evident veins, fleshy at first but becoming brittle, of 2 types, the lower very tightly imbricate, short, and wide, the upper larger, scattered to somewhat imbricate, and alternate. Inflorescence a compact raceme, each flower axillary to a sessile bract, the pedicels very short to elongate, the bracts longer than the calyx. Calyx tubular, 2-lipped, split anteriorly, 2- or 4- to 5-toothed or -lobed, the divisions broadly to narrowly acute or rounded; 1 or 2 subulate bractlets may arise on the base of the calyx, or these may be absent. Corolla cream-colored, tubular, sometimes reflexed apically, 2-lipped, the upper lip rounded, notched, rarely 3- or 4-lobed, external in the bud, the lower lip 3-lobed, or rarely 1- or 2-lobed, the lobes rounded to acute;

corolla somewhat persistent, eventually ruptured and dislodged by the enlarging capsule. Stamens 4 (-5?), the lateral 2 sometimes connate, epipetalous, inserted above the ovary; the filaments elongate; anthers free, exserted, thecae somewhat divergent, basally attenuate, glabrous to sparingly pilose; pollen grains triaperturate. Style apically reflexed, included or exserted, persistent on or deciduous from the fruit; stigma capitate, slightly depressed centrally to horizontally furrowed. Fruit a 2-valved, single-celled, dull dark brown to black capsule dehiscing irregularly or anteroposteriorly. Seeds oval, triangular, quadrangular, or rhomboidal with rounded or, less often, sharp angles, light brown to dark brown, with brown to black lines forming a reticulum. (Name from the Greek *conos*, cone and *pholis*, scale.)

Type species. Conopholis americana (Linnaeus) Wallroth (*Orobanche americana* Linnaeus).

KEY TO THE TAXA

1. Plants of eastern United States and Canada; scale length: width ratio 1.5-2.3 (3); bract length: width ratio 1.6-2.5 (3.3); inflorescence loose, 13-28 mm thick; fruit mostly with the style persistent; plant glabrous to slightly pubescent; corolla not over 14 mm long, mostly not reflexed; bracts nearly or wholly concealing the calyx; anthers glabrous. . . . . 1. *C. americana*
1. Plants of western United States, Mexico, and Central America; scale length: width ratio 2.4-4.2; bract length: width ratio 3-5.2; inflorescence mostly compact, (20) 28-40 mm thick; fruit mostly with the style deciduous; plant glabrous to densely glandular pubescent; corolla to 20 mm long, mostly much reflexed; bracts sometimes concealing the calyx, sometimes not; anthers often sparingly pilose . . . . 2.
2. Plants of southern Mexico and Central America; scales membranous, the veins slightly visible to plain; corolla 7.5-13.5 mm long; plant glabrous; bracts nearly or wholly concealing the calyx; calyx lobes often rounded, 0.3-1.6 mm long . . . . 2a. *C. alpina* var. *alpina*
2. Plants of western United States and northern Mexico; scales firm, the veins invisible; corolla (10.5) 14-20 mm long; plant glandular pubescent, at least along margins of scales and calyx lobes; bracts not concealing the calyx; calyx lobes sharply acute, (0.5) 1.5-4 mm long. . . . . 2b. *C. alpina* var. *mexicana*

1. CONOPHOLIS AMERICANA (Linnaeus) Wallroth, Orob. Gen. Diask. 78. 1825.

Orobanche americana Linnaeus Mant. Pl. 88. 1767.

Stems erect, simple or rarely branched, glabrous, 6-20 (27) cm high, 4-12 mm in diameter. Leaves glabrous, with sessile glands, or rarely minutely glandular pubescent along the margins, broadly to narrowly lanceolate or elongate triangular, 5.5-18 (21) mm long, 4.5-12 mm wide, widest at or just above the base, apex acute to nearly rounded; veins obscure to slightly visible. Bracts glabrous or rarely minutely pubescent along the margins, broadly to narrowly lanceolate or elongate triangular, often nearly or wholly concealing the calyx, 5.5-18 mm long, 2-8 mm wide. Calyx irregularly 4- to 5-toothed or -lobed, the tube more or less cylindric, 3.3-8 mm long, split anteriorly from half-way to nearly to the base, the teeth or lobes acute, 0.5-3 mm long; bractlets two, 2.5-12 mm long. Corolla 8-14 mm long. Filaments 6-10.5 mm long; anthers glabrous, 1.5-2.3 mm long. Capsule mostly with the style and stigma persistent, 5-13 mm long, 5.5-11 mm in diameter. Seeds 0.5-1.5 mm long, 0.5-1.2 mm wide, and 0.4-0.7 mm thick. Figure 1.

Under oaks in moist, deciduous or mixed woods from Nova Scotia to western Wisconsin and south to Florida. Flowers from mid-February in the south to mid-June in the north.

Holotype: U.S.A. "CAROLINA": Garden (*Linn. Herb. 798.5*) (LINN). Figure 6.

2a. CONOPHOLIS ALPINA Liebmann var. ALPINA, Forh. Skand. Naturf. Möde 4: 184. 1847.

Conopholis panamensis Woodson, Ann. Missouri Bot. Gard. 25: 835. 1935.

Conopholis sylvatica Liebmann, Forh, Skand. Naturf. Möde 4: 185. 1847.

Stems erect, simple, glabrous, 8-28 cm high, 6-10 mm in diameter. Leaves glabrous, lanceolate to narrowly elongate triangular, (7) 12-21 mm long, 3-7 (11) mm wide, widest at or just above the base, apex usually sharply acute; veins slightly visible to prominent. Bracts glabrous, lanceolate to narrowly elongate triangular, often concealing the calyx, 10-20 mm long, 4-6 mm wide. Calyx irregularly 2- or 4- to 5-toothed or -lobed, the tube more or less cylindric, 3.3-4.5 mm long, split anteriorly from about half-way to all the way to the base, or not split at all, the teeth or lobes acute, to rounded, 0.3-1.6 mm long; bractlets 1 or 2 or absent, 2-4.5 mm long. Corolla 7.5-15.5 mm long. Filaments 9-12.5 mm long; anthers glabrous, rarely sparingly pilose, 1.6-2 mm long. Style and stigma 5.5-8 mm long. Capsule mostly with the style and stigma deciduous, 8-16 mm long, 5-11 mm in diameter. Seeds 0.4-1.7 mm long, 0.3-1.2 mm wide, and 0.3-0.8 mm thick. Figure 2.

Under oaks in montane forests, southwestern Tamaulipas south to Michoacan, Mexico and Chiriquí, Panama. Flowering from mid-December to late April.

Lectotype: MEXICO. PUEBLA: In rupibus Tepeyecuapa pr. Chinaulta ad radices Pinorum. Alt. 8600 ft. *Liebmann 3719*, March 1841 (C). Isotype: F. In the original description Liebmann referred to two collections. He did not designate either one as the type; therefore, I am herein designating one as the lectotype. Figure 7.

After examining the type specimens of *C. alpina*, *C. sylvatica*, and *C. panamensis*, I concluded that all are plants of the same species. The names *C. alpina* and *C. sylvatica*, described in the same publication, have 88 years priority over *C. panamensis*. Following article 57 (Lanjouw, 1966) I have chosen *C. alpina* as the specific name.

2b. CONOPHOLIS ALPINA Liebmann var. MEXICANA (Gray ex Watson) Haynes, Sida 3: 347. 1969.

Conopholis americana sensu Endlicher Iconogr. t. 81. 1838.

Conopholis mexicana Gray ex Watson, Proc. Amer. Acad. Arts & Sci. 18: 131. 1883.

Stems erect, simple, glabrous, 11-33 cm high, 5-12 mm in diameter. Leaves mostly quite glandular pubescent, rarely so only along the margins, narrowly lanceolate or narrowly elongate triangular, (7) 12-22 mm long, 3-9 mm wide, widest at or just above the base, apex mostly acute, rarely rounded; veins usually invisible. Bracts mostly quite glandular pubescent, rarely so only along the margins, narrowly lanceolate or narrowly elongate triangular, mostly not concealing the calyx, 12-22 mm long, 1.5-7 mm wide. Calyx irregularly 4- to 5-toothed or -lobed, the tube more or less cylindric, (3.5) 6-9 mm long, split anteriorly from about half-way to all the way to the base, or not split at all, the teeth or lobes acute, (0.5) 1.5-4 mm long; bractlets 1 or 2 or absent, (0.8) 2-6.7 mm long. Corolla (10.5) 14-20 mm long. Filaments 7-12 mm long; anthers mostly sparingly pilose, 1.5-2.5 mm long. Style and stigma 5-12 mm long. Capsule mostly with the style and stigma deciduous, 8-15 mm long, 6-12 mm in diameter. Seeds 0.5-1.3 mm long, 0.5-1 mm wide, and 0.4-0.8 mm thick. Figure 3.

Under oaks in oak woodlands and mixed montane forests, Trans-Pecos Texas to northern New Mexico and central Arizona, south to central Oaxaca. Flowering from mid-February to late July, rarely to September.

Holotype: MEXICO. COAHUILA: Sierra Madre, 40 miles south of Saltillo. *Palmer 996*, March 1880 (GH). Isotypes: F, NY, PH, US, VT. Figure 8.

Over most of its range this variety is easily distinguishable from var. *alpina*. In areas of overlap, however, some specimens cannot confidently be placed into either taxon. For this reason I consider these two taxa to be varieties of one species.

Variety *mexicana* occurs sympatrically with var. *alpina* only in the southernmost part of its range. In this area it can generally be distinguished from var. *alpina* by the veins of its leaves and bracts being invisible, by its bracts mostly not concealing the calyx, and by its pubescence being mostly glandular.

EXCLUDED SPECIES

Conopholis ludoviciana Wood, Class-Book Bot. 512. 1867. =*Orobanche ludoviciana* L.

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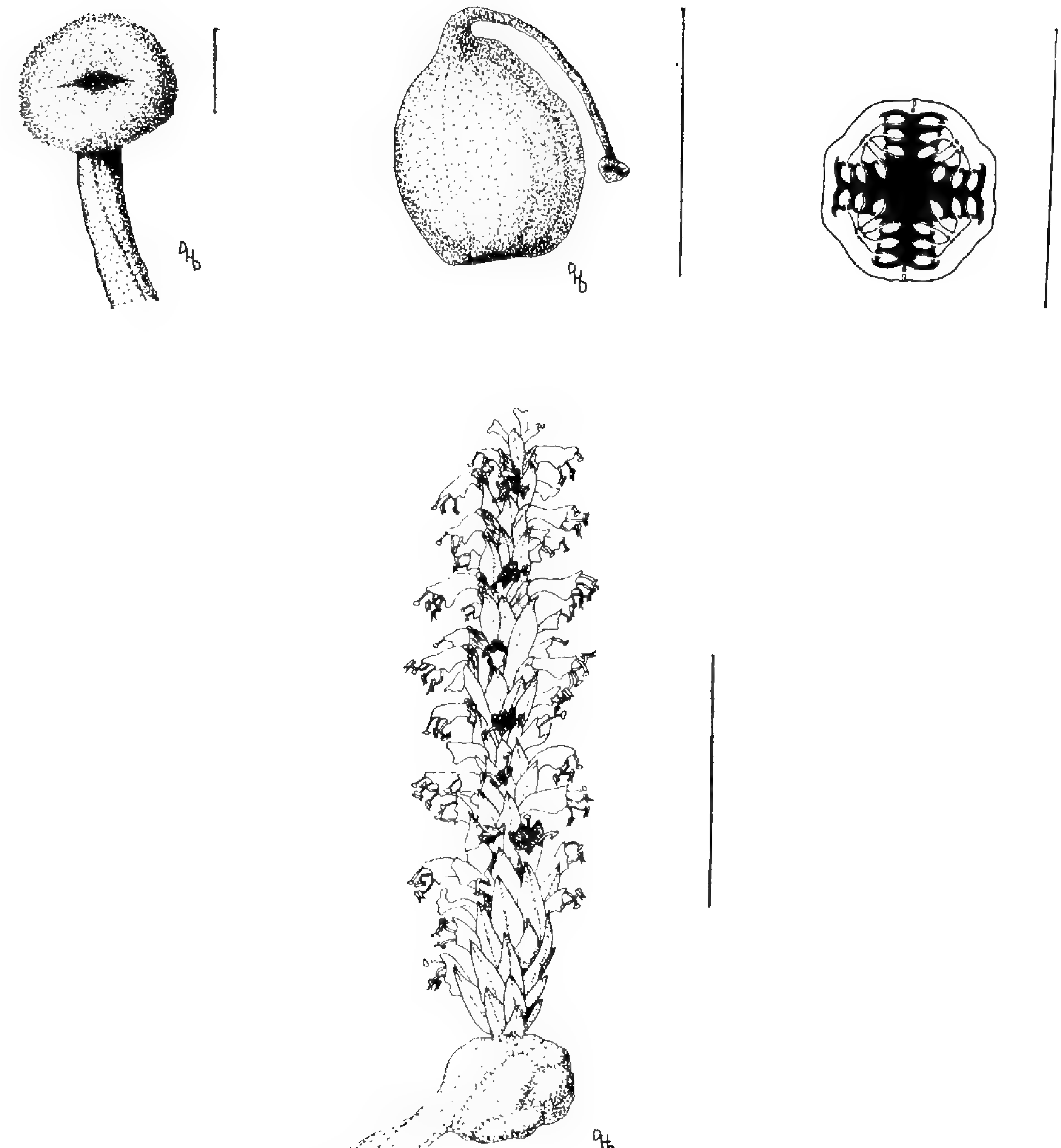

Fig. 1. *Conopholis americana*. Stigma (upper left), the vertical line represents 0.1 cm. Fruit (upper center), cross-section of ovary (upper right), the vertical lines represent 1 cm. Habit sketch (lower), the vertical line represents 5 cm.

Fig. 2. *Conopholis alpina* var. *alpina*. Habit sketch (left), the vertical line represents 5 cm. Seed (upper right), the vertical line represents 0.1 cm. Fruit (lower right), the vertical line represents 1 cm.

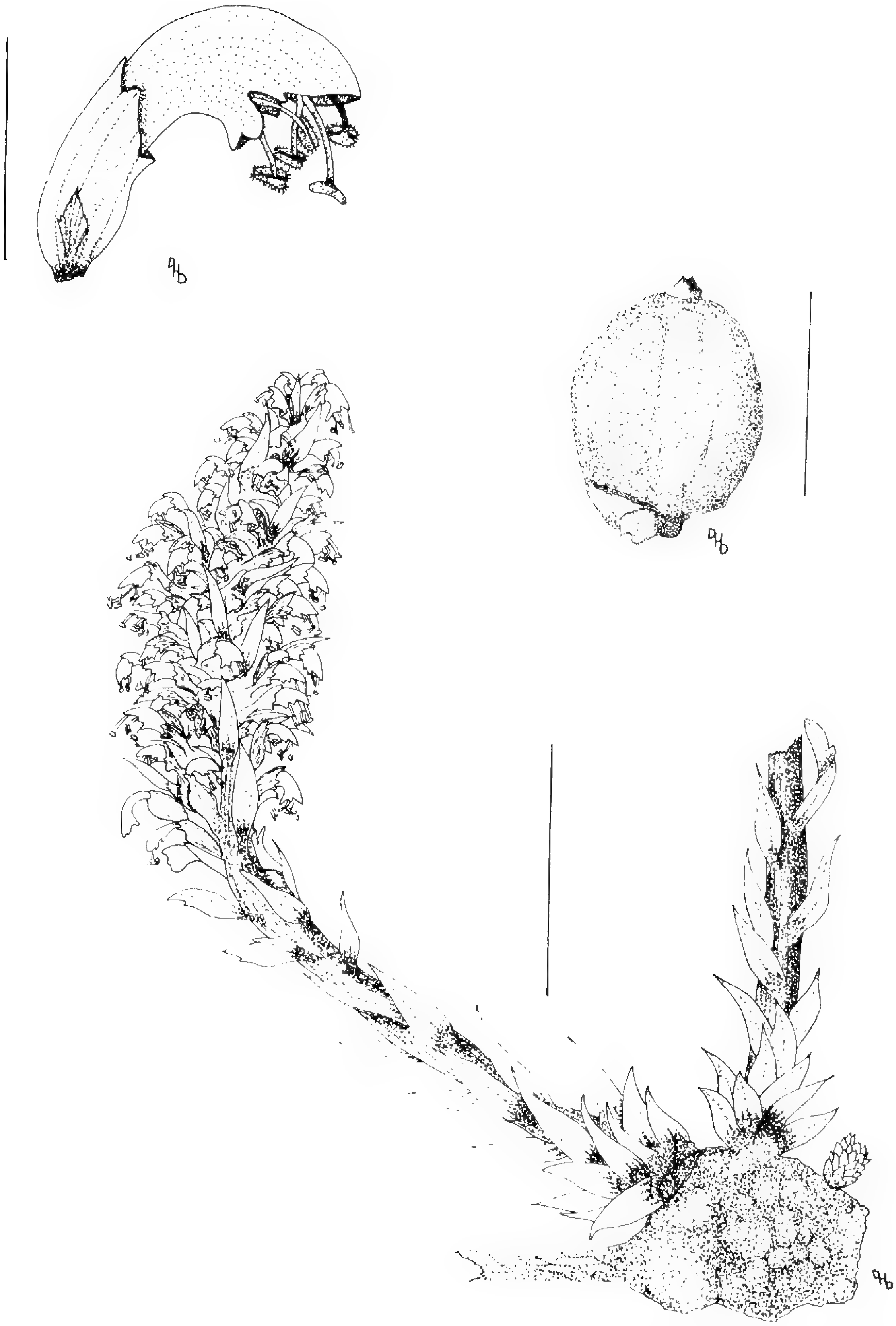

Fig. 3. *Conopholis alpina* var. *mexicana*. Flower (upper left), fruit (upper right), the vertical lines represent 1 cm. Habit sketch (lower), the vertical line represents 5 cm.

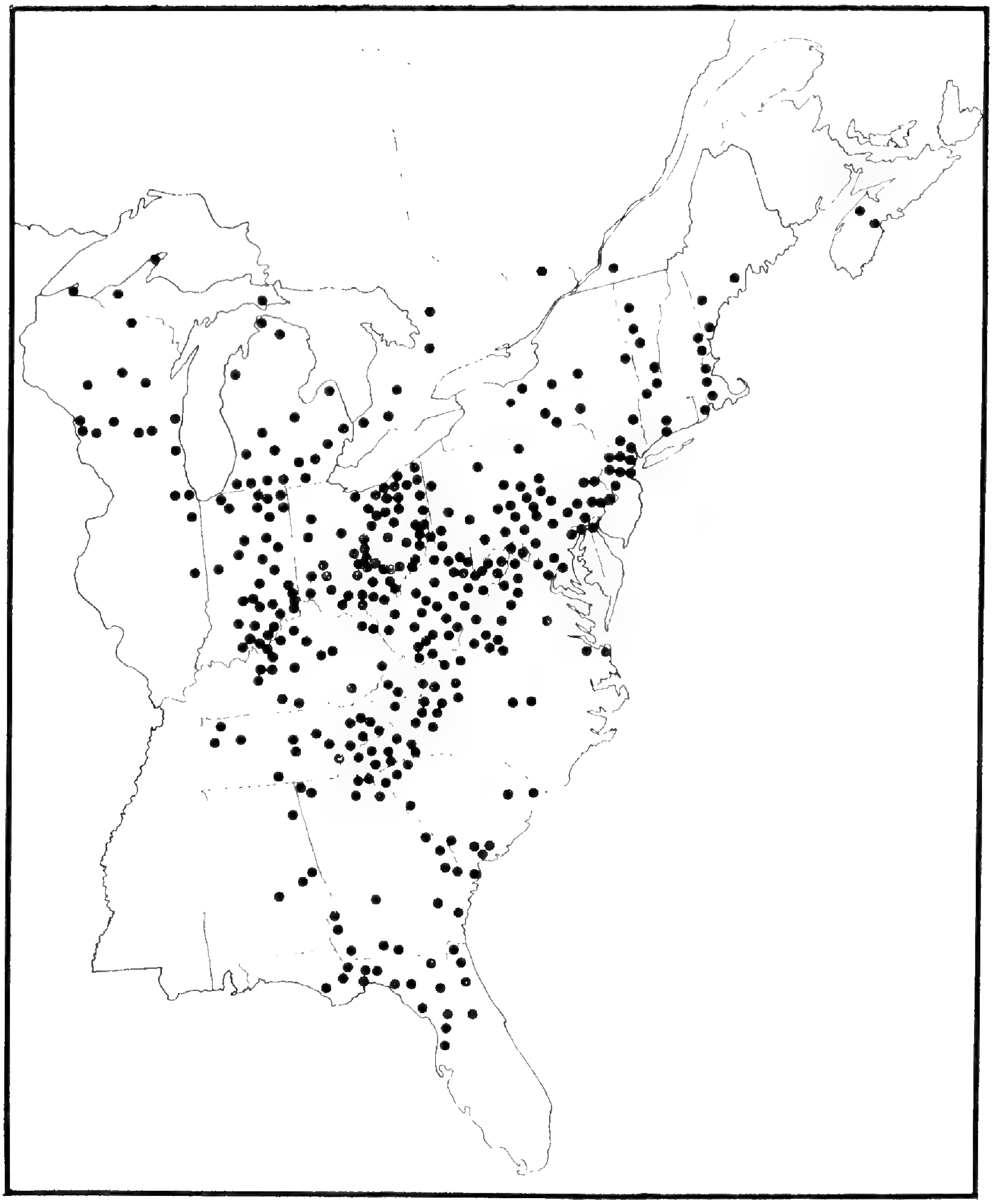

Fig. 4. *Conopholis americana*. Documented distribution.

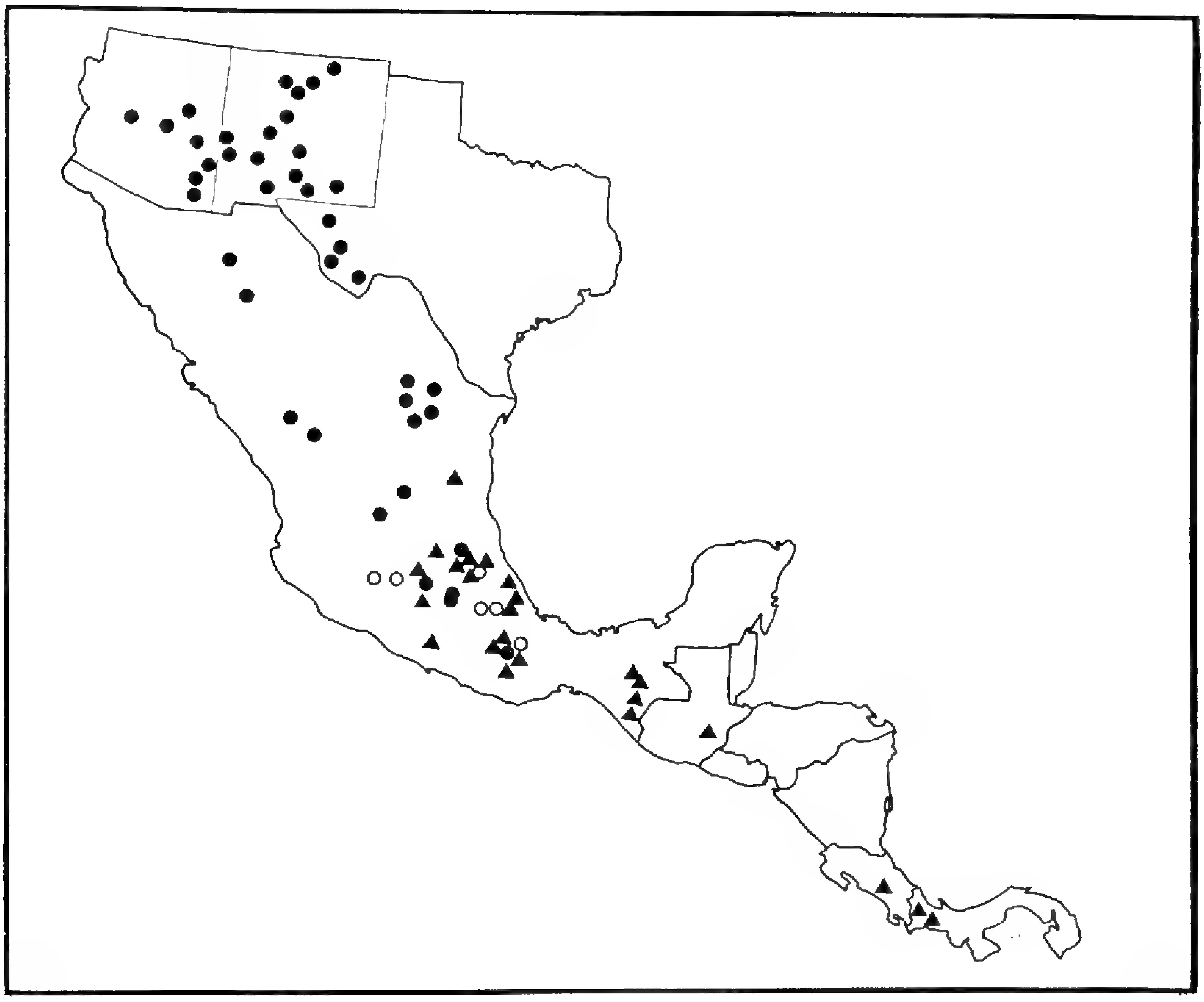

Fig. 5. *Conopholis alpina.* Documented distribution. *C. alpina* var. *alpina* (triangle); *C. alpina* var. *mexicana* (closed circle); *C. alpina*, specimens that could not be determined to variety (open circle).

Fig. 6. *Conopholis americana*. Photograph of holotype.

Fig. 7. *Conopholis alpina* var. *alpina*. Photograph of lectotype.

Fig. 8. *Conopholis alpina* var. *mexicana*. Photograph of holotype.

TAXONOMY OF SARTWELLIA (COMPOSITAE HELENIEAE)[1]

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Sartwellia is a genus of three species confined to gypsiferous soils of southern New Mexico, western-most Texas and north-central Mexico (Fig. 4). It was first proposed by Gray (having been named in honor of Dr. H. P. Sartwell, a botanical correspondent and "zealous student and collector of the plants of Western New York . . .") in 1852 from a collection of Charles Wright made in trans-Pecos Texas.

Previous to the present, the only definitive study has been that of Rydberg (1915) who also recognized three species. Johnston (1941) subsequently added an additional species name, *S. humilis*, but this has been reduced to synonymy under *S. mexicana* in the treatment that follows.

Meiotic chromosome counts of $n=18$ have been reported for all three of the species (Table 1). At diakinesis and metaphase I the bivalents are of moderate size showing mostly 2 chiasmata.

In describing *Sartwellia*, Gray stated that it ". . . is chiefly remarkable from its invalidating the distinctions of the subtribe Flaverieae [heretofore containing but one genus, *Flaveria*] to which, on account of its whole habit and general characters, I am obliged to refer it, notwithstanding the pappus and the pedicellate (not glomerate nor strictly fascicled, though crowded) capitula." Rydberg, in his treatment of the tribe Helenieae for The North American Flora, followed Gray in retaining the two genera as sole members of the subtribe Flaverinae.

Turner and Johnston (1961) have suggested that these two genera are closely related to *Haplöesthes*, a genus which most authors (including Gray, 1884; Bentham, 1876; and Hoffmann, 1894) have placed in the tribe Senecioneae. Ornduff *et al.* (1963), noting the suggestion as to tribal position made by Turner and Johnston, have commented, that if *Flaveria* ($n=18$), *Haplöesthes* ($n=18$) and *Sartwellia* ($n=18$) are placed in the Senecioneae that "Their morphology and chromosome number give them an isolated position in that tribe, whereas removal to Heliantheae or Helenieae would be less taxing to tribal homogeneity."

Assuming that the Helenieae is an artificial assemblage as has been suggested by several authors (Turner, 1956), inclusion of these genera as a subtribe within the Senecioneae (as presently circumscribed) would be as defensible as including them within the Heliantheae. In fact, as indicated by Skvarla and Turner (1966) the former tribe is palynologically more

[1] Field work for this study supported in part by NSF Grant GB-5448X.

TABLE 1. CHROMOSOME NUMBERS OF SARTWELLIA POPULATIONS

SPECIES	LOCALITY AND VOUCHER	NUMBER
S. flaveriae Gray	NEW MEXICO. Socorro Co.: 17 mi E of San Antonio. *Turner & Powell 6126* (TEX).	18
S. flaveriae Gray	TEXAS. Culberson Co.: 6.2 mi W of Salt Flat. *Turner & Powell 6140* (TEX).	18
S. mexicana Gray	MEXICO. Coahuila: 45 mi SW of Cuatro Cienagas. *Turner 6004* (TEX).	18
S. mexicana Gray	MEXICO. Coahuila: 1 mi S of Estacion Hermanas. *Turner 6009* (TEX).	18
S. mexicana Gray	MEXICO. Nuevo Leon: 12 mi S of Coahuila line on Matehuala highway. *Graham & Johnston 4199* (TEX).	18**
S. mexicana Gray	MEXICO. San Luis Potosi: 30 mi S of Matehuala. *Ellison 59* (TEX).	18*
S. mexicana Gray	MEXICO. San Luis Potosi: 11 mi N of Huisache. *Birdsong & Turner 178.1* (TEX).	18
S. puberula Rydb.	MEXICO. Durango: 2 mi NW of Bermejillo. *Stuessy 937* (TEX).	18

* Powell & Turner (1963).
** Turner & Johnston (1961).

heterogenous than is the Heliantheae, and if we are to accept the subtribe Labineae and some of the genera such as *Arnica* and *Bartlettia*, recognized as belonging to the Senecioneae by Rydberg (1927), it is as morphologically diverse as the Heliantheae. Certainly the three genera appear to be seneciod in habit (opposite, mostly clasping, leaves); involucre mostly in 1 or 2 series; pappus (when present) of bristles (at least in part); style branches truncate; and achenes columnar, usually ribbed (Figs. 1-3). While the genera appear to have no close relatives in either tribe, I believe they are reasonably close to *Arnica* ($x=19$) and might well be positioned within or near that taxon, as indeed, as has been suggested by Hoffmann's treatment of the tribe (*i.e.*, he positions *Haplöesthes* next to *Arnica*). As to the $x=18$ chromosome base, this number is as rare in the Heliantheae as it is in the Senecioneae; in any case it is not too difficult to imagine its origin at some ancestral time through chromosomal loss from *Arnica* ($x=19$), if one does not wish to assume an ancestral base of $x=9$ for the genus itself.

SARTWELLIA A. Gray, Pl. Wright. 1:122. 1852. Type species: *S. flaveriae.*

Annual or short-lived perennial herbs 6-30 inches tall, the stem branching from the base. Leaves narrowly linear, opposite. Heads radiate, 10-45 flowered, in corymbiform cymes. Involucre turbinate to broadly campanulate; bracts typically 5, in two series, broadly oval or oblong to elliptic, yellowish. Receptacle small, convex, glabrous. Ray florets 3-5, fertile; ligules very small, yellow, narrowly to broadly oval or rarely linear, truncate or variously 2-3 toothed. Disk florets 5-parted, 10-40, fertile; corolla tube about as long as the throat; style branches short, truncate, penicillate at the apex. Achenes black at maturity, cylindric or nearly so, 10-ribbed; pappus of the disk florets of 5 erose squamellae, alternating with 5 bristles, these wholly united into a cup-like crown (in *S. flaveriae*) or else variously united at the base of the corolla tube and deciduous with the latter; pappus of the ray florets usually reduced but similar to those of the disk, rarely completely absent.

Base chromosome number, $x=18$.

KEY TO SPECIES

1. Florets 20-40 per head; involucre campanulate, the outer 3 involucral bracts broadly oval, 2-3 mm long, 1.5-2.0 mm wide, *not* conspicuously thickened and keeled at the base; plants usually 4-15(40) cm tall . . . . 1. *S. mexicana*
1. Florets 8-15 per head; involucre turbinate to narrowly campanulate, the outer 3 involucral bracts broadly linear to oval (rarely elliptic), 1.5-2 mm long, ca 1 mm wide, conspicuously thickened and somewhat keeled at the base.
    2. Pappus of disk achenes fused, forming a lacinate crown or cup ca 0.5 mm long (rarely the pappus of 5 distinct squamellae alternating with 5 bristles, as in *S. mexicana*, below); plants of the United States (Texas and adjacent New Mexico) . . . . 2. *S. flaveriae*
    2. Pappus of disk achenes with 5 squamellae, 0.5-1.0 mm long, alternating with 5 somewhat longer bristles, not united into a distinct crown or cup; plants of northern Mexico . . . . 3. *S. puberula*

1. SARTWELLIA MEXICANA A. Gray (S. Wats. Proc. Am. Acad. 18:107, *hyponym.* 1882), Proc. Am. Acad. 19:34. 1884. Holotype GH!: MEXICO. Coahuila: Monclova. Aug 23-31, 1880. *E. Palmer 683.* (Mounted on same sheet with *E. Palmer 683* is a glabrate specimen of *S. puberula*). Isotype US!.

Sartwellia humilis I. M. Johnston, Jour. Arn. Arb. 22:167. 1941. Holotype GH!: MEXICO. San Luis Potosi: 4 mi S of Cedral, gypsum plain, 1938, *I. M. Johnston 7567.* Isotype US!.

Herbs 6-15(40) cm high, glabrous; leaves narrowly linear, 2-6 mm long, ca 1 mm wide or less; heads 25-45 flowered; involucre 2.2-3.0 mm high, the 3 outer bracts broadly oval to obovate, yellow and membraneous, with faint orange ribs, usually rounded at the apex, glabrous; ray flowers 5, ligules 0.5-1.0 mm long, ca 0.75 mm wide; disk corollas 1.5-2.0 mm long; achenes

1 mm long or less, sparsely hispidulous; pappus of 5 squamellae, 0.5-1.0 mm long, alternating with 5 somewhat longer bristles. Chromosome number, $n=18$.

Distribution: Gypseous soils of eastern Coahuila, western Nuevo Leon south to Zacatecas and San Luis Potosi, reportedly common in "alkaline plains" and flats. Aug-Oct.

Both Rydberg (1915) and, surprisingly, I. M. Johnston (1941) failed to recognize the more distinguishing features which characterize what I treat here as *S. mexicana* and *S. puberula*. While Rydberg recognized two species for northern Mexico, *S. puberula* and *S. mexicana*, he did not recognize the biological integrity of the numerous-flowered, campanulate-headed taxon which I treat as *S. mexicana*; rather he applied the latter name to the fewer-flowered, turbinate-headed populations of more western Coahuila and adjacent Chihuahua. Rydberg inadvertently gave the name *S. puberula* to the latter populations in describing, as a new species, puberulent forms of what he accepted as *S. mexicana*. Johnston (1941) largely recognized the inadequacy of Rydberg's treatment, himself believing *S. puberula* to be " . . . no more than a puberulent variety of *S. mexicana* Gray." While Johnston, in his recognition of *S. humilis*, clarified to some considerable degree the biological status of the several taxa, he unfortunately failed to examine the holotype of *S. mexicana* closely, for the specimen is clearly a robust form of his *S. humilis*. Johnston's carelessness is perhaps understandable in that he thought of his *S. humilis* as a uniformly small, compact plant; also he apparently did not appreciate fully the floral distinctions which characterized *S. humilis*, remarking only, in a comment following his description of the species, that *S. humilis* differs from *S. mexicana* " . . . in having numerous very short spreading stems and slightly larger heads." Finally, it is possible that Johnston was misled by the holotype of *S. mexicana* for it is mounted, with overlapping heads, on the same sheet with a glabrate specimen of *S. puberula* from San Lorenzo, southwestern Coahuila (*E. Palmer 683*). That Johnston should fail to find the definitive characters that marked his *S. humilis* (or *S. mexicana* of this treatment) is surprising, for it is more distant from *S. puberula* than the latter is from *S. flaveriae*, a species recognized almost solely on characters of the pappus (which occasionally break down) and distribution.

In habit *S. mexicana* is characteristically low and compact but spindly specimens up to 40 cm high have been collected well to the south of Saltillo (*Waterfall 15736*) and, as mentioned above, the holotype itself is very similar in habit to *S. puberula*.

Specimens examined: MEXICO. Coahuila: 1 mi S of Hermanas, 22-24 Aug 1938, *I. M. Johnston 7058* (GH, US); 6 mi N of La Ventura, 12-13 Sep 1938, *I. M. Johnston 7634* (FM, UC); on Vanegas-Saltillo rd, Jul-Aug 1934, *C. L. Lundell 5719* (ARIZ, DS, US); Las Hermanas, 26 mi N of Monclova, 24 Aug 1938, *F. Shreve 8425* (ARIZ, US); 6 mi N of La Ventana, 13 Sep 1938, *F. Shreve 8723* (ARIZ, US); N of La Ventura (14 mi N of Salvador), 20

Aug 1940, *E. R. Tinkham 9609* (ARIZ, GH); 1 mi S of Hermanas, 23 Aug 1959, *U. T. Waterfall 15795* (F, SMU). Nuevo Leon: 46 mi S of Saltillo, 8 Oct 1959, *M. C. Johnston & J. Graham 4199* (TEX); 74 mi N of Matehaula, 24 Aug 1951, *U. T. Waterfall 16595* (SMU, UC). San Luis Potosi: 30 mi S of Matehuala, 25 Aug 1960, *W.L. Ellison 59* (TEX); Matehuala, 13 Aug 1959 *J. Rzedowski 11489* (TEX); 40 mi S of Matehuala, 20 Aug 1959, *U.T. Waterfall 15736* (F, SMU). Zacatecas: Cedros, Oct 1907, *F.E. Lloyd 14* (UC, US); Cedros, Oct 1907, *F. E. Lloyd & J. E. Kirkwood 145* (GH); Hacienda de Sierra Hermosa, 4-5 Sep 1938, *I. M. Johnston 7405* (FM, GH, UC); 14 mi S of Zacatecas-Coahuila state line on Highway 54, 2 Aug 1965, *J. Strother 464* (TEX).

2. SARTWELLIA FLAVERIAE A. Gray, Pl. Wright. 1:122. 1852. Holotype GH!. TEXAS: "prairies of the Rio Seco." Oct 1849, *C. Wright 386* Isotype US!.

Erect, tap-rooted, annual herb, 10-40 cm high, glabrous; leaves narrowly linear, 2-5 cm long, ca 1 mm wide (lower-most leaves rarely up to 2.5 mm wide); heads 9-15 flowered; involucre turbinate, 2.0-2.3 mm high; bracts 5 in two series, the 3 outer ones ca twice as long as wide, fleshy-membranous above but thickened below forming a distinct fleshy keel along the lower midrib; ray florets 3-5; yellow; ligules oval to linear, ca 2 mm long, 1 mm wide; disk corollas ca 2 mm long; achenes 1.5-1.8 mm long, hispidulous; pappus of disk florets wholly united into an erose crown, ca 0.5 mm long or rarely of 5 erose squamellae alternating with 5 bristles, these variously united at the base; pappus of ray florets similar to but smaller than that of the disk, rarely completely absent. Chromosome number, $n=18$.

Distribution: Gypseous soils of western-most Texas and adjacent New Mexico. (May) Aug-Sept.

The pappus of this species, while normally united into a crown or cup, may occur as 5 squamellae alternating with 5 bristles, such as occurs in *S. mexicana* and *S. puberula*. This variation is found both within populations and between populations (e.g., *E. Whitehouse 16998,* SMU; *16869,* SMU; *Correll & Correll 26035,* LL).

S. flaveriae, except for the pappus, is very similar to *S. puberula*. Their ranges do not overlap, however, unless one considers some of the pappus forms mentioned above as belonging to the latter species.

Representative specimens: UNITED STATES. NEW MEXICO. De Baca Co.: 27.5 mi S of Ft Sumner, 23 Sep 1967, *J. B. Secor 80* (TEX); Eddy Co.: 3.5 mi S of Loving, 17 Sep 1946, *E. Whitehouse 16869* (ARIZ, SMU, UC); Chaves Co.: 54 mi SE of Vaughan, 12 Aug 1947, *U. T. Waterfall 7741* (NY); Lincoln Co.: White Mountains, 23 Aug 1897, *E. O. Wooton 383* (DS, POM, UC, US); Otero Co.: White Sands, 31 Aug 1904, *E. O. Wooton 2619* (US); Socorro Co.: hills S of rd from Ben Rentfrow's Ranch to "upper crossing of malpais," 13 Sep 1923, *W. W. Eggleston 19432* (US). TEXAS. Culberson

Co.: 30 mi N of Van Horn, 16 Sep 1948, *B. H. Warnock & B. L. Turner 203* (LL, SMU); Crane Co.: 11 mi E of Grand Falls, 3 Oct 1935, *V. L. Cory 27357* (LL); Hudspeth Co.: W side of Salt Lake on hwy 62, 21 Sep 1946, *E. Whitehouse 16998* (SMU, US); Loving Co.: along & above Salt Creek near hwy 285 N of Orla, 27 Sep 1962, *D. S. Correll & H. B. Correll 26035* (LL); Pecos Co.: ca 10 mi NE of Grandfalls, 19 Aug 1947, *L. C. Hinckley 3995* (SMU); Reeves Co.: 1 mi NE of Pecos, 7 Jun 1943, *U. T. Waterfall 4376* (ARIZ, NY, SMU); Ward Co.: ca 1 mi W of Peyote, 18 Sep 1966, *D. S. Correll 33654* (LL); Winkler Co.: 10 mi SW of Kermit, 4 Sep 1954, *T. Collins 685* (SMU).

3. SARTWELLIA PUBERULA Rydb., N. Am. Fl. 34:141. 1915. Holotype NY: MEXICO. Chihuahua: plains below San Carlos. *C. C. Parry (Mex. Bound. Surv.) 640.* Isotype (fragment) UC!.

Erect, tap-rooted, annual or short-lived perennial herb, 15-45 (100) cm high, glabrous to rarely puberulent; leaves narrowly linear, 2-7 cm long, 1-2.5 mm wide; heads 10-18 flowered; involucre turbinate, 2.0-2.5 mm high; bracts 5 in two series, the 3 outer ones nearly twice as long as wide, fleshy-membranous above, fleshy and thickened below and somewhat keeled; ray florets 5, yellow; ligules oval to linear 1.5 mm long, 1 mm wide or less; disk corollas ca 2 mm long; achenes 1.0-1.5 mm long, hispidulous in lines along the ribs; pappus of disk florets of 5 squamellae, 0.5-1.0 mm long, alternating with 5 somewhat longer bristles (the pappus sometimes partially united, approaching that of *S. flaveriae*); pappus of ray florets usually reduced but similar to that of the disk (rarely completely absent). Chromosome number, $n = 18$.

Distribution: Gypseous soils of western Coahuila and eastern Chihuahua, south to northern Durango; common locally on flats and plains; (May) Aug-Sep.

Through misapplication of the type, this species has long gone under the name, *S. mexicana* (see discussion under the latter species). Rydberg (1915) inadvertently gave the name *puberula* to the taxon through his description, as a new species, of puberulent forms of what he took to be *S. mexicana*. Actually, *S. puberula*, as treated here, is nearly always glabrous, puberulent forms having been collected only in the vicinity of Castillon, Coahuila (*Johnston & Muller 1267*; just south of the type locality of the species) and more recently in northern Durango (*Stuessy 937*). Sparsely puberulent forms are also known (*Johnston & Muller 1438*) and it appears that relatively few genes segregate for this character, these occurring sporadically over a broad region.

The species is to be expected in trans-Pecos Texas, (gypseous exposures of the Big Bend area) since collections have been made just south of Presidio, Texas by I. M. Johnston (see cited specimens, below).

Representative specimens: MEXICO. Chihuahua: 5 mi S of Ojinaga, 9-10 Aug 1941, *I. M. Johnston 8000* (GH); 4 mi S of Chapo, 21-22 Sep 1940, *I. M. Johnston & C. H. Muller 1438* (GH); near Jimenez, 20 Sep 1892, *C. G. Pringle 5264* (GH); Rancho San Jose del Progreso, 21 Sep 1942, *R. M. Stewart 2323* (GH). Coahuila: 4 mi N of Parras, 15-17 Sep 1938, *I. M. Johnston 7705* (GH, US); Castillon, gypsum flats by corrals of the hacienda, 13 Aug 1941, *I. M. Johnston 8187* (GH); near Tanque La Luz on gypsum beds along escarpment, 26 Aug 1941, *I. M. Johnston 8497* (GH); Puertecito, gypseous bank just E of ranch, 28 Aug 1941, *I. M. Johnston 8588* (GH); ca 2 mi E of Tanque La Palma, 30 Aug 1941, *I. M. Johnston 8609* (GH); 5-7 mi SW of Rosario, 3-4 Sep 1941, *I. M. Johnston 8817* (GH); San Lorenzo de Laguna & vicinity, 22-27 leagues SW of Parras, 1-10 May 1880, *Dr. E. Palmer 683* (F, GH, US); Cerro de Cypriano, Jul 1910, *C. A. Purpus 4476* (F, GH, US); rd from San Vicente, 4-5 Oct 1941, *R. M. Stewart & I. M. Johnston 1957* (GH). Durango: 2 mi NW of Bermejillo on rte 49, 16 Aug 1967, *T. F. Stuessy 937* (TEX).

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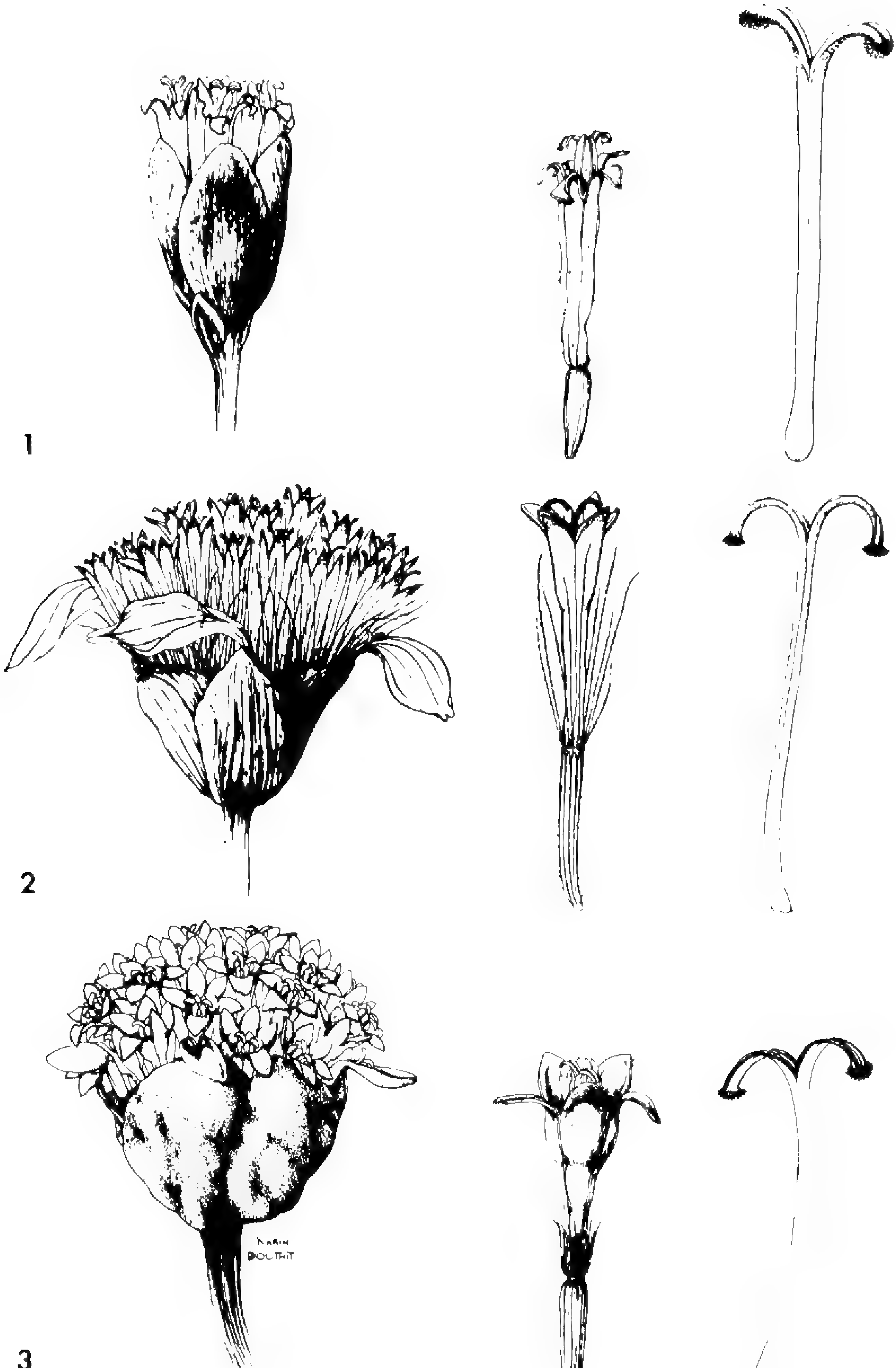

Fig. 1-3. Heads, disc florets and style of (1) *Flaveriae pringlei* (*King 2533*, TEX); (2) *Haplöesthes* (*Ellison & Turner 43*, TEX); and (3) *Sartwellia mexicana* (*Johnston 4199*, TEX). Sketches by *K. Douthet.*

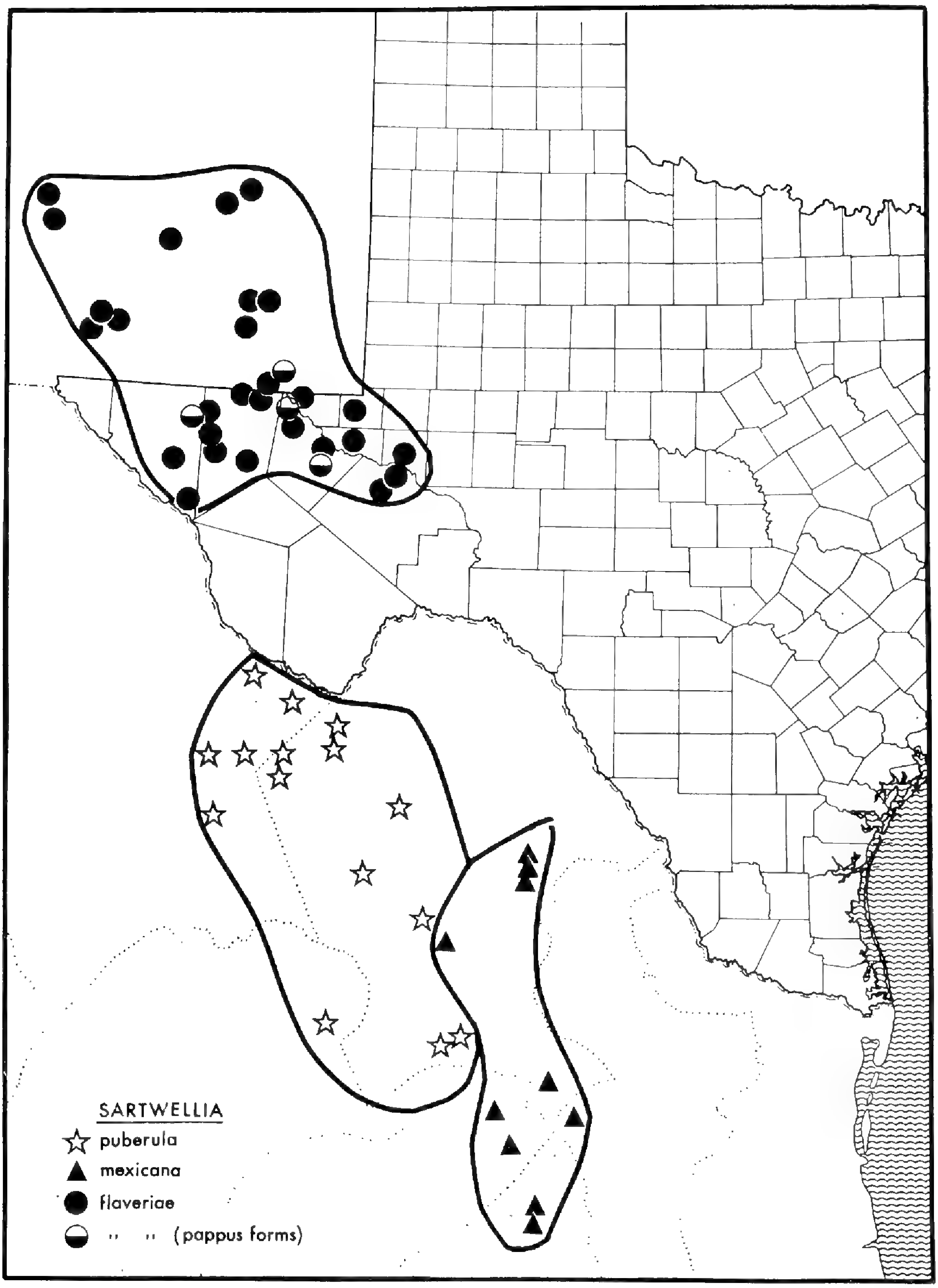

Fig 4. Distribution of three species of *Sartwellia*. Pappus forms of *S. flaveriae* superficially resembling those of *S. puberula* are shown within the range of the former taxon. Additional explanation in text.

NOTES

KUHNIA L. TRANSFERRED TO BRICKELLIA ELL. (COMPOSITAE).—Fortunately all the names for *Kuhnia* are available for transfer to *Brickellia*. The transfers are listed here in the same order followed in my "Revision of the genus Kuhnia L." (Wrightia 1: 122-144, 1946).

BRICKELLIA **Schaffneri** (A Gray) Shinners, comb. nov. *Kuhnia Schaffneri* A. Gray, Proc. Amer. Acad. 17: 207. 1882. *K. microphylla* Shinners, Wrightia 1: 127. 1946. At the date of my revision, the current rules of nomenclature called for the rejection of names based on a mixture. Subsequently they were emended to permit retention of such names if redefined on the basis of one element in the mixture. Under the present Code, therefore, Gray's name is the valid one for this species.

B. **leptophylla** (Scheele) Shinners, comb. nov. *Kuhnia leptophylla* Scheele, Linnaea 21: 598. 1848.

B. LEPTOPHYLLA var. **mexicana** (Shinners) Shinners, comb. nov. *Kuhnia leptophylla* var. *mexicana* Shinners, l.c. 128. 1946.

B. **chlorolepis** (Wooton & Standley) Shinners, comb. nov. *Kuhnia chlorolepis* Wooton & Standley, Contrib. U.S. Nat. Herb. 16: 177. 1913.

B. **oreithales** (B. L. Robinson) Shinners, comb. nov. *Kuhnia oreithales* B. L. Robinson, Proc. Amer. Acad. 54: 263. 1918.

B. **Mosieri** (Small) Shinners, comb. nov. *Kuhnia Mosieri* Small, Man. S.E. Fl. 1329 and 1508. 1933.

B. **eupatorioides** (L.) Shinners, comb. nov. *Kuhnia eupatorioides* L., Sp. Pl. (ed. 2) 2: 1662. 1763. At the time of my revision, the rules of nomenclature required adoption of the first published varietal name referable to what is now to be called var. *eupatorioides*. The latter epithet therefore replaces var. *pyramidalis* Raf.

B. EUPATORIOIDES var. **ozarkana** (Shinners) Shinners, comb. nov. *Kuhnia eupatorioides* var. *ozarkana* Shinners, l.c. 136. 1946.

B. EUPATORIOIDES var. **texana** (Shinners) Shinners, comb. nov. *Kuhnia eupatorioides* var. *texana* Shinners, l.c. 136. 1946.

B. EUPATORIOIDES var. **corymbulosa** (T. & G.) Shinners, comb. nov. *Kuhnia eupatorioides* var. *corymbulosa* T. & G., Fl. N.A. 2: 78. 1841. (Emend. A. Gray, Syn. Fl. N.A. 1 pt. 2: 103. 1884.)

B. **adenolepis** (B. L. Robinson) Shinners, comb. nov. *Kuhnia adenolepis* B. L. Robinson, Proc. Amer. Acad. 47: 201. 1911.—*Lloyd H. Shinners*.

BIGELOWIA NUDATA VAR. AUSTRALIS (L. C. ANDERSON) SHINNERS, COMB. NOV. (COMPOSITAE).—Based on *Bigelowia nudata* (Michx.) DC. subsp. *australis* L. C. Anderson, Sida 3 (7): 463. 1970. This is to permit uniformity in my projected account of the Compositae of the Southeastern United States.—*Lloyd H. Shinners*.

TEUCRIUM CUBENSE JACQ. VAR. LAEVIGATUM (VAHL) SHINNERS, COMB. NOV. (LABIATAE).—Based on *Teucrium laevigatum ("Lavigatum")* Vahl, Symb. Bot. 1: 40. 1790. "Habitat in Bonaria" (type not seen, and not cited by McClintock & Epling, Brittonia 5: 503—505, 1946). *Melosmon laevigatum* (Vahl) Small, Fl. S.E. U.S. 1019 and 1337. 1903. *Teucrium cubense* subsp. *laevigatum* (Vahl) McClintock & Epling 5: 503. 1946. (*T. cubense* subsp. *Chamaedrifolium* (Mill.) Epling, Ann. Mo. Bot. Gard. 12: 112, 1925, is now to be called subsp. *cubense* or var. *cubense*. *T. cubense* subsp. *depressum* (Small) McClintock & Epling, with consistently annual habit and small corolla, I consider a distinct species, restoring its original name, *T. depressum* Small.)—*Lloyd H. Shinners.*

SELAGINELLA ARENICOLA SSP. RIDDELLII (SELAGINELLACEAE) IN ARKANSAS.—The following collections are apparently the first records of *Selaginella arenicola* ssp. *Riddellii* (Van Eselt.) Tryon from Arkansas: OUACHITA CO.: Chidester, ca. ½ m. N of Chidester Baptist Church, sandy soil, a patch of about 3 acres, *G. E. Tucker 7857*, 19 April 1969. POPE CO.: Russellville, sandstone bluffs above Arkansas River at Pussy Point, on Norristown Mountain, *G. E. Tucker 6563*, 16 September 1967. The taxon had been previously reported only from Oklahoma, Texas, and Louisiana.

At the sandy barrens area near Chidester it is locally abundant along with other species typically found under relatively xeric conditions. These include *Streptanthus hyacinthoides* Hook., *Astragalus leptocarpus* T. & G., *Cnidoscolus texanus* (Muell. Arg.) Small, *Stillingia sylvatica* Garden, *Chamaesyce cordifolia* (Ell.) Small, *Helianthemum georgianum* Chapm., *Breweria pickeringii* var. *pattersoni* Fern. & Schub., *Phlox drummondii* Hook., *Penstemon murrayanus* Hook., and *Hymenopappus artemisiaefolius* DC.

The Pope County station is situated along the crest of a bluffline at a height of approximately 200 feet above the impounded waters of the Arkansas River. The *Selaginella* is locally abundant on thin soil derived from sandstone. The area is primarily vegetated with a scrubby growth of woody plants, including *Quercus stellata* Wang., *Q. marilandica* Muenchh., *Carya* spp., *Ulmus alata* Michx., and *Vaccinium arboreum* Marsh.

Specimens of the Pope County collection cited above were distributed in the Eighth Distribution of North American Plants, sponsored by the Southern Appalachian Club, and were misidentified as *Selaginella rupestris* (L.) Spring. Determinations of specimens collected from both locations were recently verified by Dr. Rolla Tryon.

Specimens have been deposited at the herbaria of the University of North Carolina at Chapel Hill, Southern Methodist University, University of Arkansas, and Arkansas Polytechnic College.—*G. E. Tucker, Biology Department, Arkansas Polytechnic College, Russellville, Arkansas 72801.*

THELESPERMA SHINNERSII FLYR (COMPOSITAE), A NEW SPECIES FROM COAHUILA, MEXICO—T. simplicifolio proxissima. Differt involucri squamis exterioribus longioribus, interioribus fere ad basim divisis, radiis sulphureis bicoloratis tenuioribus.

Perennial 1 m or less in height from a nearly vertical short woody rootstock. Stems simple or sparingly branched, internodes about 10 cm long. Leaves opposite, simple and entire or trifid with linear segments to 7.5 cm long and 1 (2.5) mm wide. Heads solitary or rarely sub-cymose on long naked peduncles. Involucre about 10 mm broad, 7 mm high; outer bracts 7 or 8, narrowly lanceolate, about as long as the inner, 4-6 mm long, dark green, somewhat striate, whitish on the margins; inner bracts 8, divided within 2 mm of the base, ovate, dark brown or black with membranaceous margins 0.6-0.7 mm wide, acute at the apex. Paleae of receptacle lanceolate, scarious, with two brown median lines. Ray florets 7-8, neutral; ligule obovate, shallowly 3-lobed, sulfur yellow: darker distally, lighter proximally (not apparent in dried material), about 10 mm long, 5 mm broad; tube 1.3 mm long. Disk florets about 45, yellow with dark red veins, 4-5 mm long with a narrow tube 1.6-1.7 mm long abruptly flared into a campanulate throat, evenly 4-5-toothed at the summit. Achenes 4 mm long, strongly incurved, somewhat 3-angled, light brown, reddish, or purple, dorsally verrucose or occasionally completely warty or rarely even smooth, usually 10 or fewer achenes per head maturing. Pappus none, but sometimes mimicked by two small cusp-like projections at the summit of the achene or by the cartilaginous ring to which the disk corollas are attached. Chromosome number as determined from meiotic material of the type collection: $n = 11$.

MEXICO: northern Coahuila, Sierra Jardín, 29° 05′ N, 102° 38′ W, occasional in moist meadows in pine forests, elevation 8500 ft and above, *Flyr 1177*, 1 September 1966. HOLOTYPE: SMU. ISOTYPES: TEX, NY, GH. Known only from the type locality and this collection.

Although closely related to *Thelesperma simplicifolium* Gray, *T. shinnersii* is unquestionably a distinct species. They are very similar except in morphological details of the capitulum, but it must be noted that both are almost irreducible in their vegetative simplicity. The two species occupy very different habitats: *T. shinnersii* is found in very moist grassy areas in pine-fir forests while *T. simplicifolium* is characteristic of the semidesert shrub and grassland formation (usually much overgrazed) of central and western Texas as well as northern Mexico. When seen in the field, *T. shinnersii* is strikingly distinct because of the two shades of sulfur yellow found in the ray florets. Both species occur in the area of the Sierra Jardín, but *T. simplicifolium* occurs only below about 6000 ft while the new species is found at 8500 ft or above. The altitudinal gap between them corresponds roughly to the extent of the pinyon-oak belt. The Sierra Jardín is located at the western limit of the Mexican distribution of *T. simplicifolium* as given by Melchert (1963) and may well be the only locality for the new species, there being no comparable elevations within 250 miles of this isolated range.

The chromosome number of *T. shinnersii* does not serve to distinguish it from *T. simplicifolium*, there being counts of $n = 11$ for this species from nearby Brewster County, Texas. The only count from Mexican material of either *T. simplicifolium* or the closely-related *T. subaequale* Blake is $n = 12$ for the former from Nuevo León (Melchert, 1963).

This species is named in honor of Dr. Lloyd H. Shinners of Southern Methodist University, student of Texas Compositae in general and of *Thelesperma* in particular, his treatments of the genus in Texas (1950a, 1950b) being little changed in Melchert's as yet unpublished dissertation.—*David Flyr, Route One, Stratford, Texas 79084.*

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SHINNERS, L. H. 1950a. The Texas species of *Thelesperma* (Compositae). Field and Lab. 18: 17-24.

SHINNERS, L. H. 1950b. Addenda on Texas *Thelesperma* (Compositae). Field and Lab. 18: 98-99.

PHYSALIS LAGASCAE (SOLANACEAE) IN LOUISIANA: NEW TO THE CONTERMINOUS UNITED STATES.—A groundcherry frequent in sugarcane fields in West Baton Rouge Parish, Louisiana, has proved to be *Physalis lagascae* Roem. et Schult., a neotropical species not previously recorded from the conterminous United States. The specimens, with their nearly glabrous stems, represent var. *glabrescens* O. E. Schultz. The plants were branched, erect to sprawling, fibrous-rooted annuals. The lower branches—as much as 45 cm long—of some individuals were prostrate. The corollas were pale yellow, 5-6 mm long, 6-8 mm wide; the anthers were blue, 1.5 mm long; and the fruiting calyces, 16-18 mm long, were more or less terete, with the 10 ribs prominent and the base slightly sunken. Among the associates of the *Physalis* were *Acalypha ostryifolia, Commelina diffusa, Corchorus orinocensis, Cucumis melo* var. *dudaim, Cyperus iria, Digitaria sanguinalis, Euphorbia heterophylla, E. maculata, Leptochloa filiformis, Melochia corchorifolia, Panicum reptans, Physalis angulata,* and *Portulaca oleracea*. Voucher specimens (DUKE, GH, LAF, OKLA, SMU) were collected from two localities. West Baton Rouge Parish: sugarcane field ca. 4 miles NW of Port Allen (Lobdell-Lida Grove area) near Baton Rouge-Opelousas highway, 18 September 1970, *Thieret 32344* (determined by Dr. U. T. Waterfall); sugarcane field ca. 4 3/4 miles SE of Erwinville, 24 October 1970, *Thieret 32639*.—*John W. Thieret, University of Southwestern Louisiana, Lafayette 70501.*

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CONTENTS

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TAXONOMY AND DISTRIBUTION OF THE GENUS RORIPPA (CRUCIFERAE) IN NORTH AMERICA[1]

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Rorippa consists of those yellow-petaled, numerous-seeded, readily-dehiscent-fruited marsh and shore plants in the Cruciferae. Distributed primarily in temperate, less so in subtropical and tropical regions, the genus occurs on every continent except Antarctica, but the species are more numerous in the northern hemisphere. The number of valid species is usually given as between 40 and 50, but this number may increase to 60 or 70 with expanded knowledge. Jonsell (1968) considered there to be about 70 species, some imperfectly known. One highly variable species, *R. palustris*, is known from each continent where the genus occurs. Busch (1915) discussed and mapped seven species for Eurasia; Wannenmacher (1960) had eight species for Middle Europe; and, in *Flora Europaea*, Valentine (1964) included 10 species. Several species are known from southern Asia, Africa, and South America. I recognize 21 species and 25 varieties (including typical ones) as native to North America; seven species are considered as introduced. The evolutionary relationship of these foreign members to the North American species is not understood.

In North America, *Rorippa* is most common and abundant, both as to individuals and taxa, in the mountainous regions of western United States. The plants usually grow in open, damp or wet, naturally-disturbed habitats along sandy shores of lakes and alluvial banks of creeks, streams, and rivers, and in marshes and swales; or in wet artificially-disturbed sites along roadside, drainage, and irrigation ditches, about edges of farm ponds, in low fallow or cultivated fields and gardens, along railroad grades and ditches, and about dumps or on ballast.

HISTORY OF THE GENUS

The yellow cresses have a confused nomenclatural history. *Rorippa* begins with Scopoli (Fl. Carn. ed. 1. 520. 1760), who wrote the first, but brief, generic diagnosis. Although he did not provide binomials, three species were named. The first contains the exact phraseology as that provided by Linnaeus (Sp. Pl. 675. 1753) for *Sisymbrium sylvestre.* Scopoli cited Linnaeus as one of five sources; on this basis, *Rorippa sylvestris* (Linnaeus) Besser is taken as the type of the genus. Abrams (1944) listed *Sisymbrium am-*

[1] Based on and revised from a doctoral dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in The University of Michigan, Ann Arbor, 1965. Contribution from the Botany Program (Paper No. 770) and The Herbarium of The Ohio State University.

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phibium Linnaeus as the type, a selection for which I find no basis, since Scopoli made no reference to this species. Included in Linnaeus' concept of *Sisymbrium* (16 species) were members of present-day *Sisymbrium* and *Rorippa* and also watercress (*Nasturtium*). Mackenzie (1925), in a review of Linnaeus' *Sisymbrium*, noted that these 16 species have been placed in nine to 11 different genera. Linnaeus treated two species of present-day *Rorippa*, *S. sylvestre* and *S. amphibium*. To the latter he appended three varieties, α *palustre*, β *aquaticum*, and δ *terrestre*. Pollich (Hist. Pl. 230. 1777) raised α *palustre* to specific rank in *Sisymbrium*, and, later, Besser (Enum. Pl. Volh. 27. 1822) transferred the epithets *palustre*, *amphibium*, and *sylvestre* to *Rorippa*.

In proposing the genus *Brachiolobus* (sometimes spelled *Brachilobus*, *Brachyolobos*, or *Brachylobus*) Allioni (Fl. Pedem. 1: 278. 1785) cited *Radicula* of Dillenius (Gen. Pl. Nov. 121. 1719) as the basis for his concept. Included in the original account were three species, *B. amphibius*, *B. sylvestris*, and *B. pyrenaicus*. *Rorippa* Scopoli is treated as a synonym of *B. sylvestris*. Allioni's species are now placed in *Rorippa*, and so there is no doubt that *Brachiolobus* is a synonym of *Rorippa*, as all subsequent authors have considered it.

As early as 1719—34 years before *Species Plantarum*—Dillenius (Gen. Pl. Nov. 121) was, according to Greene (1905), the first to characterize the yellow cresses as a genus under the name *Radicula*. Hill (Brit. Herbal 264. 1756) took up the name *Radicula*, but his specific names are not valid because he did not use the binomial system or refer to a work that did. It was not until 1794 that Moench (Meth. 262. 1794) provided and validated the specific epithets under *Radicula*. Those botanists who advocated strict priority or did not follow the code used *Radicula*. Greene (1905) and Mackenzie (1929) argued for its use, and many North American authors formed combinations under it. However, according to the *International Code* (Article 20), "The name of a genus may not coincide with a technical term currently used in morphology unless it was published before 1 Jan. 1912 and was accompanied, when originally published, by a specific name published in accordance with the binary method of Linnaeus." The name *Radicula* coincides with the technical term *radicula* (radicle) and, when originally published, was not accompanied by a specific name in accordance with the Linnaean method (Hill, Brit. Herbal 264. 1756). Moench (Meth. 262. 1794), who validated the genus, included the type species of the older generic name *Rorippa* (Scopoli, Fl. Carn. ed. 1. 520. 1760). In accordance with the rules, *Radicula* Moench must be rejected in favor of *Rorippa* Scopoli. The code cites this situation as an example to illustrate this rule.

Robert Brown in Aiton (Hort. Kew. ed. 2. 4: 109. 1812) enlarged the concept of the yellow cresses to include the white-flowered watercress, and he proposed the generic name *Nasturtium*. Included in this concept were not only watercress (*Nasturtium officinale* R. Brown) but also *N. sylvestre*, *N. terrestre*, *N. amphibium*, and *N. pyrenaicum*, all based on Willdenow (Sp.Pl. 3: 489. 1800), whose epithets in turn were taken from Linnaeus (Sp. Pl. 657.

1753). *Nasturtium* was long used for both the yellow cresses and watercress, but later workers, as pointed out by Sprague (1924), regarded watercress as a genus separate from yellow cresses; as a result, the older name *Baeumerta* Gaertner, Meyer, and Scherbius (Fl. Wett. 2: 419. 1800) was revived for the former. This led Janchen to propose that the name *Nasturtium* be conserved for watercress (Prop. Amplif. Liste Nom. Gen. Conserv. 4. 1909), and at the Brussels Congress of 1910, *Nasturtium* was added to the list of *nomina conservanda*. At that time only two *nomina rejicienda* were listed—*Cardaminum* Moench (Meth. 262. 1794) and *Baeumerta*. Since then, *Nasturtium* Miller (Gard. Dict. Abr. ed. 4. 1754) has been added to the list. I regard watercress as a genus separate from *Rorippa* (*see* section on "Relationships to Other Genera").

DeCandolle (Syst. Nat. 2: 188. 1821) first attempted to bring together, under *Nasturtium*, knowledge of watercress and the yellow cresses. The genus was subdivided into three sections on the basis of petal color and size and silique shape. Section *Cardaminum* contained watercress, *Nasturtium officinale*, white flowered. Section *Brachylobus* included the yellow cresses with short or ellipsoid siliques—the species around which the concept of *Rorippa* began, e.g., *N. sylvestre, N. palustre*, and *N. amphibium*. Section *Clandestinaria* contained plants devoid of petals or with small white petals, and elongate siliques. This was a dubious group of entities of Asia and South America whose relationships are little understood. None of them is native to North America; they are not considered in my paper. DeCandolle's work predominated, and so many species described from North America during early exploration were put in *Nasturtium*. Schulz in Engler and Prantl (*Die natürlichen Pflanzenfamilien*, ed. 2, 17b: 551. 1936) used the name *Nasturtium* and followed DeCandolle in characterizing the sections. Jonsell (1968) reviewed Schulz's treatment.

A further problem causing much confusion arose when Scopoli (Fl. Carn. ed. 2. 2: 24, 25. 1772) employed the spelling *Roripa* instead of *Rorippa* as published in his first edition (Fl. Carn. ed. 1. 520. 1760). Adanson (Fam. Pl. 2: 417. 1763) also used *Roripa*. Schinz and Thellung (Viert. Nat. Ges. Zürich 53: 537. 1909) and Knowlton and Deane (Rhodora 18: 200. 1916) accepted *Roripa* on the ground that *Rorippa* was a typographical error later corrected by its author. A number of North American authors used *Roripa*. However, Briquet (Prodr. Fl. Corse. 2: 28. 1913) pointed out that there was no evidence to indicate a typographical error, and he adhered to the original spelling, *Rorippa*. As to the source of the name, Scopoli provided the reference "Nomen Genericum Gesnerianum est," but no botanist knew to what work this referred, until Sprague (1930) discovered the source of the name—it was spelled *Rorippa*.

North American *Rorippa* has had little study. Torrey (1857) pointed out that the North American species needed careful revision. His statement was made 41 years after Desvaux (1814) named *Brachilobus* [sic] *hispidus*, the first entity described from North American material. In the intervening years, several species were proposed, but the treatment of 15 species under

Nasturtium by Torrey and Gray (1838-1843) was the first summary of these plants for the continent. Later, Watson (1895) prepared a treatment for the continent of ten species and seven varieties, which was slightly revised by Robinson. Aside from this work, no detailed study dealing strictly with the genus in North America has ever been undertaken. Various workers contributed small papers, but most of these were prepared on a local or regional basis. For example, regional revisions, no two being in agreement, were prepared for the *Rorippa palustris* complex by Marie-Victorin (1930), Butters and Abbe (1940), Fernald (1928, 1940), and Hultén (1945). Rollins (1941, 1961) contributed papers dealing primarily with members here placed in section *Sinuatae*. Nearly 100 years after Torrey's call for a study of North American *Rorippa*, a number of writers, including Hultén (1945), Harrington (1954), Mason (1957), and Rollins (1960, 1961), continued to point out the need for a detailed study.

SCOPE OF THE PRESENT STUDY

Data, primarily morphological and geographical, were obtained and correlated from: (1) examination of over 6000 herbarium specimens, (2) field studies in the Rocky Mountains and Great Lakes regions of the United States, (3) greenhouse observations on approximately half of the North American taxa, and (4) literature survey, each reference examined in the original or in photocopy. Important morphological characters for delimiting the taxa of North American *Rorippa* are: (1) fruit size and shape, (2) style length, shape, and mode of attachment to the silique, (3) pedicel position and length in fruit, (4) petal length, and length in relation to the sepals, (5) manner of raceme development, (6) trichome types and location, (7) leaf shape and lobing, (8) seed size, surface markings, and number per silique, and (9) replum shape. For the most part, descriptive terminology follows Lawrence (1951), Featherly (1954), and recent papers by Rollins (1941, 1961). Seed terminology is based on Murley (1951). All measurements given were made on herbarium specimens. Measurements of reproductive structures were usually made from among the mature lower five pedicels, siliques, and styles of the terminal raceme on those plants which have one, or on the lowest lateral raceme of those plants without terminal racemes. Because most herbarium specimens are in fruit, measurements of flower parts necessarily had to be made on flowers present in the upper portion of the raceme.

Pedicel position was resolved into three categories: (1) Recurved. These leave the raceme axis at right angles and then bend downward slightly or very strongly. Sometimes they may even bend back over the axis, and the siliques then appear to be borne unilaterally. (2) Divergent. These diverge from the axis at angles of about 65° to 90°. (3) Ascending. These diverge from the axis at angles less than 65°.

Silique width was measured at about 2/3 of the way up from the base of the silique perpendicular to the replum. Therefore, the width measurements are often slightly wider than the width of the replum or the valve.

Style lengths in fruit are quite variable. Those mostly over 1 mm. long are found in section *Sinuatae*; those mostly under 1 mm. long, in section *Rorippa*. To distinguish species within section *Rorippa* on the basis of style length, as is sometimes done in manuals, is often meaningless. Style shape and mode of attachment to the silique apex are more significant. The three basic style types are discussed in the summary of section *Rorippa* and are illustrated in figure 8-B. These styles show the unexpanded stigma condition —the stigma in fruit is no wider than the style apex. A stigma is considered expanded in fruit when it is wider than the style apex, e.g., in *R. palustris* subsp. *palustris* var. *palustris* and subsp. *glabra* var. *fernaldiana*.

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My thanks are extended to many who have contributed in various ways during my study of *Rorippa:* Dr. Edward G. Voss, Dr. William S. Benninghoff, Dr. William H. Burt, Dr. Peter B. Kaufman, Dr. Rogers McVaugh, Dr. Warren P. Stoutamire, Dr. Warren H. Wagner, Jr., Dr. Reed C. Rollins, Dr. Bengt Jonsell, Dr. Charles Feddeman, Drs. Alan and Shirley Graham, Dr. David B. Lellinger, Dr. John T. Mickel, Dr. Orson Miller, Dr. Martin A. Piehl, Dr. Alfred E. Schuyler, Mr. Stanwyn G. Shetler, Mr. Walter Kleinschmidt, Mr. Frederick Becker, Dr. John Cantlon, Prof. Joseph Ewan, Dr. Robert K. Godfrey, Mrs. Rebecca Nunan, Dr. James S. Pringle, Dr. Richard Homola, Mr. Chester W. Laskowski, and Mr. Melvern F. Tessene.

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SOURCES OF HERBARIUM SPECIMENS

I am grateful to the curators of the following herbaria whose specimens were studied for my dissertation: A, BLH, FSU, GH, HAM, MICH, MO, MSC, ND, ND-G, NEBC, NY, OC, OS, PH, UMBS, US, USFS, WIS, and WUD. A few critical or type specimens were seen from BM, ISC, JEPS, K, POM, RSA, and WS.

My original set of specimens collected in western United States in summer 1963 is deposited at MICH. Duplicate sets in various degrees of completeness are at GH, UPS, DAO, WIS, WTU, US, NY, DUKE, and OS.

Since I wrote the dissertation (1965), additional specimens have been seen from the following herbaria: LAF, MICH, PENN, WVA, Arizona State University (Tempe), and Ohio University (Athens). Significant data from these specimens have been incorporated into the text or maps.

To conserve space, citation of specimens examined is not included in this paper. I shall be pleased to send a list of these specimens to anyone who requests it.

SOURCES OF BASE MAPS

Maps 1, 19, 20: compiled by the author. *Maps 2, 4, 5, 6, 9, 11, 12, 13:*

United States. Museum of Zoology, Univ. Michigan, modified from map of United States by U. S. Geol. Surv. 1932. *Map 3:* Mexico, No. 112. Goode's Series of Base Maps, Univ. Chicago. Date unknown. *Maps 7, 14:* United States, No. 209. Goode Base Map Series, Dept. Geog., Univ. Chicago. 1961. *Map 8*: Caribbean America. Source unknown. *Map 10*: Caribbean America, No. 900H. Hall's Outline Maps and Graphs, John Wiley & Sons, Inc., New York. 1935. *Maps 15, 16, 17, 18, 21, 22*: North America, No. 202. Goode Base Map Series, Dept. Geog., Univ. Chicago. 1961.

THE GENUS RORIPPA

GENERIC DESCRIPTION (NORTH AMERICAN SPECIES)

RORIPPA Scopoli, Fl. Carn. ed. 1. 520. 1760.

Brachiolobus Allioni, Fl. Pedem. 1: 278. 1785.

Radicula Dillenius ex Moench, Meth. 262. 1794.

Nasturtium R. Brown, Hort. Kew. ed. 2. 4: 109. 1812. [p.p.]

Tetrapoma Turczaninow ex Fischer et Meyer, Ind. Sem. Hort. Petrop. 1: 39. 1835.

Tetracellion Turczaninow ex Fischer et Meyer, Ind. Sem. Hort. Petrop. 1: 39. 1835, pro syn.

Plants summer, fall, winter, or spring annuals, seldom biennials, from a slender to thick vertical taproot, or perennial from spreading slender to thick underground roots and stems. Secondary roots slender, fibrous, much branched. Stems 1-6(14) dm. tall, one to many, often from the center of a well-developed basal rosette, erect, decumbent, or prostrate, unbranched or much branched from the base and upward on the stem, glabrous, sparingly to densely villous, hirsute, pilose, or with scattered vesicular trichomes. Basal and lower cauline leaves sessile to short-petiolate, alternate (1-3 phyllotaxy), simple, oblong, obovate, oblanceolate, lanceolate to spatulate in outline, mostly 4-12 cm. long, 1-3 cm. wide; the margins entire, crenate, irregularly serrate, repand, laciniate, or dentate, or variously pinnatifid, sinuate, lyrate, or pectinate; middle lobes linear, elliptic, oblong to obovate in outline and with margins entire, crenate, or minutely to coarsely dentate; either or both leaf surfaces smooth or occasionally rough with hyaline ridges, glabrous or sparingly to densely hirsute, occasionally pilose, villous, puberulent, or with vesicular trichomes; leaf base attenuate to cuneate, somewhat auriculate with rounded to pointed lobes, glabrous to sparingly pubescent, slightly clasping the stem to non-auriculate, non-clasping; leaf apex acute to obtuse. Upper cauline leaves usually similar in shape, margins, dissection, and pubscence, but gradually reduced in length and width in comparison to the lower cauline leaves. Racemes terminal and lateral, forming during or after stem elongation, the siliques therefore nearly equal in age (development) at corresponding points on all racemes, or the oldest siliques on the lower portion of the terminal raceme; or racemes lateral, developing during stem elongation in the axils of the lower leaves and progressing upward, without the formation of a true terminal raceme, the oldest siliques on the lower axillary racemes. Pedicels 0.5-13.5 mm. long in fruit, slender, slightly to strongly recurved, divergent, or ascending, often somewhat expanded at the summit, glabrous to sparingly hirsute, rarely pilose, or with a few vesicular trichomes. Sepals ovate, lanceolate, or oblanceolate to oblong, 0.6-4.7 mm. long, 0.4-2 mm. wide, green, often tinged purple to red, becoming yellow to brown upon aging, with hyaline and entire margin, strongly saccate to flat, glabrous to minutely hirsute or rarely pilose in bud, persistent or caducous in fruit. Petals absent or present, obovate, oblanceolate, oblong, narrowly or broadly spatulate, 0.6-6 mm. long, 0.1-2 mm. wide, shorter, equal to, or longer than the sepals, erect or spreading between the sepals during full anthesis, sometimes slightly notched at the apex, cuneate at base, rarely sharply differentiated into blade and claw, pale to bright sulfur yellow, becoming white upon drying, glabrous, caducous in fruit. Stamens 6, slightly tetradynamous, rarely 3-5, the two shorter ones with a pair of minute glands at the base, the longer ones separated by a short conic gland; filaments 0.8-3.1 mm. long, slender, glabrous; anthers 0.5-1.5 mm. long, introrse, crowded against the stigma at anthesis, retained within the flower, glabrous, either globose to subglobose, ca. 1-1.5 times as long as wide and notched at the apex, or elongate, sagittate at a wide base, tapering toward the apex, ca. 1.5-3 times as long as wide and apiculate. Ovary cylindrical, elongating in fruit. Style very short, elongating and persistent in fruit. Ovules numerous. Siliques plump, short to elongate-cylindrical, ellipsoid, or slightly constricted at the middle, oblong, or subglobose to globose; the long ones straight or slightly to strongly falcate, obtuse, cuneate, or acute below, strongly tapering to not at all tapering, or clavate toward the apex, 0.8-20 mm. long, 0.5-3.5 mm. wide, as long as to several times longer than wide, less than, equal to, or longer than the subtending pedicels. Valves 2, sometimes 4, rarely up to 6, thin, turgid, strongly convex, usually readily dehiscent, or rarely indehiscent, non-elastic, nerveless or obscurely nerved, smooth or occasionally rough with hyaline ridges, glabrous, minutely to strongly papillose or rarely sparingly to densely pilose or strigose. Replum narrowly rectangular, elliptic, triangular, or circular in outline, sometimes twisted upon drying, margin straight, concave, or convex, glabrous, hirsute, or with vesicular trichomes. Style nearly absent to prominent, 0.1-1.6 mm. long, 0.1-1 mm. wide in fruit, straight throughout, expanded or tapering toward the apex, abruptly attached or gradually merging into the rounded, obtuse, acute, or pointed silique apex, glabrous or rarely sparingly pilose. Stigma expanded or unexpanded in fruit, unlobed to obscurely 2-lobed. Seeds regularly to angularly cordiform or oblong, ca. 0.4-1.1 mm. long, wingless, numerous and crowded into 2 irregular rows filling the locules, 10 to over 200 per silique; surface reddish or yellowish brown, colliculate, foveolate, or reticulate-foveolate; cotyledons accumbent. Flowering and fruiting mostly from May to September in central and northern United States, Canada, and Alaska; mostly from December to May and occasionally into the summer in southern United States, Mexico, Central America, and the West Indies.

Type species: *R. sylvestris* (Linnaeus) Besser.

The yellow petals and small, numerous, reddish to yellowish brown, mostly colliculate, foveolate, or reticulate-foveolate seeds, in two irregular rows in each locule; the usually two convex, non-elastic, obscurely nerved valves; and the usually readily dehiscent silique distinguish *Rorippa* from related genera.

RELATIONSHIPS TO OTHER GENERA

Rorippa apparently has close affinities with *Nasturtium, Armoracia,* and *Cardamine.* A study of the affinities of these and other Cruciferae is needed. *Nasturtium*, the genus of watercress, has been treated in *Rorippa* by authors in both Europe and America, the most recent treatment for North America being by Green (1962). The native North American species of *Rorippa* do not show a close relationship to *Nasturtium.* The distinguishing characters for watercress are the long white petals, prominently reticulate seeds, and somewhat fleshy, glabrous, pinnate leaves with round to oblong, usually entire lobes. The plants, typically aquatic, produce extensive creeping or floating stems often rooting at nodes. *Rorippa* is largely confined to fresh-water strands and produces roots at the nodes only when by chance (e.g., after a rise in water level of the lake or river) submersed in water for a period of time.

Armoracia, at least *A. aquatica*, is separated from *Rorippa* by its usually submersed leaves pinnately dissected into numerous filiform segments. When these readily deciduous leaves become separated from the parent plant, they may produce new plants at the base (LaRue, 1943). Although stems of several *Rorippa* are known to form roots at the nodes when in water, the leaves are not known to grow roots or form young plantlets. Other characters that distinguish *A. aquatica* from *Rorippa* are the white petals and the vestigial replum.

Cardamine differs from *Rorippa* in having white, pink, or purple petals, flattened elastic valves, and usually oval, oblong, or subrectangular seeds in one row in each locule of the straight silique.

KEY TO SECTIONS OF RORIPPA (NORTH AMERICAN SPECIES)

1. Basal rosettes wanting even in young plants; lower cauline leaves mostly sinuate-lobed, thick, fleshy, gray, dark green in living plants. . . . . SINUATAE (species 1-6)
1. Basal rosettes present in young plants; basal and lower cauline leaves mostly unlobed to variously laciniate, pinnatifid, lyrate, or pectinate, rarely sinuate-lobed, thin, not fleshy, bright green in living plants. . . . . RORIPPA (species 7-21)

KEY TO SPECIES OF RORIPPA IN NORTH AMERICA

1. Pedicels subtended by leafy bracts. (Asian, one collection from ballast on Vancouver Island). . . . . 27. *R. microsperma*
1. Pedicels not subtended by leafy bracts (2)
   2. Siliques 4- to rarely 6-valved; style in fruit thick, 0.5-1 mm. wide;

stem villous, especially on lower portion. (Mostly on unglaciated territory of Alaska and Yukon). . . . . . . 21. *R. barbareifolia*

2. Siliques 2-valved; style in fruit slender, 0.1-0.5 mm. wide; stem glabrous, sparingly to densely hirsute, pilose, or with vesicular trichomes (3)

3. Petals absent (4)

3. Petals present (6)

4. Pedicels longer than 4 mm.; siliques 10-25 mm. long; style in fruit longer than 0.5 mm. (Sporadic, apparently introduced from tropical areas of South America). . . . . 28. *R. heterophylla*

4. Pedicels shorter than 3.2 mm.; siliques 3-8.5(10) mm. long; style in fruit shorter than 0.5 mm. (5)

5. Plants glabrous; valves smooth to rough with minute hyaline ridges, glabrous; seeds light yellowish brown, deeply foveolate, usually more than 150 per silique; leaves sessile, obovate, oblong, oblanceolate to spatulate, the margins entire, crenate, irregularly serrate or repand, not pinnatifid; siliques nearly equal in age (development) at corresponding points on the terminal and lateral racemes. (Mostly south of the southern limit of Wisconsin glaciation in the Mississippi embayment and southeastern United States). . . . . 13. *R. sessiliflora*

5. Plants with hemispherical or obovate to clavate vesicular trichomes; valves smooth to rough with minute hyaline ridges or with hemispherical vesicular trichomes; seeds dark reddish brown, somewhat reticulate to shallowly foveolate, usually fewer than 100 per silique; leaves petiolate, oblong to oblanceolate, pinnately divided nearly to the midrib, the lobes oblong to elliptic, the margins entire, deeply crenate, or angularly toothed; oldest siliques on lower axillary racemes. (West Indies). . . . . 12. *R. portoricensis*

6. Petals shorter than or equal to the sepals (7)

6. Petals longer than the sepals (17)

7. Seeds less than 0.5 mm. in length; vesicular trichomes present on lower portion of stems, upper surface of basal and lower cauline leaves, pedicels, or siliques (8)

7. Seeds more than 0.5 mm. in length; vesicular trichomes (not necessarily other types) absent from all parts of the plant (9)

8. Style in fruit longer than 0.5 mm.; pedicels (1.4)2.5-4.5(5.2) mm. long, usually longer than 2.5 mm.; seeds usually more than 100 per silique. (Coastal Plain of southern United States and Mexico and sparingly on east coast of Central America). . . . . 11. *R. teres*

8. Style in fruit shorter than 0.5 mm.; pedicels (0.6)1-2.2(3) mm. long, usually shorter than 2.2 mm.; seeds usually fewer than 100 per silique. (West Indies). . . . . 12. *R. portoricensis*

9. Petals usually longer than 1.2 mm.; oldest siliques on lower portion of the terminal raceme. (Mostly throughout North America north of Mexico). . . . . 20. *R. palustris*

9. Petals usually shorter than 1.2 mm.; oldest siliques on lower axillary

racemes, or siliques nearly equal in age (development) at corresponding points on the terminal and lateral racemes. (Occasionally in *R. pinnata* and in *R. intermedia* of Mexico and Central America, the oldest siliques may be on the lower portion of the terminal raceme) (10)

10. Replum margin minutely hirsute and the valves readily dehiscent, or if replum margin glabrous, the valves not readily dehiscent; pedicels and stem often with slender, short, retrorse, pointed trichomes; petals spreading between the sepals in living plants. (Mostly west of the Continental Divide in North America). . . . . 8. *R. curvisiliqua*

10. Replum margin and pedicels glabrous; valves readily dehiscent; stems occasionally with a few scattered, but not retrorse, trichomes below; petals erect in living plants (11)

11. Siliques globose, 1-1.3 times as long as wide; replum circular in outline. (Scattered throughout southwestern United States). 19. *R. sphaerocarpa*

11. Siliques short- to elongate-cylindrical, 1.5-5 or more times as long as wide; replum oblong to triangular in outline (12)

12. Plants mostly shorter than 3 dm., prostrate to decumbent; cauline leaves usually fewer than 10; oldest siliques on lower axillary racemes, or if about equal in age at corresponding points on the racemes, the valves minutely papillose (13)

12. Plants mostly taller than 3 dm., prostrate, decumbent, or erect; cauline leaves usually more than 10; oldest siliques on lower portion of the terminal raceme, or siliques nearly equal in age at corresponding points on the terminal and lateral racemes, the valves glabrous (14)

13. Siliques rough with minute papillae, tapering to the apex, slightly curved inward, occasionally curved outward, not constricted at the center, (2)3.5-7(8.5) mm. long, ca. 1.5-2.5(4) times as long as wide; style in fruit thick, ca. 0.2-0.4 mm. wide, tapering toward the apex, gradually merging into the pointed silique apex; leaves lyrate divided, the margin entire. (Central Nevada and Utah, southern and Lower California, eastern Idaho, western Montana, and in the Columbia, Platte, Rio Grande, and Missouri river valleys, often growing with R. truncata). 7. *R. tenerrima*

13. Siliques glabrous, not at all or only slightly tapering toward the apex, straight, constricted at the center, (2.3)3-5(8.2) mm. long, ca. 2-4.2(6) times as long as wide; style in fruit slender, ca. 0.1-0.2 mm. wide, straight throughout, abruptly attached to the obtuse to truncate silique apex; leaves pinnate-divided to the midrib, the margin angularly toothed. (Central and southern California, eastern Arizona, northeastern Idaho, western Montana, Columbia, Platte, Rio Grande, and Missouri River valleys, often growing with R. tenerrima). . . . 17. *R. truncata*

14. Cauline leaves unlobed, the margin entire, crenate, irregularly serrate or repand. (Abundant in the Rocky Mountains of the United States mostly below 9000 ft., occasional westward, and sparingly

eastward) . . . . 18. *R. curvipes*

14. Cauline leaves pinnately divided to the midrib, the margin mostly angularly toothed. (Extreme southwestern United States, south through Mexico to Costa Rica) (15)

15. Siliques 6.7-11 mm. long, 2-4 times as long as the pedicels; seeds 0.8-1.1 mm. long, coarsely colliculate. (Mountains of central Costa Rica north to Guatemala). . . . . 14. *R. megasperma*

15. Siliques 2.7-6.5 mm. long, 0.8-1.5 times as long as the pedicels; seeds 0.5-0.8 mm. long, finely colliculate (16)

16. Pedicels recurved; siliques thick, (1.1)1.4-2.3 mm. wide; seeds 0.7-0.8 mm. long, usually more than 30 per silique; lower surface of the leaves smooth. (Central Valley of Mexico, south to Guatemala). . . . . 15. *R. pinnata*

16. Pedicels divergent to erect; siliques narrow, 0.7-1.3 mm. wide; seeds 0.5-0.6 mm. long, usually fewer than 20 per silique; lower surface of the leaves rough with hyaline ridges on the midrib. (Extreme southwestern United States, southward into western Mexico). . . . . 16. *R. intermedia*

17. Fruiting pedicels longer than 12 mm.; leaves pustulate, unlobed, the margin crenate to dentate; seeds 1.5-2 mm. long; petals longer than 6 mm. (Along the Yellowknife Highway near Great Slave Lake of northwestern Canada). . . . . 22. *R. crystallina*

17. Fruiting pedicels shorter than 12 mm. (if longer, the leaves pectinate); leaves without pustules, unlobed or variously sinuate, pectinate, or pinnate-divided; seeds 0.5-1.1 mm. long; petals shorter than 6 mm. except in R. coloradensis (18)

18. Petals shorter than 2.5(3) mm.; style in fruit usually shorter than 0.8(1.2) mm.; anthers globose, 1-1.5 times as long as wide, notched at the apex (fig. 8-A, 2) (transitional in size and shape in R. mexicana) (19)

18. Petals longer than 2.5(2.0) mm.; style in fruit usually longer than 0.8 mm.; anthers elongate, 1.5-3 times as long as wide, apiculate (fig. 8-A, 1) (22)

19. Fruiting pedicels longer than 7 mm.; plants stout, erect, mostly taller than 4 dm.; oldest siliques on lower portion of the terminal raceme. (Long-petaled plants mostly west of the Continental Divide in North America, sparingly elsewhere on the continent north of Mexico). . . . . 20. *R. palustris*

19. Fruiting pedicels shorter than 7 mm.; plants weakly erect to decumbent or prostrate, mostly shorter than 4 dm.; oldest siliques on lower axillary racemes, or siliques nearly equal in age at corresponding points on the terminal and lateral racemes (20)

20. Replum margin minutely hirsute and the valves readily dehiscent, or if replum margin glabrous, the valves not readily dehiscent; pedicels and stem often with slender, short, retrorse, pointed tri-

chomes; petals spreading between the sepals in living plants; pedicels divergent to ascending. (Mostly west of the Continental Divide in the Pacific Northwest of the United States). . . . . 8. *R. curvisiliqua*

20. Replum margin and pedicels glabrous; valves readily dehiscent; stems occasionally with a few scattered, but not retrorse, trichomes below; petals erect in living plants; pedicels divergent to recurved (21)

21. Cauline leaves pinnate-divided to pectinate, the lobes less than 4 mm. wide, the margins entire to minutely toothed; style in fruit thick, ca. 0.3-0.4 mm. wide, expanded below the stigma; oldest siliques on lower axillary racemes; seeds ca. 70-100 per silique. (Uplands of northern Mexico, southward in the mountains in Central America to Costa Rica). . . . . 10. *R. mexicana*

21. Cauline leaves unlobed, margin entire, crenate, irregularly serrate to repand, occasionally deeply divided, but lobes more than 4 mm. wide; style in fruit slender, ca. 0.1-0.3 mm. wide, straight throughout; siliques nearly equal in age at corresponding points on the terminal and lateral racemes; seeds ca. 20-80 per silique. (Central Rocky Mountains of the United States at elevations mostly above 9000 ft.). . . 18. *R. curvipes*

22. Stems decumbent to prostrate; leaves and stems with hemispherical vesicular trichomes or elongate, slender, pointed trichomes; basal rosettes wanting in living plants, shallow to deeply sinuate-lobed or pinnatifid (Section Sinuatae) (23)

22. Stems erect; leaves and stems glabrous, or if minutely puberulous, then lobes at base of leaf strongly sagittate; basal rosettes present in young plants; leaves thin, not fleshy, bright, grass green in living plants, unlobed or pinnate-divided to pectinate (28)

23. Petals 6-7.5 mm. long, strongly differentiated into blade and claw; sepals 3.8-5 mm. long. (One collection from southwestern Colorado) . . . . 6. *R. coloradensis*

23. Petals 2-5.5(6) mm. long, slightly or not at all differentiated into blade and claw; sepals 0.7-4.5 mm. long (24)

24. Trichomes vesicular on stems, lower surface of leaves, and sometimes on pedicels and valves, other times these parts of the plant glabrous; siliques short- to elongate-cylindrical or lanceolate with pointed apex, straight to strongly falcate, (4.5)5.7-12.5(16) mm. long, (2.5)4-8 times as long as wide; sepals caducous in fruit; seeds usually more than 35 per silique (25)

24. Trichomes elongate and pointed on stems, lower surface of leaves, and sometimes on pedicels and valves, other times these parts of the plant glabrous; siliques oblong to subglobose with rounded apex, straight, (1.6)2.3-5.5(7) mm. long, 1.3-2.3 times as long as wide; sepals persistent in fruit; seeds usually fewer than 35 per silique (26)

25. Petals (2.5)3.5-5.5(6) mm. long; outer sepals saccate; pedicels divergent to recurved, (3.5)5-11.5(15) mm. long; siliques nearly equal in age at corresponding points on the terminal and lateral racemes. (Widespread throughout the United States mostly west of the Mississippi River). . . . . 4. *R. sinuata*

25. Petals 2.5-3.5 mm. long; outer sepals flat; pedicels divergent to ascending, 3-5.2(6.5) mm. long; oldest siliques on lower axillary racemes. (Uplands of northeastern Mexico in Coahuila and northern Durango, north to the Rio Grande). . . . . 5. *R. ramosa*

26. Siliques glabrous or rarely sparingly pilose; stigma unexpanded in fruit; axillary racemes subumbellate, mostly less than 0.5 dm. long when fully developed. (Sandy shore of Lake Tahoe and vicinity in California and Nevada). . . . . 3. *R. subumbellata*

26. Siliques densely pilose to short-strigose; stigma expanded in fruit; axillary racemes elongate, 0.5-1.5 dm. long when fully developed (27)

27. Siliques densely pilose with elongate trichomes unexpanded at the base; pedicels ascending; sepals and style pilose. (Within the area of the Columbia River basaltic lava [Tertiary age] plateau in northern California, Oregon, and Washington). . . . . 2. *R. columbiae*

27. Siliques densely strigose with short trichomes expanded at the base; pedicels recurved; sepals and style glabrous. (Sandy banks of the Yellowstone River in eastern Montana and northwestern North Dakota). . . . . 1. *R. calycina*

28. Siliques longer than 8 mm. when seeds are formed and mature, equal to or up to 4 times as long as the pedicels; if mature siliques lacking seeds (R. sylvestris), the replum longer than wide (oblong in outline) and the siliques sometimes less than 8 mm. long; style in fruit 0.5-1 mm. long (29)

28. Siliques shorter than 8 mm. when seeds are formed and mature, shorter than the pedicels; if mature siliques lacking seeds (R. austriaca), the replum as wide as long (circular in outline); style in fruit 1-3 mm. long (31)

29. Leaves unlobed, non-auriculate at the base, the margins irregularly serrate; siliques strongly curved upward. (Asian, known from cultivated sites in Chicago and at the New York Botanical Garden). . . . . 29. *R. indica*

29. Leaves pinnately divided to the midrib, auriculate at the base; siliques straight to slightly curved (30)

30. Mature siliques usually lacking seeds; plants clonal from slender spreading underground roots and stems. (European, common in northeastern United States and southeastern Canada, sparingly elsewhere in North America). . . . . 23. *R. sylvestris*

30. Mature siliques with seeds; plants solitary from a vertical taproot. (Uplands of Chihuahua, Mexico, Arizona, and extreme western New Mexico in the United States). . . . . . . 9. *R. microtitis*

31. Siliques globose, 1-1.5 mm. long, as long as wide, often not forming seeds; replum circular in outline; style as long as the silique; cauline leaves unlobed except for clasping, sagittate base. (European, sparingly adventive in northeastern, central, and western United States and central Canada). . . . . 24. *R. austriaca*

31. Siliques elongate-cylindrical, 2-6 mm. long, 2 to 4 times as long as wide, seeds formed; replum oblong to elliptic in outline; style 1/2 to 1/5 as long as the silique; cauline leaves unlobed, laciniate to pectinate and clasping with rounded lobes or non-clasping (32)

    32. Stems hollow; cauline leaves mostly unlobed with margins entire, crenate to serrate, or pectinate; roots often forming at lower leaf nodes; growing in water or along water's edge. (European, sparingly adventive along the St. Lawrence River in Canada and in Maine and Massachusetts). . . . . 25. *R. amphibia*

    32. Stems solid; cauline leaves mostly laciniate-divided, often nearly to the midrib; roots absent from the leaf nodes; growing in drier places. (European, sparingly adventive in coastal eastern United States). . . . . 26. *R. prostrata*

SECTION SINUATAE

Section **Sinuatae** Stuckey, sect. nov.

Perennials; stems decumbent to prostrate, not erect, much branched from below and above, few to numerous from slender spreading underground horizontal roots and stems, forming large clones; basal rosettes wanting; cauline leaves oblong to broadly oblanceolate, shallowly to deeply sinuate, or subpinnatifid to pinnatifid, thick, fleshy, gray green; tips of young sepals and auricles of leaves usually glabrous, except in *R. columbiae* whose sepals and leaves are densely pilose; petals bright sulfur yellow, showy, slightly longer to nearly twice as long as the sepals; anthers elongate, sagittate at a wide base and tapering toward the apex, ca. 1.5-3 times as long as wide, apiculate (fig. 8-A, 1); style usually longer than 1 mm. in fruit.

Herbae perennes; caulibus decumbentibus vel procumbentibus numerosis ramosis; foliis rosulatis absentibus; foliis caulinis vulgo sinuatilobatis crassis; petalis quam sepalis longioribus; antheris elongatis sagittatis apiculatis.

Type species: *Rorippa sinuata* (Nuttall in Torrey et Gray) A. S. Hitchcock. Six species of North American *Rorippa* belong to *Sinuatae*.

1. RORIPPA CALYCINA (Engelmann) Rydberg, Mem. N. Y. Bot. Gard. 1: 175. 1900. [as "*Roripa*"]

   Nasturtium calycinum Engelmann in Warren, Prelim. Rep. 156. 1858, reprint 1875; Trans. Am. Philos. Soc. n. s. 12: 184. 1861. ("Sandy bottoms of the Yellowstone river; Fort Sarpy to Fort Union." Lectotype: MONTANA: [Custer Co.]: Sandy bottoms on Yellowstone [River] near Fort Sarpy [Fort Alexander Sarpie was at about the present location of Sheffield], Jul 1854, *F. V. Hayden s.n.*, MO! Photo at MICH! OS! Isolectotypes, GH! NY!)

Nasturtium sinuatum Nuttall in Torrey et Gray var. *calycinum* (Engelmann) Watson in Gray, Syn. Fl. N. Am. 1: 147. 1895.

Radicula calycina (Engelmann) Greene, Leafl. Bot. Obs. & Crit. 1: 113. 1905.

Stems 1-4 dm. tall, moderately to densely hirsute with simple slender trichomes slightly expanded at the base and pointed at the apex; middle cauline leaves sessile, auriculate and partly clasping the stem, oblong to oblanceolate, 2.5-5 cm. long, 0.5-1 cm. wide, shallow to strongly sinuate with the sinuses reaching about half-way to the midrib, both surfaces hirsute, especially on the midrib, the apex acute to obtuse; racemes terminal and axillary, ca. 0.5-1.5 dm. long, forming simultaneously after stem elongation, the siliques therefore nearly equal in age at corresponding points on the racemes, or racemes lateral, developing during stem elongation in the axils of the lower leaves and progressing upward, without the development of a true terminal raceme, the oldest siliques therefore on the lower axillary racemes; pedicels 3.5-6.5 mm. long, glabrous to sparingly hirsute, ca. 1.5-2 times as long as the siliques, strongly recurved, often in the same direction and giving the siliques the appearance of being borne unilaterally; sepals ovate to lanceolate, 2.1-3.1 mm. long, 0.7-1.2 mm. wide, saccate, persistent in fruit, glabrous; petals oblong to oblanceolate, (2)2.5-3.7 mm. long, 0.6-1.3 mm. wide, up to 1 mm. longer than the sepals; siliques globose to subglobose, 2.3-3.4 mm. long, 1.2-2.3 mm. wide, ca. 1.3-2 times as long as wide, the valves densely strigose with very short trichomes expanded at the base and pointed at the apex; replum elliptic in outline, the margin convex and hirsute; style 1-2.2 mm. long, ca. 0.1-0.2 mm. wide in fruit, straight throughout, abruptly attached or somewhat gradually merging into the rounded silique apex, glabrous; stigma expanded in fruit; seeds regularly cordiform, ca. 0.7-0.8 mm. long, ca. 20 per silique, the surface prominently colliculate; flowering and fruiting May-July (August-September).

Rorippa calycina is unique in this section in having globose to subglobose siliques densely covered with very short sharp-pointed trichomes expanded at the base, a very long, slender, glabrous style in fruit, glabrous persistent sepals, strongly recurved pedicels, and shallowly sinuate-lobed entire leaves. It is most closely allied to *R. columbiae*.

Rorippa calycina has long been confused in the literature. Piper (1906) reported it from Washington, Oregon, and Montana. The collection he cited, "Sandberg & Leiberg in 1892," is *R. columbiae*. Wooton and Standley (1915) gave the range as Washington and Oregon to Colorado and northern New Mexico, citing, for the latter state, several localities. Plants labeled by them as *R. calycina* from these localities possess prominent hemispherical vesicular trichomes on the fruit; they are *R. sinuata*. The confusion has come about through equating the vesicular trichomes on the siliques of *R. sinuata* from New Mexico and Colorado with the very short-pointed, thick-based, simple hairs on fruits of *R. calycina*. Reports by Daniels (1911) and Rydberg (1906) from Colorado and by Fosberg (1940) from New Mexico are similarly *R. sinuata.*

DISTRIBUTION: Map 20-A.

Known from sandy banks of the Yellowstone River in eastern Montana and at its mouth in northwestern North Dakota, *R. calycina* was first collected by Hayden during 1854-55. These specimens were used by Engelmann when he described the species, giving, as the source localities, "sandy bottoms of the Yellowstone river, Fort Sarpy to Fort Union." The latter is at the mouth of the Yellowstone River in Mackenzie County, North Dakota. Ft. Sarpy was located on the Yellowstone above the mouth of the Tongue River approximately where Sheffield in western Custer County, Montana, is today. I have chosen as lectotype the specimen from Ft. Sarpy because it is the most complete, having mature fruits and racemes. Since Hayden, only one other botanist, Blankinship, is known to have collected this species in the Yellowstone River valley. On the label of a specimen at MO, Blankinship wrote "Custer, Montana (type locality)." This collection came from either the town of Custer (farther up the Yellowstone from Sheffield) or from approximately the type locality, if Blankinship meant Custer County.

Mulligan and Porsild (1966) reported *R. calycina* on a delta of the Anderson River in the Northwest Territories, about 2500 miles north of the species' range in Montana and North Dakota. They seem to suggest that, at the Anderson River, *R. calycina* is probably an introduction rather than a preglacial relic or a remnant of a postglacial prairie migration.

2. RORIPPA COLUMBIAE Suksdorf ex Howell, Fl. N. W. Am. 1: 40. 1897. [as "*Roripa*"]. ("*Nasturtium Columbiae Suksdorf in Herb. distr. 952.*" Holotype: WASHINGTON: Klickitat Co.: Low gravelly bank of the Columbia River near Bingen, 21 Sep, 14 Oct 1890, *W. N. Suksdorf 952*, presumably at ORE. Isotypes, GH! MO! MSC! US! WS! Photo of MO specimen at MICH! OS!)

Nasturtium sinuatum Nuttall in Torrey et Gray var. *columbiae* Suksdorf ex Robinson in Gray, Syn. Fl. N. Am. 1: 147. 1895. [Based on *Suksdorf 952*]

Nasturtium sinuatum Nuttall in Torrey et Gray var. *pubescens* Watson in Gray, Syn. Fl. N. Am. 1: 147. 1895. (Holotype: OREGON: [Multnomah Co.]: Sauvie's Island, 1 Jun 1884, *Joseph Howell s.n.*, GH!)

Roripa [sic] *sinuata* (Nuttall in Torrey et Gray) A. S. Hitchcock var. *pubesens* (Watson in Gray) Howell, Fl. N. W. Am. 1: 40. 1897.

Nasturtium columbiae Suksdorf ex Howell, Fl. N. W. Am. 1: 40. 1897, pro syn.; Suksdorf, Deutsch. Bot. Monatsschr. 16: 211. 1898. (Holotype: *Suksdorf 952*, WS!)

Radicula columbiae (Howell) Greene, Leafl. Bot. Obs. & Crit. 1: 114. 1905.

Rorippa calycina (Engelmann in Warren) Rydberg var. *columbiae* (Suksdorf ex Robinson in Gray) Rollins, Contr. Dudley Herb. 3: 176. 1941.

Stems 1-3(4) dm. tall, densely pilose with simple, very slender trichomes nearly equal in diameter throughout and pointed at the apex; middle cauline leaves sessile to short-petiolate, auriculate and partly clasping the stem to non-auriculate and non-clasping, oblong to oblanceolate, 2.5-5 cm. long, 0.5-1 cm. wide, deeply sinuate or pinnatifid with the sinuses often nearly reaching the midrib, both surfaces pilose, the lobes mostly oblong to elliptic with margins entire to minutely toothed, the apex acute to obtuse; racemes terminal and axillary, ca. 0.5-1.5 dm. long, forming simultaneously after stem elongation, the siliques therefore nearly equal in age at corresponding points on the racemes, or rarely racemes lateral, developing during stem elongation in the axils of the lower leaves and progressing upward, without the development of a true terminal raceme, the oldest siliques therefore on the lower axillary racemes; pedicels (2.5)4.0-9.8(11.5) mm. long, densely pilose, ca. 1-2.5 times as long as the siliques, ascending in two or more directions and not giving the siliques the appearance of being borne unilaterally; sepals ovate to oblong, 2.1-3.5 mm. long, 0.7-1.5 mm. wide, mostly flat, persistent in fruit, densely pilose; petals oblong-oblanceolate to spatulate, 2.7-4.1 mm. long, 0.8-1-8 mm. wide, up to 1 mm. longer than the sepals; siliques oblong to subglobose, (1.6)2.5-5.4(7) mm. long, (0.9)1.8-2.8(3.4) mm. wide, ca. 1.5-2.2 times as long as wide, the valves densely pilose with simple, very slender trichomes nearly equal in diameter throughout except pointed at the apex; replum oblong to elliptic in outline, the margin convex and pilose; style 0.7-3.1 mm. long, ca. 0.3-0.4 mm. wide in fruit, straight throughout, abruptly attached or somewhat gradually merging into the rounded silique apex, densely pilose; stigma strongly expanded in fruit; seeds regularly cordiform, 0.8-0.9 mm. long, ca. 20-30 per silique, the surface prominently colliculate; flowering and fruiting June-October.

ILLUSTRATIONS: Abrams (1944, p. 281, fig. 2024); Hitchcock & Cronquist (1964, p. 538), as *R. calycina* var. *columbiae*.

Rorippa columbiae is distinct from other North American *Rorippa* in having the stems, both leaf surfaces, pedicels, sepals, siliques, and styles densely pilose. In addition, it is distinguished from its close relative, *R. calycina*, by the deeply pinnatifid lobes of the leaves with minutely toothed margins, more oblong slightly thicker siliques on ascending pedicels, and well developed expanded stigma. From *R. subumbellata*, also a close relative, it differs in having more elongate racemes, densely pilose siliques, usually longer pilose style, and expanded stigma.

Plants with these characters were first carefully observed by Suksdorf. His collections, from "low gravelly bank of the Columbia River near Bingen," were labeled "952 Nasturtium Columbiae n. sp." and were distributed to a number of botanists. Robinson, who edited Watson's (1895) treatment of *Rorippa* in Gray's *Synoptical Flora of North America*, first gave formal recognition to this taxon, publishing "Nasturtium sinuatum Nutt. var. Columbiae, Suksdorf (as spec.)" and citing "Suksdorf, distr. 952." Howell (1897), unaware of Robinson's work, described the taxon as a species under the name *Roripa* [sic] *columbiae*, citing the Suksdorf collection. Howell probably had one of Suksdorf's specimens, and therefore presumably the holotype is in Howell's herbarium at ORE. Suksdorf (1898) finally published the name *Nasturtium columbiae*, but since he cited both Robinson's and Howell's names, his name is superfluous.

The only difference between Watson's (1895) *Nasturtium sinuatum* var. *pubescens* and *R. columbiae* is the slightly longer pedicels of the former.

Abrams (1944), Munz and Keck (1959), and Hitchcock and Cronquist (1964) accurately describe *R. columbiae*; however the latter two works follow Rollins in maintaining it as a variety of *R. calycina*. Peck's (1961) report that *R. columbiae* extended to Montana, Nebraska, and New Mexico is a case of confusing it with *R. calycina* or with plants of *R. sinuata* having fruits with vesicular trichomes. The report of *Radicula columbiae* by Winter (1936) from Scotts Bluff County, Nebraska, was based on a specimen (duplicate seen at NY and US) of *R. sinuata* with vesicular trichomes on the fruits.

DISTRIBUTION: Map 1-A; 20-B.

The distribution of *R. columbiae* appears to be related to the Columbia River lava plateau of Tertiary age. This plateau, one of the largest basaltic lava fields ever formed, was built up by successive eruptions that reached great intensity about the Miocene (Hussey, 1947). Map 1-A shows the distribution of *R. columbiae* to lie in the area covered by this soil formation. That the distribution of *R. columbiae* shows relationship with lava soils is suggested from label data of a collection from Siskiyou County, California, "lava slopes of lava beds," (*Thompson 13148*, GH, MO, NY, PH, RSA, US) and from Klamath County, Oregon, "heavy-soiled playa," (*Constance, Molseed, Weiler 3680*, FSU, GH, MO, MSC, RSA, US, WIS).

In map 1-A, circles represent pre-1905, and dots represent post-1905 specimens. Only in the Klamath Lake region of Oregon and California has this species been found recently. I propose later in this paper that *R. columbiae* is an isolated relic probably once more abundant and widespread than today. I think it may have decreased its range even in the past 60 years, as the map data reveal. In 1963, my attempt to rediscover *R. columbiae* and *R. sinuata* in the type localities ended in failure after a 4 days' search along the Columbia River from The Dalles to Sauvies Island.

3. RORIPPA SUBUMBELLATA Rollins, Contr. Dudley Herb. 3: 177. 1941. (Holotype: CALIFORNIA: El Dorado Co.: Meek's Bay, Lake Tahoe, 6100 ft, 29 Jul 1919, *A. A. Heller 13329a*, GH! Isotypes, MO! NY! US! WIS! Photo of MO specimen at MICH! OS!)

Stems 0.5-1.5(2.8) dm. tall, glabrous to sparingly pilose with simple, very slender trichomes nearly equal in diameter throughout and pointed at the apex; middle cauline leaves sessile to very short petiolate, non-auriculate, oblong to broadly oblanceolate, 1-3 cm. long, 0.3-1 cm. wide, sinuate to subpinnatifid, upper surface sparingly pilose to glabrous, lower surface moderately pilose, the lobes mostly oblong to elliptic with margins usually entire, the apex mostly obtuse; racemes terminal and axillary, up to 0.5 dm. long, forming simultaneously after stem elongation, the siliques therefore nearly equal in age at corresponding points on the racemes; pedicels

4.1-9 mm. long, pilose, ca. 1-2 times as long as the siliques, ascending in 2 or more directions; sepals ovate to oblong, 2.3-2.8 mm. long, 0.9-1.5 mm. wide, flat, persistent in fruit, glabrous to sparingly pilose; petals oblong-oblanceolate to spatulate, 2.7-3.4 mm. long, 1-1.5 mm. wide, up to 1 mm. longer than the sepals; siliques oblong to subglobose, 3.5-5.5 mm. long, 2-3(3.7) mm. wide, ca. 1.5-2.3 times as long as wide, the valves glabrous to very sparingly pilose; replum oblong to elliptic in outline, the margin convex and glabrous; style 0.7-1.5 mm. long, 0.3-0.4 mm. wide in fruit, straight throughout, abruptly attached or somewhat gradually merging into the rounded silique apex, glabrous; stigma unexpanded in fruit; seeds somewhat angularly cordiform, ca. 0.9-1.1 mm. long, ca. 20-30 per silique, the surface very prominently colliculate; flowering and fruiting June-September.

ILLUSTRATION: Rollins (1941, p. 184, pl. XLVI, fig. 2)

Rorippa subumbellata is most closely allied to *R. columbiae* and is distinguished from it in having glabrous to sparingly pilose siliques, short subumbellate racemes, an unexpanded stigma, usually shorter, glabrous styles, and larger, very prominently colliculate seeds. The leaves appear more fleshy and the stems more stiff.

Before Rollins' recognition of *R. subumbellata*, specimens passed under the name *R. sinuata* or its synonyms as indicated from descriptions and localities cited (e.g., Greene, 1891; Jepson, 1925, 1936). Mason (1957), Munz and Keck (1959), and Rollins (1941) considered it endemic to shores of Lake Tahoe. Two old collections in Greene's herbarium (ND-G) extend the distribution to Truckee and Tallac Lake.

Rollins recollected specimens of *R. subumbellata* at the type locality in 1942. I did not find it there in 1963 but did find two colonies on the beach at Bliss Memorial Park. Here this rare species survives in shifting sand, enduring much abuse from the tramping feet of swimmers and sun bathers.

DISTRIBUTION: Map 1-B; 20-C.

4. RORIPPA SINUATA (Nuttall in Torrey et Gray) A. S. Hitchcock, Spring Fl. Manhattan 18. 1894.

Nasturtium sinuatum Nuttall in Torrey et Gray, Fl. N. Am. 1: 73. 1838. ("Banks of the Oregon [River] and its tributaries; also in Arkansas." Lectotype: OREGON or WASHINGTON: [county unknown]: Columbia river & Arkansas, [ca. 1834, *fide* Pennell (Bartonia 18: 36. 1936), *Thomas Nuttall s.n.*], BM. Photo no. BM 2124, GH! [The specimens were originally labeled "Nasturtium *sinuatum" by Nuttall.] Isolectotype, PH!)

Nasturtium trachycarpum Gray, Bull. U. S. Geol. & Geog. Surv. Terr. 2: 233. 1876. ("Southwestern Colorado," [also, "S. W. Colorado, on the San Juan [River], &c.," Gray (1876). This reference is given in the literature cited.] Holotype: COLORADO: [Probably Archuleta Co.]: S. W. Colorado, 1871, *T. S. Brandegee 1180*, GH! Isotype, [with printed label, "Hayden's U. S. Geological Survey, 1875"] MO! Photo at MICH! OS!)

Roripa [sic] *trachycarpa* (Gray) Greene, Pittonia 3: 96. 1896.
Radicula sinuata (Nuttall in Torrey et Gray) Greene, Leafl. Bot. Obs. & Crit. 1: 113. 1905.
Radicula trachycarpa (Gray) Rydberg, Bull. Torrey Club 39: 322. 1912.

Stems 1-4(5) dm. tall, sparsely to densely pubescent with hemispherical vesicular trichomes; middle cauline leaves sessile, auriculate and partly clasping the stem to non-auriculate and non-clasping, oblong to oblanceolate (1.6)2.8-6(8.5) cm. long, 0.4-1.3(1.8) cm. wide, shallow to deeply sinuate, pinnatifid to subpinnatifid nearly to the midrib, the lower surface sparsely to densely covered with vesicular trichomes on the midrib, upper surface glabrous, the lobes oblong to elliptic with margins entire to minutely toothed, the apex acute to pointed; racemes terminal and axillary, ca. 1-2.5 dm. long, forming simultaneously or the axillary ones forming somewhat earlier, the siliques therefore nearly equal in age at corresponding points on the racemes; pedicels (3.5)5-11.5(15) mm. long, glabrous, or sparsely to densely covered with vesicular trichomes, recurved to ascending or often divergent at right angles to the raceme axis and then becoming recurved or ascending near the distal end; sepals oblong, ovate to lanceolate, 2.7-4.5 mm. long, 1.1-1.7 mm. wide, strongly saccate, caducous in fruit, glabrous or with a few vesicular trichomes on the lower portion of the dorsal surface; petals oblong, oblanceolate, or narrowly spatulate, (2.5)3.5-5.5(6) mm. long, 1.4-2.2 mm. wide, up to 3 mm. longer than the sepals; siliques short- to elongate-cylindrical, oblong, to somewhat lanceolate, obtuse below and slightly to strongly falcate toward the raceme axis, (4.5)5.7-12.5(16) mm. long, 1-1.8(2.5) mm. wide, ca. (2.5)4-8 times as long as wide, ca. (0.3)0.6-2 times as long as the pedicels, the valves glabrous or rough with minute or prominent hemispherical vesicular trichomes over the entire surface or on the edges only; replum linear to narrowly oblong in outline, the margin straight to slightly concave, and glabrous or sparingly with vesicular trichomes; style (0.5) 1-2(3.4) mm. long, ca. 0.3-0.5 mm. wide in fruit, tapering to the apex, gradually merging into the pointed silique apex, glabrous; stigma unexpanded when the siliques produce mature seeds, expanded when seeds fail to mature; seeds sharp, angularly cordiform, ca. 0.7-0.9 mm. long, ca. 0.5-0.6 mm. wide, longer than wide, ca. (25)40-80(100) per silique, the surface finely colliculate; flowering and fruiting April-October.

ILLUSTRATIONS: Abrams (1944, p. 277, fig. 2023); Britton & Brown 1897, p. 124, fig. 1714; 1913, p. 160, fig. 2027); Fassett (1940, p. 232, fig. 16); Fernald (1950, p. 715, fig. 1108), siliques and leaves; Gleason (1952, p. 239); Hitchcock & Cronquist (1964, p. 540); Steyermark (1963, p. 759, pl. 185, no. 3).

Rorippa sinuata is a distinct but variable species, especially in length of fruits and pedicels. The distinctive siliques are short- to elongate-cylindric or lanceolate, nearly straight to strongly falcate, and usually on long pedicels arising at right angles from the raceme axis but then bending up or down. The unusual trichomes are somewhat vesicular and hemispherical rather than elongated and pointed. On dried specimens they often appear flat and scale-like because they are collapsed. They are rather sparse on stems and on the midrib of the lower leaf surface in specimens mostly from the plains states. Increase in trichome abundance and density occurs on material primarily from mountainous regions of western United States. The silique valves vary from glabrous or sparsely covered with trichomes (often only along the edges) to entirely and densely covered with them, as on siliques of a specimen collected in southwestern Colorado in 1875 by Brandegee and used by Gray (1876) as the basis of his *N. trachycarpum.* Pubescent pods occur on most specimens from Arizona and New Mexico, from El Paso in Texas, and from Wyoming except the one seen from Cheyenne. Fruits with glabrous valves are found in the Texas panhandle, Oklahoma, Arkansas, Minnesota, and Montana. Plants with a complete spectrum of trichome variation occur in Illinois, Iowa, Missouri, Nebraska, Kansas, Colorado, and the Great Basin. Plants from the Great Basin are mostly glabrous but a few have indications of trichomes. Although there is some geographic segregation of the two valve-surface types, there is considerable overlap through the central plains states. There is also considerable variation in abundance, distribution, and development of these trichomes on plants throughout the species, sometimes even on the same plant. Although Great Basin plants tend to have smaller petals (ca. 2.5-4.0 mm.), often shorter siliques and pedicels, and a more prominently colliculate seed, I find no feature correlating with the trichome variation pattern. Two separate species or two varieties of one species should therefore not be maintained. I agree with Rollins (1961) that these peculiar vesicular trichomes alone are not a basis for taxonomic separation.

With regard to typification of *R. sinuata*, I agree with Rollins (1961).

DISTRIBUTION: Map 2; 20-D.

Rorippa sinuata is most abundant in the Rocky Mountains of southern Wyoming, Colorado, and northern New Mexico, extending eastward onto the plains in the Texas panhandle, western Oklahoma, Nebraska, and South Dakota where it is common. East of longitude 100° the localities are mostly along major rivers, such as the Arkansas, Kansas, Missouri, and Mississippi. Southward the plants grow along the Rio Grande in New Mexico and the Little Colorado in Arizona. Additional stations in these two states are in wet places in the mountains. The species is absent from Utah and then recurs in the Humboldt and Truckee river valleys of Nevada as well as in a few other localities in Nevada and California. To the northwest it is almost entirely confined to the banks of the Snake and Columbia rivers. It seems plausible that the species had its origin in the Colorado Rocky Mountains. In addition to being frequent there, the plants vary much in pedicel length, fruit shape and length, and trichome distribution on the fruit. Outward from this region the plants are often found along or in the valleys of the major river systems. I believe the distribution pattern of *R. sinuata* has come about primarily by migration down major rivers. Factors favoring such migrations are discussed later, but first it is important to determine when this migration may have occurred and to establish which parts of the range have come about by natural means and which by artificial.

Certainly its spread into western Canada, eastern South Dakota, Minnesota, and Wisconsin occurred since retreat of the Wisconsin glacier. Specimens collected before 1870 are significant in that many of them come from localities on the present edge of the species' range. Of particular importance are Nuttall's collections in Arkansas and along the Columbia River. *Rorippa sinuata* was probably as widely distributed west of the Mississippi then as it is now. Most scattered outlying occurrences presumably came about naturally before European man became established in western United States.

East of 97° longitude, the plants are found primarily along major rivers. Those along the Minnesota and upper Mississippi rivers in Minnesota and Wisconsin are disjunct from those in South Dakota and western Iowa. Patman and Iltis (1961) stated that the Wisconsin plants were introduced from western United States, implying, perhaps, a rather recent introduction. *Rorippa sinuata* may well be introduced into Wisconsin, but it is interesting to note when this introduction may have occurred. Parry (1852) collected *R. sinuata* along the lower St. Peter's [Minnesota] River in 1848—before much settlement by European man there. The two collections from northeastern Illinois ("R.R. track, Naperville"; "on ballast, Palos Park") are certainly introductions. Besides these collections, the species is confined, in Illinois, to the Mississippi River except for one collection from Greenfield and those mapped by Jones and Fuller (1955), for which I have not seen specimens. *Rorippa sinuata* occurs in Iowa along the western edge of the Missouri River valley, plus one collection at Cordova in the south central part of the state. In Arkansas the species has been found on the Arkansas River, in addition to a collection from Corning in the northeastern corner. Although this may be of no significance, the three towns mentioned above are served by railroads, and the colonies may have become established through man's activity. The collection from Daviess County in northwestern Missouri, however, came from an area not now served by a railroad.

North and east of Illinois there have been a few reports for *R. sinuata*. Walpole (1927) listed it from Marquette County, Michigan, but that collection is *R. sylvestris*. Wilson (1906) stated that a colony persisted for 15 years along a railroad west of Greencastle, Indiana. In the absence of a verifying specimen, Deam (1940) excluded the species from the Indiana flora. I have not seen the specimen cited from Maryland by Reed (Phytologia 10: 345. 1964). In summary, it appears that *R. sinuata*, native to the southern Rocky Mountains and the Great Plains, has migrated down major rivers to the east, south, and west. Its present distribution has come about by this migration, rather than through man's interference except for those plants in Maryland, the Chicago area, and possibly some of the localities east of 97° longitude but not on a major river.

Rorippa sinuata is perennial. Once a plant is established, young buds and vegetative shoots may grow from the roots and a massive clone may be formed if the soil is wet and growing conditions are favorable. If drier conditions develop, the roots remain alive. With a return to more favorable conditions, the plants may then grow and continue to spread. In the greenhouse, once the roots penetrate the cinders on the bench, new plants reappear from the old roots long after the potted plants have been removed. Stems of *R. sinuata*, placed in water, grow roots (two at each node) within a week. When transferred to soil, the stems grow, send out branches, and form new colonies.

Rorippa sinuata is well adapted to a wide variety of soil types and habitats. Loose sandy, gravelly, or alluvial wet soil is ideal for spread of the roots. Lake shores and stream banks are frequent habitats. The perennial roots may penetrate and survive in much drier soils, or the clone may continue to live if the water level is lowered. Data on herbarium labels indicate that plants were found in sandy clay, saline, alkaline, granitic, sandstone, and heavy black loam soils and in disturbed sites such as parking lots, roadsides, railroad banks, ballast, and buffalo wallows. I collected *R. sinuata* in very wet soil along a Colorado irrigation ditch, a wet roadside in western Iowa (where Isely collected it 11 years earlier), and at the margin of a dry corn field in Colorado. The ability of the roots to rejuvenate under favorable (wet) conditions long after aerial parts of the plants have been removed, the ability of the stems to grow roots at nodes when kept very damp or in water, and the ability of the plants to persist for years by forming perennial colonies are adaptations aiding *R. sinuata* in its dispersal down the major river systems in western United States as well as in its establishment in man-disturbed sites.

Of native North American *Rorippa, R. sinuata* best shows downriver dispersal. When plants of perennial species get rafted downstream, take root, and become established, they have a mechanism for survival for several years. In contrast, many annuals show less apparent migration down river; their survival mechanism is, by comparison, poor. If an individual of an annual (e.g., *R. tenerrima* or *R. truncata*) becomes established on an exposed open bank it may persist a few years; but should the water level become lower, the soil drier, and the site not disturbed for several years, other plants move in and the annual can no longer compete. On the other hand, the perennial can withstand for a longer time some drying and competition. The differences are reflected in collections made over 100 or more years in places to which these plants have migrated. Chances are greater that plants of perennial species will be collected. Thus, when one compares distributions of species that show downriver migration, e.g., *R. sinuata*, with *R. tenerrima* or *R. truncata*, the perennial one, *R. sinuata*, is more common than the annual one (compare map 2 with map 4 or map 11). The introduced perennial *R. sylvestris* (Stuckey, 1966b), which spreads like *R. sinuata*, is more widely dispersed in the eastern half of the continent than the introduced annual *R. palustris* var. *palustris*, which is confined to places where it apparently was originally introduced along the east coast.

Not only is the wide distribution of *R. sinuata* indicative of success in becoming established in various habitats, but it also grows in the dry Great Plains, a region where annuals occur very sporadically and that receives little rainfall, usually less than 16 inches. The correlation is shown well by the distribution of *R. sinuata* (map 1) and that of *R. curvipes*, an annual (map 14). *Rorippa curvipes* is virtually confined to the Rocky Mountains in areas of over 16 inches of rainfall a year. *Rorippa palustris* var. *fernaldiana*, annual, is also absent from the dry prairie region of western Texas, Oklahoma, and Kansas.

5. RORIPPA RAMOSA Rollins, Rhodora 63: 4. 1961. (Holotype: MEXICO: DURANGO: In a dry arroyo, 3 miles northwest of Ceballos, 4 May 1959, *D. S. Correll, I. M. Johnston 21449*, GH! Isotype, LL., *fide* Rollins, 1961.)

Stems 1-5 dm. tall, sparsely pubescent with hemispherical vesicular trichomes; middle cauline leaves sessile, auriculate and partly clasping the stem, oblong to broadly oblanceolate (2)3-5 cm. long, 0.5-1.2 cm. wide, deeply sinuate, pinnatifid to subpinnatifid, the lower surface with vesicular trichomes on the midrib, upper surface glabrous, the lobes oblong to elliptic with margins entire to minutely toothed, the apex acute to pointed; racemes lateral, ca. 0.5-1(1.7) dm. long, developing somewhat after or during stem elongation in the axils of the lower leaves and progressing upward, without the formation of a true terminal raceme, the oldest siliques therefore on the lower axillary racemes; pedicels 3-5.2(6.5) mm. long, divergent to ascending, sparsely covered with vesicular trichomes; sepals oblong, 2-2.5 mm. long, 0.7-1.3 mm. wide, flat, caducous in fruit, glabrous or with a few vesicular trichomes on the lower portion of the dorsal surface; petals spatulate, 2.5-3.5 mm. long, 0.7-1.3 mm. wide, up to 2 mm. longer than the sepals; siliques oblong to lanceolate, slightly curved inward, obtuse below and tapering toward the apex, 5.5-9.8(11) mm. long, ca. 2-3 mm. wide, ca. 2.5-4 times as long as wide, ca. 1.5-2 times as long as the pedicels, the valves glabrous to sparingly rough with hemispherical vesicular trichomes except along the edges where the trichomes are very dense; replum linear to oblong in outline, the margin straight to slightly concave and sparingly with vesicular trichomes; style 1-2 mm. long, ca. 0.3-0.5 mm. wide in fruit, tapering to the apex, merging into the silique apex, glabrous; stigma unexpanded to slightly expanded in fruit; seeds angularly cordiform, 0.7-0.8(1) mm. long, 0.8-1.2(1.5) mm. wide, ca. 40-80 per silique, the surface colliculate; flowering and fruiting March-May.

ILLUSTRATION: Rollins (1961, p. 5, fig. A-C)

I agree with Rollins (1961) that *R. ramosa* and *R. sinuata* are related in their sinuate-pinnatifid leaves, vesicular trichomes, caducous sepals, elongate-cylindrical fruits tapering toward the apex and merging into the style, and unexpanded stigma. Distinguishing characters of *R. ramosa*, in addition to those in the key, are a slightly thicker, more lanceolate silique, a tendency toward shorter styles, usually shorter axillary racemes, and less angular, more prominently colliculate seeds wider than long.

Rollins (1961) described *R. ramosa* as a densely leafy, highly ramified, flat, nearly circular plant, with numerous stems at the summit of a tap-root, the plants growing in colonies with individuals interconnected under-ground, with stems single or at most with three or four emergences at a given locus. Although *R. sinuata* may behave in this manner, I have seen many herbarium specimens with numerous stems from a common base. Living plants in the greenhouse show the latter feature, especially when pot-bound. Whitehouse noted "spreading by runners" on a collection label. Although I did not study wild plants, it appears that *R. ramosa* may also spread in a fashion similar to *R. sinuata*, and that the differences in growth habit and clonal formation are not as real as they appear.

DISTRIBUTION: Map 3; 20-E.

Rorippa ramosa is geographically isolated from *R. sinuata* although the species may occur together along the Rio Grande.

6. RORIPPA **coloradensis** Stuckey, sp. nov. (Holotype: COLORADO: [Probably Alamosa Co.]: S. W. Colorado, [probably in the vicinity of the lakes of San Luis valley], 1875, *T. S. Brandegee 1069* PH! Photo at MICH! Fig. 1.)

Stem slender, strigose with elongate pointed often retrorse trichomes; cauline leaves petiolate, non-auriculate, oblong to broadly oblanceolate, 2.3-3 mm. long, 0.5-1 mm. wide, shallowly to somewhat deeply sinuate-lobed, strigose with elongate pointed trichomes on lower surface, the upper surface nearly glabrous, leaf apex obtuse, the margins entire to very slightly toothed; buds 3.5-5 mm. long, 2.5-3 mm. wide; sepals oblong to oblanceolate, 3.8-5 mm. long, 1.8-2.5 mm. wide, strongly saccate, glabrous or with a few short trichomes at the apex; petals broadly spatulate, strongly differentiated into blade and claw, 6-7.5 mm. long, 2.2-2.5 mm. wide, up to 2.5 mm. longer than the sepals; siliques immature but one (at the time the petals have fallen) ca. 2 mm. long, 0.6 mm. wide, covered with delicate slender pointed trichomes; mature fruit not known.

Herba perennis; caulibus gracilibus strigosis; foliis petiolatis non auriculatis oblongis vel late oblanceolatis 2.3-3 cm. longis, 0.5-1 cm. latis sinuatilobatis strigosis; sepalis oblongis vel oblanceolatis 3.8-5 mm. longis, 1.8-2.5 mm. latis saccatis; petalis late spathulatis 6-7.5 mm. longis, 2.2-2.5 mm. latis.

ILLUSTRATION: Fig. 1.

The extremely large buds and flowers with spatulate petals strongly differentiated into blade and claw make this species distinctive from others in *Sinuatae* and from most other *Rorippa*. It is closely related to *R. calycina* in leaf and trichome characters, but the undeveloped fruits are rather elongated; fully developed, they apparently would resemble those of *R. sinuata* or *R. ramosa*, thereby bridging the two evolutionary lines in *Sinuatae*.

The one collection known consists of three small plants obtained by Bran-

Fig. 1. Photograph of the holotype of *Rorippa coloradensis* Stuckey. (*T.S. Brandegee 1069*, PH). Univ. Mich. Neg. No. 1688.

degee during his southwestern Colorado expedition under F. V. Hayden in 1875. The collection (PH) is identified as *Nasturtium trachycarpum* Gr[ay], and bears no additional information except the number 1180 on the label, and the number 1069 glued to one of the plants. The number 1180 is also on both the holotype (GH) and an isotype (MO) of *N. trachycarpum* (=*R. sinuata*), also Brandegee specimens made on the same expedition. The number 1069 suggests this is really a separate collection rather than that the type material of *N. trachycarpum* is heterogeneous.

According to Ewan (1942) "no field notebooks appear to have been kept" by Brandegee, and no collections appear to have been numbered by him, except some southwestern Colorado specimens; numbers may have been assigned by Porter or Redfield, who supplied printed labels for the survey collections. Printed labels on two sheets of *Rorippa* from this survey in the Redfield Herbarium at MO are numbered 1068 and 1180 opposite Brandegee's name, with 1068 in parentheses. These must be Brandegee's numbers. The number 4268 or 4267 is written in the upper left hand corner, and these (not the numbers 1068 and 1180) are probably the numbers newly assigned by Redfield or Porter. They are consecutive, suggesting that the new numbers were given after the plants were taxonomically grouped. Plants of Brandegee's 1069 were apparently considered the same as his 1180, and distributed under the name *N. trachycarpum*. Collection 1068 was kept separate and labeled *N. sinuatum*. Duplicates of collection 1069 have not been found.

To determine the localities for Brandegee's Colorado expedition specimens is a problem because they are often labeled merely "S. W. Colorado." Ewan (1942) reported that Brandegee's Colorado collections of 1875 came from the San Juan, Rio Mancos, and Rio la Plata drainages. *Nasturtium trachycarpum* (1180) came from the San Juan River, according to Gray (1876). In the report of Brandegee's itinerary, Ewan gives only the localities for the 1875 trip and the county in which the plants were collected. No dates or specimen numbers are listed; thus localities cannot be correlated with specimens. If we consider these apparent Brandegee numbers as field numbers perhaps assigned consecutively as plants were obtained, and because 1068 came from "Lakes of San Luis valley," and that number 1069 follows next, this unusual *Rorippa* probably came from there. It should be sought along rivers and lakes of southwestern Colorado.

Summary of Section Sinuatae. Two evolutionary lines of morphological development are present in *Sinuatae*. One group—*R. calycina*, *R. columbiae*, and *R. subumbellata*—is characterized by slender, elongate-pointed trichomes, oblong to subglobose siliques rounded at the apex, persistent sepals, and seeds usually fewer than 35 per silique. The other group—*R. sinuata* and *R. ramosa*—is distinctive in having hemispherical vesicular trichomes, short- to elongate-cylindrical siliques pointed at the apex, caducous sepals, and seeds usually more than 35 per silique. Characters of the groups converge in *R. coloradensis*. The distributions of species of *Sinuatae* do not overlap, except for *R. sinuata* and *R. columbiae* along the Columbia River.

Sinuatae is probably a very old group of plants once more widespread and more variable but now differentiated and isolated, especially those with oblong to subglobose fruits. For comparison we can look to such species complexes as *R. curvisiliqua* and *R. palustris*, today probably undergoing an evolutionary explosion. These two complexes show tremendous variation in certain areas central in their ranges. Radiating from these centers are clinal variation and segregation of character combinations. These segregates often become confined to river valleys or mountain ranges. Morphological differences have been built up, but there appear to be interbreeding and gene flow among them, often where ranges overlap, so that character combinations distinguishing a particular segregate are sometimes in part obscured. This variation pattern justifies recognition of infraspecific taxa (varieties). These highly variable, polymorphic species complexes are today undergoing speciation, and if some catastrophe (shifting of land forms or a drying of the habitat), or various mechanisms to prevent interbreeding were to intervene, particularly in areas of overlap of the varieties, we would expect the surviving isolated populations to diverge morphologically and become well-defined species.

When the region was more mesic and had more wet habitats, one of these species complexes (the group with the oblong to subglobose fruits) in western North America had one line of development in the region of the Yellowstone River, one on the basaltic lava formation of the Columbia River, and one extending toward Lake Tahoe. The center of diversity may have been in present Colorado. Throughout time these plants were subjected to rigors of the environment and competition from other plants. Drying of the habitat probably was a major factor in bringing about isolation. The result was that intermediates, both morphological and geographical, died out. The population was isolated into several segments and the plants in each area may have kept their original prototype or continued to diverge morphologically. The remnants of this once widespread complex, *R. calycina*, *R. columbiae*, and *R. subumbellata*, are three of the most well-defined species in the genus.

Species of *Sinuatae* have characters considered primitive: perennial growth habit, clone formation, petals longer than the sepals, elongate anthers apiculate at the apex, long styles, and the relatively few and large, prominently colliculate seeds. These further support the idea that the group is an old one. Species in section *Rorippa*, which are annuals and possess derived or advanced characters, are believed young in comparison to those of *Sinuatae*, an idea discussed later.

SECTION RORIPPA

Section *Rorippa*

Spring, summer, fall, or winter annuals, rarely biennials or perennials; stems erect, decumbent, or prostrate, simple to much branched, one to many from a slender to thick vertical taproot, not spreading by underground roots or forming clones; basal rosettes present; basal and lower cauline leaves obovate, oblanceolate, lanceolate to spatulate in outline, unlobed to variously laciniate, pinnatifid, lyrate, or pectinate, rarely sinuate, thin, not fleshy; tips of young sepals and auricles (if present) of leaves usually sparingly hirsute; petals pale yellow, usually not showy, mostly shorter than the sepals or absent; anthers globose to subglobose, somewhat lobed at the base, ca. 1-1.5 times as long as wide, notched at the apex (fig. 8-A, 2); style usually shorter than 1 mm. in fruit.

Rorippa microtitis and *R. mexicana*, placed in this section for convenience, have petal and anther characters of *Sinuatae.* Showy petals longer than the sepals occur also in certain varieties of *R. curvipes*, *R. curvisiliqua*, and *R. palustris*, and elongate anthers reappear in *R. barbareifolia.* My characterization of section *Rorippa* is for the native North American taxa. Introduced species from Eurasia show some character combinations of both sections.

Fifteen species of North American *Rorippa* belong to section *Rorippa.*

7. RORIPPA TENERRIMA Greene, Erythea 3: 46. 1895. [as "*Roripa*"]; emended Pittonia 3: 96. 1896. (Holotype: CALIFORNIA: Modoc Co.: [Without locality], 1894, *Mrs. R. M. Austin s.n.*, ND-G 5513!)

Cardamine palustris ("Leysser" [Linnaeus]) O. Kuntze α *brevipes* (A. P. DeCandolle) O. Kuntze 3. *umbrosa* O. Kuntze, Rev. Gen. 1: 24. 1891. ("Engelm[ann] msc." Lectotype: MISSOURI: [St. Louis Co.]: Sandy woods on the Mississippi [River] above St. Louis, May 1845, *George Engelmann s.n.*, MO! Photo at MICH! OS! Isolectotype, GH! [The specimens were originally labeled "Nasturtium obtusum umbrosum" by Engelmann.])

Radicula tenerrima (Greene) Greene, Leafl. Bot. Obs. & Crit. 1: 113. 1905.

Glabrous summer, fall, and winter annual; stems 1-2 dm. long, decumbent to prostrate, much branched from the base; basal and cauline leaves short-petiolate, non-auriculate, non-clasping, oblong, oblanceolate to spatulate, 2-5(8) cm. long, 0.8-1.5 cm. wide, lyrate-divided nearly to the midrib, rarely undivided, the middle lobes oblong to elliptic, 3-6(10) mm. long, 1-4(9) mm. wide with entire margins, the terminal lobe wider than the laterals and obtuse at the apex; racemes terminal and axillary, ca. 0.5-1 dm. long, forming simultaneously during stem elongation, the siliques therefore nearly equal in age at corresponding points on the racemes, or racemes lateral, developing during stem elongation in the axils of the lower leaves and progressing upward, without the formation of a true terminal raceme, the oldest siliques therefore on the lower axillary racemes; pedicels (1)1.7-3(4.2) mm. long, ascending, glabrous to rough with minute papillae; sepals ovate to oblong, 0.7-1.2 mm. long, 0.4-0.6 mm. wide, flat, caducous in fruit; petals oblong to very narrowly spatulate, 0.6-0.8 mm. long, 0.1-0.3 mm. wide, 0.2-0.4 mm. shorter than the sepals; siliques elongate-cylindrical, slightly curved inward, occasionally curved outward, obtuse below and tapering toward the apex, (2)3.5-7(8.5) mm. long, 0.8-1.7(2.3) mm. wide, ca. 3-5(7) times as long as wide, ca. 1.5-2.5(4) times as long as the pedicels, the valves rough with minute papillae; replum oblong to narrowly elliptic in outline and the margin straight to concave; style (0.1)0.5-1 mm. long, ca. 0.2-0.4 mm. wide in fruit, tapering toward the apex, gradually merging into the pointed silique apex; stigma unexpanded in fruit; seeds regularly cordiform, ca. 0.5-0.7 mm. long, ca. 20-40 per silique, the surface reddish brown, finely colliculate; flowering and fruiting (May)June-October.

ILLUSTRATIONS: Britton & Brown (1897, p. 124, fig. 1715; 1913, p. 160, fig. 2028); same illustration in Abrams (1944, p. 281, fig. 2026), labeled either as *Rorippa* or *Radicula obtusa.* (The drawing is somewhat atypical in that the enlarged silique does not taper toward the apex, the style is somewhat abruptly attached, and the stigma is slightly expanded. The growth habit, ascending pedicels, and the leaves are more characteristic.)

Rorippa tenerrima is very distinct in being decumbent to prostrate, delicate, glabrous, freely branched, and usually up to 1-2 dm. long. Glabrous, lyrate-divided, entire leaves are best developed in this species. The elongate, slender, cylindrical siliques on very short, filiform, ascending pedicels taper toward the apex and are usually curved inward toward the raceme axis. The valves are minutely papillose. An unexpanded stigma tops the style, which gradually merges into the pointed silique apex. Morphologically *R. tenerrima* shows close relationship to *R. curvisiliqua*, especially var. *orientalis*.

Rorippa tenerrima first received formal recognition by Kuntze (1891) when he applied the name *Cardamine palustris* α *brevipes* 3. *umbrosa* to this taxon, citing "Engelm msc." as his source of information. A specimen (MO) labeled by Engelmann as "Nasturtium obtusum umbrosa" must have been the basis for Kuntze's name. Kuntze was in St. Louis in September 1874 and may have seen the Engelmann specimen then. I have selected the specimen at MO as the lectotype.

Greene's description (1895) agrees with my concept of this species, although the holotype is somewhat atypical in its nearly smooth valve surface and rather short (ca. 2-4 mm. long), apically acute fruits, these suggesting *R. curvipes* var. *curvipes*. Greene (1896) later pointed out that the ovaries [valve surface] were minutely scabrous. He also said he had detected, the previous summer in Nevada, a plant identical with the type collected by Mrs. Austin. One specimen collected on "27 July 1896, Cañon above Golconda [Nevada]" (ND-G 5515), was labeled by him *R. tenerrima* and may be the plant he had in mind when he emended his description. This delicate, glabrous plant with minutely papillose fruits and lyrate leaves matches my concept of the species.

Rorippa tenerrima has not been generally recognized as a separate species. Watson (1895) (or his editor, Robinson), not having seen specimens, quoted Greene's description. Howell's (1897) description was essentially Greene's rewritten slightly. Most western United States floras since 1900 have treated *R. tenerrima* within *R. obtusa*, except Harrington (1954), who accurately described it under *R. lyrata*. The plants at US, the basis for the report of *Radicula lyrata* by Standley (1921) from Glacier National Park, are *R. tenerrima*. Most specimens of *R. tenerrima* from the Pacific Northwest and from east of the Rocky Mountains have been called *R. obtusa*. In Utah, Nevada, and Colorado, the name *R. lyrata* often has been used, and in southern California, the name *R. curvisiliqua*.

DISTRIBUTION: Map 4; 20-F.

On the basis of morphological data and geographical position, *R. tenerrima* is the end of one evolutionary line in section *Rorippa* (map 20-F). Its sparse occurrence over a wide area of western United States is of great interest, suggesting a relic species, more abundant in the past, which has persisted in favorable habitats in isolated localities, particularly along major rivers such as the Columbia, Missouri, Rio Grande, Platte, and Humboldt. These rivers have doubtless aided in the dispersal of this species.

8. RORIPPA CURVISILIQUA (Hooker) Bessey ex Britton, Mem. Torrey Club 5: 169. 1894. [as "*Roripa*"]

Sisymbrium curvisiliquum Hooker, Fl. Boreal Am. 1: 61. 1830. ("Common on the North-West coast of America, lat. 47°48′, in sandy soils, near streams. *Douglas*." Holotype: WASHINGTON: [Probably Gray's Harbor or Jefferson Co. Specimen not seen, presumably at KEW.])

Cardamine indica (Linnaeus) O. Kuntze ε *normalis* ("sensu Hooker et Thompson" [O. Kuntze]) 2. *curvisiliqua* ("Nuttall" [Hooker]) O. Kuntze, Rev. Gen. 1: 24. 1891.

Radicula curvisiliqua (Hooker) Greene, Leafl. Bot. Obs. & Crit. 1: 113. 1905.

Nasturtium curvisiliqua (Hooker) Nuttall in Torrey et Gray, Fl. N. Am. 1: 73. 1838. (Nuttall's specimens actually belong to *Rorippa sinuata* (Nuttall in Torrey et Gray) A. S. Hitchcock, and are at BM, GH in part! NY! PH!.)

Summer, fall, or winter annual, occasionally biennial; stems 1-6 dm. long, erect, decumbent, or prostrate, single or much branched from the base, glabrous to moderately covered with very slender, short, retrorse, pointed trichomes; basal and cauline leaves sessile to short-petiolate, auriculate, clasping to non-auriculate and non-clasping, oblong, obovate, oblanceolate, spatulate, or rhombic-spatulate, (2)4-10(15) cm. long, 0.8-2(3.5) cm. wide, crenate to serrate, repand, incised, or pinnatifid to pectinate, both surfaces glabrous to hirsute, the middle lobes oblong, elliptic, or linear, 3-10(18) mm. long, 1-6(10) mm. wide with margins entire to minutely toothed, the apex obtuse to acute; racemes terminal and axillary, ca. (0.4)0.8-2 dm. long, forming simultaneously during stem elongation, the siliques therefore nearly equal in age at corresponding points on racemes; pedicels 1.1-5(7) mm. long, divergent to ascending, not recurved, glabrous to sparingly hirsute with very slender, short, retrorse, pointed trichomes; sepals ovate to oblong, 1.1-2.5 mm. long, 0.6-1.2 mm. wide, flat, caducous to persistent in young fruit; petals oblong, oblanceolate, to narrowly spatulate, 0.6-3(3.5) mm. long, 0.3-1.2 mm. wide, equal to the sepals or as much as ca. 0.5 mm. shorter or longer than them, spreading between the sepals; siliques elongate-cylindrical, straight to strongly falcate toward the raceme axis, obtuse below and not at all or slightly tapering toward the apex, (2.4)4-12(17) mm. long, 0.4-2 mm. wide, ca. (4)5-12(17) times as long as wide, ca. 2-5(8) times as long as the pedicels, the valves thin and readily dehiscent or turgid and sparingly or not at all dehiscent, smooth, glabrous; replum narrowly oblong in outline, the margin straight and glabrous or finely hirsute; style 0.1-0.8 mm. long, ca. 0.2-0.5 mm. wide in fruit, tapering toward the apex or slightly expanded below the stigma, gradually merging into the acute silique apex; stigma unexpanded and occasionally 2-lobed in fruit; seeds regularly to angularly cordiform to somewhat oblong, ca. 0.5-0.7 mm. long, ca. 30-60 per silique, the surface reddish to yellowish brown, colliculate to recticulate-foveolate; flowering and fruiting March-October.

Rorippa curvisiliqua, a variable species with intergrading geographical segregates, is distinct from all other *Rorippa* in North America. The replum margin is either glabrous or minutely hirsute. When glabrous, the valves are very turgid and are not readily dehiscent, the seeds sometimes remaining in the pod all winter. When hirsute, the valves are readily dehiscent and not turgid. The pedicels and stems are usually covered with very slender, pointed, short, retrorse trichomes, but occasionally plants are glabrous, as best shown in var. *nuttallii*. In living plants, the petals spread outward between the sepals, resulting in more showy flowers, particularly in the Pacific Northwest, where the petals are longer than the sepals. In certain varieties the sepals tend to persist after the petals have fallen or even during silique maturation. In this character, *R. curvisiliqua* is similar to the short- and oblong-fruited members of *Sinuatae*. From fully mature fruits, however, the sepals have usually fallen.

Rorippa curvisiliqua shows morphological and geographical relationship to *R. sinuata*, *R. tenerrima*, *R. microtitis*, and *R. curvipes*. Its distribution, for the most part, lies adjacent to the first three of these. *Rorippa sinuata* is distributed to the east of *R. curvisiliqua*, but their range overlaps along the Snake and Columbia rivers. The two differ in petal length, trichomes, growth habit, pedicel and style length, and sepal longevity. They are similar in slender strongly falcate siliques, and a style gradually merging into the silique apex. Cauline leaves of var. *curvisiliqua* from Montana and Wyoming are very similar, but they are more deeply pinnatifid and pectinate in plants from Idaho, Washington, and Oregon.

Rorippa curvisiliqua is allied via var. *orientalis* to *R. tenerrima*, which it closely resembles in growth habit, silique size and shape, pedicel length, attachment of the style, and sometimes in the leaves. Variety *orientalis* differs from *R. tenerrima* in having the replum margin minutely hirsute, slender retrorse trichomes on pedicels and stem, glabrous valves, a tendency for the stigma to be 2-parted in fruit, and leaves usually pinnatifid to the midrib with the entire to irregularly toothed lobes more elliptic and pointed rather than oblong and blunt. Relationship between the two is suggested by a specimen from eastern California (*Mahurin 123*, ND), which has rough valves of *R. tenerrima* but leaves and trichomes of *R. curvisiliqua* var. *orientalis*. The western Nevada specimens of the latter variety having lyrate leaves are indeed very similar to *R. tenerrima* in this character. When Greene (1896) emended his description of *R. tenerrima*, he also included some lyrate-leaved plants that grew "along the Lower Humboldt and Truckee rivers in western Nevada and eastern California." These are *R. curvisiliqua* var. *orientalis*.

The relationships of *R. curvisiliqua* to *R. microtitis* and to *R. curvipes* var. *integra* are discussed under those taxa.

Most United States manuals have correctly interpreted *R. curvisiliqua* as a species. However, much variation is seen in treatment of the varieties, and often their recognition has been avoided. Plants called *R. curvisiliqua* in the *Arizona Flora* (Kearney and Peebles, 1951) are *R. microtitis* (see my discussion under that species), as are those reported by Shreve and Wiggins (1964). *Rorippa curvisiliqua* apparently does not grow in Arizona or Lower California.

Rorippa curvisiliqua represents perhaps the most difficult species complex because of its great morphological variation in its relatively limited range. The species is limited to west of the Continental Divide (except in Montana). Its morphological segregates correlate with some physiographic features such as river valleys and mountain ranges. There are strong phenological differences between certain segregates. Two varieties may grow together but flower and fruit at different times. Thus, geographical and phenological isolation has helped keep the varieties separate and distinct in some areas. In others, geographical distribution and phenology overlap; here there may or may not be morphological intermediates. Each variety may intergrade into one or more others, but each is quite distinct where it is isolated from certain others. The plants are most variable in northern Idaho and eastern Washington. Here nearly all varieties and plants transitional between them are found. Outward from this center clinal variation occurs, particularly along the Columbia River.

DISTRIBUTION: Map 5; 6; 7; 20-G.

Moisture apparently influences the eastern and southeastern limits of *R. curvisiliqua*, this species being absent from the dry regions of eastern Montana, central Wyoming, Nevada, and parts of southern California. The species is most frequently found in areas of continental northwestern United States that receive over 16 inches of annual rainfall (see map 7, to which I have added the 16-inch isohyet).

Descriptive Key to Varieties of Rorippa curvisiliqua

1. Plants erect; pedicels longer than 3 mm. (except in var. curvisiliqua from Idaho and westward and in var. occidentalis); siliques (5)8-17 mm. long (except in var. curvisiliqua and var. spatulata); petals usually equal to or longer than the sepals (except in var. occidentalis) (2)
1. Plants prostrate; pedicels shorter than 3 mm.; siliques (2.4)4-8.3(12)

mm. long; petals usually shorter than the sepals (6)

2. Pedicels shorter than 3 mm.; petals 0.8-1.5 mm. long; cauline leaves mostly more than 10 (except in var. occidentalis) (3)

2. Pedicels longer than 3 mm.; petals 1.5-3 mm. long; cauline leaves mostly fewer than 10 (4)

3. Siliques strongly falcate, (2.4)4-8.3(10) mm. long, 0.4-1.1 mm. wide; valves readily dehiscent, not turgid; replum margin minutely hirsute; basal leaves broadly oblanceolate, pectinate or somewhat pinnatifid; lobes linear, the middle ones mostly narrower than 2 mm.; cauline leaves oblanceolate, pectinate to deeply pinnatifid or unlobed, sinuate or sharp to blunt dentate-margined; cauline leaves mostly more than 10; sepals persistent in young fruit. . . . . 8a. var. *curvisiliqua*

3. Siliques straight, (5)8-17 mm. long, (0.8)1.1-2 mm. wide; valves strongly turgid and not readily dehiscent; replum margin glabrous; basal and cauline leaves rhombic-spatulate to oblanceolate, unlobed to variously irregularly lobed, entire, repand or blunt dentate-margined; cauline leaves mostly fewer than 10; sepals caducous in young fruit. . . . . 8g. var. *occidentalis*

4. Stems, pedicels, and replum margin glabrous or very sparingly hirsute; valves strongly turgid and not readily dehiscent; petals mostly (2)2.5-3 mm. long; siliques (5)8-17 mm. long, 1.1-2 mm. wide; basal and cauline leaves broadly oblanceolate, pectinate; lobes linear, the middle segments mostly narrower than 2 mm.; sepals caducous in young fruit; flowering and fruiting March-May and October. . . . . 8b. var. *nuttallii*

4. Stems, pedicels, and replum margin sparingly to rather densely hirsute; valves readily dehiscent and not strongly turgid; petals 1.5-2.5 mm. long; siliques, leaves, and sepals as in couplet 5; flowering and fruiting from June to September (5)

5. Siliques (5)8-17 mm. long, 1.1-2 mm. wide; basal and cauline leaves oblong to slightly oblanceolate, pinnatifid, lobes oblong, the middle segments mostly wider than 3 mm., their margins serrate or toothed; sepals sparingly persistent in young fruit; northern Idaho, eastern Washington, and along the Columbia River. . . . . 8e. var. *lyrata*

5. Siliques 4-8(12) mm. long, 0.4-1.2 mm. wide; basal and cauline leaves oblanceolate to rhombic-spatulate, not pinnatifid, the margins repand to entire; sepals strongly persistent in young fruit; central Oregon, central Idaho, and northwestern Wyoming. . . . . 8f. var. *spatulata*

6. Leaves broadly oblanceolate, pinnatifid to the midrib or occasionally lyrate, the lobes mostly elliptic to oblong, their margins entire or slightly dentate; petals 0.6-1.5 mm. long; stigma usually 2-lobed in fruit; siliques straight, 0.7-1.5 mm. wide; valves readily dehiscent and not turgid; replum margin minutely hirsute; stem usually straight; plants up to ca. 2.5 dm. long. . . . . 8c. var. *orientalis*

6. Leaves oblanceolate, unlobed, the margins sharply dentate; petals 1-2.5 mm. long; stigma unlobed in fruit; siliques falcate, 0.4-1 mm.

wide; valves turgid, not readily dehiscent; replum margin glabrous; stem usually crooked; plants usually over 3 dm. long. . . . . 8d. var. *procumbens*

8a. RORIPPA CURVISILIQUA (Hooker) Bessey ex Britton var. CURVISILIQUA

ILLUSTRATIONS: Abrams (1944, p. 281, fig. 2025); Britton & Brown (1897, p. 126, fig. 1719).

Two geographical variations occur in var. *curvisiliqua*. In northern Idaho, northern Washington, and coastal Washington, Oregon, and northern California, the plants are tall, mostly over 4 dm. (the tallest in the species), both basal and lower cauline leaves are pectinate, and the pedicels are very short (mostly less than 3 mm.). In northern Idaho and along the Columbia River the plants flower and fruit in April, May, early June, and October, whereas the plants from other areas flower not only in early spring and late fall but also in summer. The second variation occurs in western Montana and northwestern Wyoming. These plants tend to be shorter (up to ca. 3 dm.), have cauline leaves mostly sinuate or sharp to blunt dentate-margined, and pedicels usually longer than 3 mm. Flowering and fruiting occur in summer. From the center of diversity in northern Idaho, var. *curvisiliqua* reaches southeastward in the Rocky Mountains as far as the Grand Tetons in Wyoming, and westward across Washington and down the coast to San Francisco Bay. The two variations do not seem distinct enough to merit varietal recognition.

Synonymy for var. *curvisiliqua* is presented before the species description. Hooker's description, quite complete, characterizes this variety well. He described the plants as barely a foot high, the lower leaves subpectinate pinnatifid, and the silique scythe-shaped—features distinctive for the typical variety. Furthermore, he gave the source locality as "North-West coast of America, lat. 47°48′." On the coast at this latitude, only var. *curvisiliqua* has been collected. Variety *procumbens*, which might be expected in coastal Washington, has unlobed, strongly dentate leaves. Hooker's description of the leaves does not characterize var. *procumbens*.

Abrams' (1944) illustration of *R. curvisiliqua* is very representative of var. *curvisiliqua*. However, the illustration for var. *curvisiliqua* in Hitchcock and Cronquist (1964), a plant with unlobed, dentate leaves, is var. *procumbens*.

DISTRIBUTION: Map 5.

8b. RORIPPA CURVISILIQUA (Hooker) Bessey ex Britton var. **nuttallii** (S. Watson) Stuckey, comb. nov.

Nasturtium polymorphum Nuttall in Torrey et Gray, Fl. N. Am. 1: 74. 1838. ("Banks of the Oregon [River]." Holotype: OREGON or WASHINGTON: [county unknown]: Columbia R[iver], [ca. 1834, *fide* Pennell (1936, p. 36), *Thomas Nuttall s.n.*], BM. Photo no. BM 2128, GH! Isotypes, GH! PH! Photo of PH specimen at MICH! OS! [The specimens were originally labeled "Nasturtium *polymorphum" by Nuttall.])

Nasturtium curvisiliqua (Hooker) Nuttall in Torrey et Gray, var. *nuttallii* S. Watson in Gray, Syn. Fl. N. Am. 1: 148. 1895. [Based on an isotype of *Nasturtium polymorphum* Nuttall in Torrey et Gray. Specimen at GH!]

Roripa [sic] *polymorpha* (Nuttall in Torrey et Gray) Howell, Fl. N. W. Am. 1: 41. 1897.

Roripa [sic] *nuttallii* (S. Watson) Rydberg, Mem. N. Y. Bot. Gard. 1: 176. 1900.

Radicula polymorpha (Nuttall in Torrey et Gray) Greene, Leafl. Bot. Obs. & Crit. 1: 113. 1905.

Radicula nuttallii (Rydberg) Greene, Leafl. Bot. Obs. & Crit. 1: 114. 1905.

Roripa [sic] *pectinata* A. Nelson, Proc. Biol. Soc. Wash. 20: 35. 1907. (" . . . at The Dalles, Oregon, by Dr. J. Lunell, April 12 and April 16, 1903. The latter is the type and is deposited under the accesson No. 54984. Secured again by the same collector, in mature condition, May 4, 1906, at the type station." Holotype: OREGON: [Wasco Co.]: The Dalles, 16 Apr 1903, *J. Lunell s.n.* [Specimen not seen, presumably at RM 54984.] Paratypes: OREGON: [Wasco Co.]: The Dalles, 12 Apr 1903, *J. Lunell s.n.*, US! In alluvial soil along the Columbia River at the type station, The Dalles, 4 May 1906, *J. Lunell s.n.*, GH! MO! NY! PH! US! WIS!)

Radicula pectinata (A. Nelson) Heller, Muhlenbergia 7: 124. 1912.

Radicula curvisiliqua (Hooker) "Bessey" [Greene] var. *hallii* attributed to Watson by Peck, Man. High. Pl. Oreg. 344. 1941. [Erroneously reported as "*Roripa* [sic] *curvisiliqua* var. *hallii*" by Hitchcock and Cronquist, Univ. Wash. Publ. Biol. 17: 535. 1941]

Radicula curvisiliqua (Hooker) "Bessey" [Greene] var. *nuttallii* attributed to Watson by Peck, Man. High. Pl. Oreg. 344. 1941.

The tendency to retain the turgid valves after seed formation is best developed in var. *nuttallii*. My collections from the Columbia River at The Dalles (*1910A*) and Hood River (*1912A*), Oregon, are of plants whose fruits had matured much earlier as the leaves died off, but the siliques still retain valves and seeds. A specimen of var. *nuttallii* (*Cronquist 5685*, NY) collected on 7 April 1949 at Maryhill, Washington, has a portion of the previous year's gray-black stem from which sprouted the present green stems and leaves. On this old stem are several old gray-black, still-intact siliques, clearly indicating the valves may persist a long time and even withstand the winter.

Watson (1895) first accorded this entity varietal rank under the name *nuttallii* based on one of the original collections of Nuttall's *Nasturtium polymorphum*. Nelson's (1907) description of *R. pectinata* is an excellent recharacterization of Nuttall's plant based on Lunell's collections made at The Dalles, Oregon. Peck (1941) attributed a var. *hallii* to Watson, but this name was never published. In fact it seems that Watson never proposed such a variety. On the original label of a collection by Howell (*1406* GH), Watson wrote "var. *nuttallii*," but the "n" and "u" are somewhat obscured by the "y" of the crossed-out word "polymorphum" written above. The two "t's" are not perfectly crossed, thus creating a rather large "H," resulting in the word "Hallii." Anyone not looking carefully at the label could easily make this mistake (as did I at first), and it appears that this is what Peck did (assuming that Peck saw this or a duplicate label written in the same manner). Peck, using the generic name *Radicula*, was apparently unaware that he was making new combinations of *Radicula curvisiliqua* in varietal rank.

In Idaho and the upper Columbia River valley are plants intermediate between var. *curvisiliqua* and var. *nuttallii* in height, number of cauline leaves, silique shape and width, and pedicel and petal length. Downstream along the Columbia the plants begin to approach those of var. *nuttallii*, so that by the time the Oregon-Washington border is reached, var. *curvisiliqua* is replaced by var. *nuttallii*, known only from the banks of the Columbia from The Dalles to Sauvies Island. At Sauvies Island, var. *nuttallii* again contacts var. *curvisiliqua*, and intermediates between the varieties, like those of the upper Columbia River valley, are found. The intermediates are shown by "triangles" in map 5. Out of the variable complex in Idaho and the upper Columbia River valley has been morphological divergence in two directions—across northern Washington and along the Pacific coast (var. *curvisiliqua*), and down the Columbia River (var. *nuttallii*), the two then apparently hybridizing where they meet in the lower Columbia River at Bingen (not mapped) and on Sauvies Island. Both varieties flower in early spring and late fall in these localities. In *Rorippa*, var. *nuttallii* is the best example of plants apparently migrating downriver, becoming isolated, and changing morphologically in the process.

DISTRIBUTION: Map 5.

8c. RORIPPA CURVISILIQUA (Hooker) Bessey ex Britton var. **orientalis** Stuckey, var. nov. (Holotype: CALIFORNIA: Eldorado Co.: Local in sandy soil under pine trees where boat trailers were parked on beach of Lake Tahoe at Meeks Bay, ca. 6100 ft [ca. 1830 m], 28 Jul 1963, *R. L. Stuckey 1939*, MICH! Photo at MICH! Isotypes to be distributed. Fig. 2.)

Herba annua procumbens; foliis late oblanceolatis, pinnatilobatis vel lyratis; lobis ellipticis vel oblongis integris vel dentatis; petalis 0.6-1.5 mm. longis; stigmatibus vulgo bilobatis; siliquis rectis (2.4)4-8.3(12) mm. longis, 0.7-1.5 mm. latis; pedicellis diversis.

ILLUSTRATIONS: Fig. 2; Jepson (1925, p. 425, fig. 415)

Variety *orientalis* is a summer-flowering plant similar to var. *curvisiliqua* and var. *nuttallii* in having deeply divided leaves with narrow segments. It represents a miniature var. *curvisiliqua* in height and petal length, and a miniature var. *nuttallii* in silique and pedicel length. Where flowering time of var. *orientalis* overlaps that of var. *curvisiliqua* in central Idaho, intermediates between the varieties are found. These are shown as "stars" in

Fig. 2. Photograph of a portion of the holotype of *Rorippa curvisiliqua* (Hooker) Bessey ex Britton var. *orientalis* Stuckey. (*R.L. Stuckey 1939*, MICH). Univ. Mich. Neg. No. 1884.

map 5. Variety *orientalis* is best developed morphologically in wet places in mountains of eastern California. In this region it is distinct from its closest relative, var. *curvisiliqua*.

DISTRIBUTION: Map 5.

8d. RORIPPA CURVISILIQUA (Hooker) Bessey ex Britton var. **procumbens** Stuckey, var. nov. (Holotype: CANADA: BRITISH COLUMBIA: Stony Creek, Pemberton Trail, 24 Jun 1916, *J. M. Macoun 91904*, NY! Photo at MICH! Isotype, GH! Fig. 3.)

Herba annua procumbens; foliis oblanceolatis integris vel dentatis; petalis 1-2.5 mm. longis; stigmatibus inlobatis; siliquis falcatis (2.4)4-8.3(12) mm. longis, 0.4-1 mm. latis; pedicellis diversis.

ILLUSTRATIONS: Fig. 3; Hitchcock & Cronquist (1964, p. 538), as var. *curvisiliqua*.

Variety *procumbens* is very similar to var. *curvisiliqua*, and the two have not been distinguished in the herbarium or the literature. Although both have very short pedicels and short, slender, strongly falcate siliques, they differ in growth habit, leaf morphology, and in certain features of the fruits (compare data in the key). One can readily determine from herbarium specimens that these plants grow prostrate—the stem is often bent at the base and often crooked throughout, and the leaves frequently appear one-sided on the stem. This variety is best developed morphologically in Canada and Alaska, growing by itself without the immediate influence of other varieties. In northern Idaho, the plants flower and fruit during summer; in this manner, var. *procumbens* is isolated from var. *curvisiliqua*, which flowers in early spring and late fall. In Washington and Oregon, the plants appear more often to flower and fruit during spring at the same time as var. *curvisiliqua*. The factors keeping the varieties relatively distinct in this region need investigation. The few California specimens suggest early spring flowering from March to May that tends to isolate this variety from var. *occidentalis*, which flowers primarily from May into summer.

Variety *procumbens* is in the center of diversity in northern Idaho. It extends across northern Washington northward to southeasternmost Alaska, and southward through western Oregon to the Central Valley of California.

DISTRIBUTION: Map 6.

8e. RORIPPA CURVISILIQUA (Hooker) Bessey ex Britton var. **lyrata** (Nuttall in Torrey et Gray) Stuckey, comb. nov.

Nasturtium lyratum Nuttall in Torrey et Gray, Fl. N. Am. 1: 73. 1838. ("Banks of the Oregon [River]." Holotype: OREGON or WASHINGTON: [county unknown]: Columbia shores, [ca. 1834, *fide* Pennell (1936, p. 36), *Thomas Nuttall s.n.*], BM. Photo no. BM 2127, GH! Isotype, PH! Photo at MICH! OS! [The specimens were originally labeled "Nasturtium *lyratum" by Nuttall.])

Nasturtium curvisiliqua (Hooker) Nuttall in Torrey et Gray var. *lyrata* (Nuttall in Torrey et Gray) S. Watson, Geol. Surv. Calif. Bot. 1: 43.

Fig. 3. Photograph of the holotype of *Rorippa curvisiliqua* (Hooker) Bessey ex Britton var. *procumbens* Stuckey. (*J.M. Macoun 91904*, NY). Univ. Mich. Neg. No. 1679.

1876.

Roripa [sic] *lyrata* (Nuttall in Torrey et Gray) Greene, Man. Bot. San Francisco Bay 20. 1894.

Radicula lyrata (Nuttall in Torrey et Gray) Greene, Leafl. Bot. Obs. & Crit. 1: 113. 1905.

Radicula curvisiliqua (Hooker) "Bessey" [Greene] var. *lyrata* (Nuttall in Torrey et Gray) attributed to Watson by Peck, Man. High. Pl. Oreg. 344. 1941.

Although occasionally a leaf is somewhat lyrate, a truly lyrate leaf, as in *R. tenerrima*, is not developed in var. *lyrata*. The leaves are oblong to slightly oblanceolate and pinnatifid with lobes serrate to dentate, much like those in Nuttall's type. Reports of *R. lyrata* by Harrington (1954) and Rydberg (1906) from Colorado, and by Standley (1921) from Montana, should be referred to *R. tenerrima*. The illustration in Hitchcock and Cronquist (1964) of var. *lyrata* is an excellent one—of var. *spatulata*.

Although var. *lyrata* is absent along the upper Columbia River in northeastern Washington, it does occur north into Canada and northern Idaho and probably has migrated west down the Snake River to the lower Columbia, where it is found in Washington and Oregon. Variety *lyrata* and var. *procumbens* intergrade in northern Idaho and eastern Washington. In that area, plants have leaves, pedicels, and silique length of var. *lyrata* but they are prostrate, have more than 10 cauline leaves per stem, and produce slender curved siliques—characters of var. *procumbens*. These intermediate plants are shown by "stars" in map 6.

Variety *lyrata* is very similar to var. *nuttallii* in size and growth form but differs as shown in the key. There is some intergradation in distinguishing characters, especially leaf morphology. The range of var. *nuttallii*, on the shores of the Columbia River, completely coincides with part of the range of var. *lyrata*, but a striking difference in flowering and fruiting time separates the two. All collections of var. *nuttallii* were made in March (plants in flower) or April or early May (plants in fruit) or in October; those of var. *lyrata*, only in summer from June to September.

I grew plants of var. *lyrata* from seeds of my collection *1927* and of var. *nuttallii* from collection *1912A*. The difference in leaf shape in the greenhouse plants was not as pronounced as in most herbarium material. Leaf lobes of living var. *nuttallii* were quite wide although entire or only slightly toothed. I do not know the leaf shape of the plants obtained in the field, since the leaves had withered and fallen. Fruit characters in the greenhouse plants were maintained. No change in leaf shape of the varieties came about when the plants were grown simultaneously under short or long days.

DISTRIBUTION: Map 6.

8f. RORIPPA CURVISILIQUA (Hooker) Bessey ex Britton var. **spatulata** Stuckey, var. nov. (Holotype: IDAHO: Blaine Co.: In dried up alpine pool, at head of Boulder, Sawtooth Nat[ional] Forest, Sawtooth Mts., 9000 ft, 6 Aug 1937, *J. William Thompson 14139*, MICH! Photo at

MICH!, Fig. 4. Isotypes, GH! US!)

ILLUSTRATIONS: Fig. 4; Hitchcock & Cronquist (1964, p. 538), as var. *lyrata*.

Herba annua erecta; siliquis 4-8(12) mm. longis, 0.4-1.2 mm. latis; foliis radicalibus caulinisque oblanceolatis vel rhombo-spathulatis fere integris; petalis 1.5-2.5 mm. longis; sepalis firme retentis.

The above-cited drawing, an excellent representation of this variety, closely matches the holotype. Variety *spatulata* is related to var. *lyrata* in petal length, readily dehiscent valves, trichomes on replum margin, and few cauline leaves per stem. Pedicels are quite variable in length, but the lowermost ones are usually over 3 mm. The specimen from Idaho County, Idaho (*Kirkwood 2015*, GH) has somewhat longer and wider siliques and approaches var. *lyrata* of that area. Like var. *lyrata*, var. *spatulata* also flowers and fruits in summer. Variety *spatulata* is also related to var. *occidentalis* in its rhombic-spatulate leaves.

Variety *spatulata* is known from northeastern and central Idaho westward to central Oregon.

DISTRIBUTION: Map 6.

8g. RORIPPA CURVISILIQUA (Hooker) Bessey ex Britton var. **occidentalis** (Greene) Stuckey, comb. nov.

Nasturtium occidentale Greene, Fl. Franciscana 2: 268. 1891. ("Very common on moist low plains bordering the upper Sacramento [River], and in the foothills adjacent." Lectotype: CALIFORNIA: [Butte Co.]: Near Chico, Jun 1890, *E. L. Greene s.n.*, ND-G 5150! Isolectotypes, ND-G 5148! ND-G 5152!)

Roripa [sic] *multicaulis* Greene, Pittonia 3: 97. 1896. ("Common on moist banks of the San Joaquin River, thence southward perhaps to Lower California." Lectotype: CALIFORNIA: San Joaquin Co.: Tracy, Apr 1892, *Michener & Bioletti s.n.*, ND-G 5141! Isolectotypes, ND-G 5144! US! Photo of the US specimen at MICH! OS!)

Roripa [sic] *occidentalis* (Greene) Greene, Pittonia 3: 97. 1896.

Radicula occidentalis (Greene) Greene, Leafl. Bot. Obs. & Crit. 1: 113. 1905.

Radicula multicaulis (Greene) Greene, Leafl. Bot. Obs. & Crit. 1: 113. 1905.

Characteristic of many specimens of var. *occidentalis* are the numerous siliques at the raceme apex. The siliques are quite sturdy, the valves turgid. Thus, when the plants are pressed, many siliques are turned and flattened perpendicular to the replum. Greene (1891) commented on this feature in his original description. This character recurs sparingly in var. *lyrata* from eastern Washington (*Horner R264B56*, GH; *Henderson 2383*, GH) and serves to link var. *occidentalis* with the center of diversity in the species. In leaves, var. *occidentalis* is similar to var. *spatulata*. In the Central Valley of California, where var. *occidentalis* is isolated from its northern relatives, it is

Fig. 4. Photograph of the holotype of *Rorippa curvisiliqua* (Hooker) Bessey ex Britton var. *spatulata* Stuckey. (*J.W. Thompson 14139*, MICH). Univ. Mich. Neg. No. 1694.

best developed morphologically.

Collections on which Greene (1896) based his *R. multicaulis* and several others he identified as that species are somewhat atypical of the usual material in central California. Plants from Tracy, California (*Michener & Bioletti s.n.*, ND-G 5141) have somewhat pectinate leaves, whereas other plants from there (*Michener & Bioletti s.n.*, ND-G 5144, US) have unlobed leaves very similar to the type of var. *occidentalis*. The plants are glabrous and the siliques are long (ca. 6-12 mm.) like those of var. *occidentalis*. The petals have fallen from the specimens in Greene's herbarium, but in the US specimen they are present and are less than 1 mm. long, the stigma in fruit is 2-parted, and the siliques are slender (ca. 1 mm. wide). In these characters Greene's *R. multicaulis* suggests var. *orientalis*; it is intermediate between the varieties. It is plausible that in the southern portion of the range of var. *occidentalis* where var. *orientalis* may have moved westward down the Sierra Nevada Mountains, the varieties may have introgressed. However, Greene's material comes from the eastern portion of the valley, somewhat removed from the closest localities of var. *orientalis*. More collections are needed to determine the variation pattern and possible reasons for its occurrence. For the present, *R. multicaulis* is placed in synonymy with var. *occidentalis*.

DISTRIBUTION: Map 6.

Summary of Rorippa curvisiliqua. Two somewhat morphologically defined groups occur in *R. curvisiliqua*: (1) plants with pectinate-pinnatifid leaves with narrow lobes (var. *curvisiliqua*, var. *nuttallii*, var. *orientalis*, map 5), and (2) plants with pinnatifid-spatulate leaves unlobed or with wide lobes (var. *lyrata*, var. *procumbens*, var. *spatulata*, var. *occidentalis*, map 6). These groups are nearly comparable to the subspecies designated in *R. palustris*, but morphological divergence in them is not so pronounced as in *R. palustris*. A well-defined character useful to separate the groups has not been found. Morphologically, only the variable leaves set them apart. The groups can also be somewhat defined phenologically. The pectinate-pinnatifid ones are primarily spring and fall flowering where they grow with members of the other group, but where they occur alone—in mountains of western Montana and eastern California—they are summer flowering. The pinnatifid-spatulate group is primarily summer flowering. Where all varieties (except two) grow together in northern Idaho and eastern Washington, plants flowering in early spring or late fall are of the pectinate group, whereas plants flowering in summer are of the spatulate group. Apparently where individuals of both groups grow together and overlap in flowering, hybridization and reshuffling of character combinations occur, forming intermediates.

In the key any one character occurs one, two, or more times in each variety of each group; these same characters have recombined variously to form the different entities. Thus the prostrate growth form has arisen in var. *procumbens* of the pinnatifid-spatulate group and in var. *orientalis* of the pectinate-pinnatifid group. Similarly, other features have arisen in one or more varieties of each group. This grouping of the same characters into various combinations to form the different segregates makes key writing extremely difficult.

The character combinations have arisen and have been selected for in various plants. Today we see the various segregates associated with certain physiographic areas. Where isolated from other varieties, they have become rather distinct morphologically. We find var. *curvisiliqua* growing alone in western Montana, var. *nuttallii* and var. *lyrata* along the Columbia River (but isolated phenologically), var. *spatulata* in the central basin of Idaho and Oregon, var. *procumbens* along the west coast from Alaska to central California, var. *orientalis* by itself in the Sierra Nevada of eastern California, and var. *occidentalis* in the central valley of California. The range of *R. curvisiliqua* is largely within a region that receives over 16 inches of rainfall per year (map 7).

9. RORIPPA MICROTITIS (Robinson) Rollins, Rhodora 59: 71. 1957.

Sisymbrium microtites Robinson, Bot. Gaz. 30: 59. 1900. (Holotype: MEXICO: CHIHUAHUA: Sierra Madre, 5 miles southeast of Colonia Garcia, 23 Jun 1897, *C. H. Townsend, C. M. Barber 43*, GH! Isotypes, NY! US!)

Nasturtium microtites (Robinson) O. E. Schulz, Repert. Sp. Nov. 34: 134. 1933.

Glabrous winter annual, possibly a short-lived perennial, from a taproot; stems 3-5 dm. tall, erect, one to few from the base; basal and cauline leaves petiolate, auriculate, but not clasping the stem, broadly oblanceolate, 5-12 cm. long, 1-3 cm. wide, pinnate-divided to pectinate, the middle lobes oblong, elliptic, or linear, (4)7-20 mm. long, 1-3(6) mm. wide, their margins entire to minutely toothed, the terminal lobe narrow, rounded at the apex; racemes terminal and axillary, ca. 1-2 dm. long, forming during stem elongation, the siliques therefore nearly equal in age at corresponding points on the racemes; pedicels divergent to ascending, 3.5-10.5 mm. long; sepals ovate to oblong, 2-2.8 mm. long, 0.6-0.9 mm. wide, saccate, caducous in fruit; petals spatulate, 2.5-3.7 mm. long, 0.6-1 mm. wide, 1-2 mm. longer than the sepals; siliques elongate-cylindrical, straight to slightly curved inward toward the raceme axis, obtuse below and not at all or only slightly tapering toward the apex, (8.5)10-16(20.1) mm. long, 0.8-1.9 mm. wide, ca. 7-11(13) times as long as wide, ca. 1.5-4 times as long as the pedicels, the valves apparently turgid and non-dehiscent (old, mature siliques not known); replum narrowly oblong in outline, the margin straight; style 0.5-1(1.3) mm. long, ca. 0.3-0.5 mm. wide in fruit, strongly tapering to the apex, gradually merging into the acute silique apex; stigma unexpanded in fruit; seeds (mature seeds not known, two immature ones examined) cordiform, ca. 0.6-0.7 mm. long, the surface reddish brown, reticulate-foveolate; flowering and fruiting June-August and probably on into the fall.

Rorippa microtitis is distinguished by a set of character combinations from both sections of the genus. It has the elongate apiculate anthers and long sulfur-yellow petals of section *Sinuatae*. In this respect it is closely related to *R. sinuata*. The plants do not form new plants from the roots; rather they grow from very sturdy taproots, and basal rosettes are present. The leaves, appearing slightly fleshy, are prominently pinnate-divided or pectinate, with lobes toothed to entire. They are broadly oblanceolate rather than oblong and are therefore closer to those of section *Rorippa*. Within section *Rorippa*, *R. microtitis*' relationship is with *R. curvisiliqua*. To the south of its range, *R. microtitis* is allied to *R. mexicana*, another transitional species. *Rorippa microtitis* not only shares characters of the two sections but also ranges between those members of each section to which it is allied.

In contrast to the *R. curvisiliqua* complex as a whole, *R. microtitis* is glabrous and has much longer petals (usually over 2.5 mm.). In pressed material, *R. microtitis* has valves flattened parallel to the replum, and they appear to be rather turgid and non-dehiscent (although old plants with mature fruits are not known); in this character the species approaches *R. curvisiliqua* var. *occidentalis*, which has straight siliques and is often glabrous. The two can readily be separated on both pedicel and petal length as pedicels in var. *occidentalis* are usually less than 2 mm. long, and petals are shorter than the sepals and no longer than 1.5 mm. In addition, var. *occidentalis* usually has spatulate to rhombic, repand to dentate leaves and the valves are often flattened perpendicular to the replum in pressed material. One interesting variation within *R. microtitis* is that, in the northern part of its range, in Arizona, the mature lower pedicels are rather short, ca. 3.5-6 mm., whereas in the southern part, in Chihuahua, they are longer, mostly 7.5-10.5 mm.

Previous to Rollins' (1957) recognition of the species, specimens of *R. microtitis* were unidentified or misidentified. He cited specimens only from Chihuahua. Kearney and Peebles (1951) reported this species from Arizona under the name *R. curvisiliqua*, expressing doubt in so referring the plants —the capsules were longer, more slender, and less curved than most specimens of *R. curvisiliqua* from the Pacific coast states. The collection of *R. microtitis* from the Mogollon Mountains in New Mexico was reported incorrectly as *Radicula sylvestris* by Wooton and Standley (1915). I have seen no material of *R. sylvestris* from New Mexico and Arizona (Stuckey, 1966b). Morphologically *R. microtitis* is very similar to *R. sylvestris*. The two, difficult to separate, represent a good example of parallel evolution. Distinguishing characters are given in the discussion of *R. sylvestris*.

DISTRIBUTION: Map 6, 7.

Rorippa microtitis grows along shores, creeks, and ditches in mountains of Arizona, New Mexico, and Chihuahua from 1700 to 2250 meters. Map 7 shows the distribution of *R. microtitis* in Arizona and New Mexico; to it has been added the 16-inch annual rainfall line. Perhaps rainfall has been a factor in bringing about isolation of *R. microtitis* from its relatives *R. curvisiliqua* and *R. sinuata*—the intermediates having since died out where they once would have occurred in the now drier outlying areas north and west.

10. RORIPPA MEXICANA (Mociño, Sessé, et Cervantes ex A. P. DeCandolle) Standley et Steyermark, Field Mus. Publ. Bot. [Fieldiana Bot.] 23: 54. 1944.

Nasturtium mexicanum Mociño, Sessé, et Cervantes ex A. P. DeCandolle, Syst. Nat. 2: 193. 1821. Cf. also A. P. DeCandolle, Calques des Dessins de la Flore du Mexique, de Mociño et Sessé, pl. 18. 1874. ("Hab[itat] in Mexico ad rivulorum margines." According to Rollins (1960), "This original label of the holotype bears the number 15-2 and the name *Sisymbrium amphibium*. There is no other information except the later assigned number 3351. The holotype compares favorably with a tracing of the original illustration cited by DeCandolle at the time of the first publication . . ." Specimen at MA. Tracing of the original illustration, GH., US!)

Nasturtium plebejum Polakowsky, Linnaea 41: 546. 1877. ("In via ferrea prope San José . . . (Nr. 534 coll.)" Holotype: COSTA RICA: PROV. SAN JOSE: Eisenbahnd. b. V. J. Jenseits d. Schienen., Nov 1875, *H. Polakowsky 534*, presumably at B. Isotype, BM! Photo at MICH! OS!)

Cardamine indica (Linnaeus) O. Kuntze δ *tanacetifolia* (Walter) O. Kuntze 2. *plebeja* (Polakowsky) O. Kuntze, Rev. Gen. 1: 24. 1891.

Cardamine palustris ("Leysser" [Linnaeus] O. Kuntze δ *mexicana* (A. P. DeCandolle) O. Kuntze, Rev. Gen. 1: 25. 1891.

Radicula mexicana (Mociño, Sessé, et Cervantes ex A. P. DeCandolle) Standley, Jour. Wash. Acad. 15: 458. 1925.

Glabrous annual, possibly a short-lived perennial; stems 0.5-3 dm. long, decumbent to prostrate, single or much branched from the base; basal and cauline leaves short-petiolate, non-auriculate, non-clasping, broadly oblanceolate to oblong, 4-8 cm. long, 0.7-1.6 cm. wide, pinnatifid to pectinate, divided to the midrib, the middle lobes oblong to elliptic, 2-7(10) mm. long, 1-4 mm. wide, their margins entire to minutely toothed, the terminal lobe narrow, rounded at the apex; racemes lateral, 0.5-1(1.5) dm. long, developing during stem elongation in the axils of the lower leaves and progressing upward, without the formation of a true terminal raceme, the oldest siliques therefore on the lower axillary racemes; pedicels (1.5)2.4-5.4(8.5) mm. long, divergent to recurved; sepals ovate to oblong, 1.4-2.1 mm. long, 0.6-1 mm. wide, flat, caducous in fruit; petals oblanceolate to spatulate, 1.7-2.6 mm. long, 0.4-0.9 mm. wide, as much as 0.5 mm. longer than the sepals; siliques elongate-cylindrical, slightly curved upward toward the raceme axis, obtuse below and not at all or only slightly tapering toward the apex, (4.2)5.5-12.5-(16.5) mm. long, (1)1.4-2.9 mm. wide, ca. 2.5-5.5(6.6) times as long as wide, ca. 1.3-3.7 times longer than the pedicels, the valves glabrous; replum oblong, the margin straight to concave; style (0.2)0.5-1.2 mm. long, ca. 0.3-0.4 mm. wide in fruit, straight to expanded below the stigma, gradually merging into the acute silique apex; stigma unexpanded to expanded in fruit; seeds regularly cordiform, ca. 0.7-0.8 mm. long, ca. 70-100 per silique, the surface light brown, coarsely colliculate; flowering and fruiting May-

October in Mexico, year around in Central America.

Rorippa mexicana is also transitional between certain species of the two sections. It is allied with *Sinuatae* in having petals longer than the sepals, but in absolute length the petals (ca. 1.7-2.6 mm. long) are shorter than in any member of *Sinuatae*. Within *R. mexicana* both anther types are developed. In the northern part of its range (Chihuahua), close to members of *Sinuatae* and *R. microtitis*, the anthers are elongate, (ca. 0.6-0.7 mm. long), twice as long as wide, but are entire at the apex; in the southern part (Guatemala and Costa Rica) they are globose to subglobose (ca. 0.2-0.3 mm. long), slightly longer than wide, and slightly notched at the apex. Geographically between these extremes (Durango) the anthers are intermediate (ca. 0.5 mm. long).

To the north, *R. mexicana* is related to *Sinuatae* via *R. microtitis*, which has elongate, apiculate anthers and petals longer than the sepals. It is also very similar to *R. microtitis* in being glabrous and having similar leaves, but differs in recurved pedicels, shorter petals, style in fruit expanded below the stigma, shorter siliques with the oldest on the lower axillary racemes, and decumbent growth. To the south it is related to a segregate of section *Rorippa* primarily distributed on the Coastal Plain and in the West Indies, especially to *R. teres*.

Rollins (1960) clarified nomenclature in *R. mexicana* with respect to the Sessé and Mociño material. In interpreting this taxon I have been guided by his annotations and a tracing and photograph of the original illustration (US).

Examination of an isotype of *N. plebejum* shows that it belongs to *R. mexicana*. Its petals are ca. 2 mm. long (longer than the sepals), the lobes of the leaves are up to 3 mm. wide, not 5 mm. wide as given by Polakowsky (1877), and the seeds are less than 6 mm. long. The pedicel, silique, style, and anther characters are also those of *R. mexicana*. When Polakowsky described *N. plebejum*, he identified another of his collections (*48*) as *N. mexicanum*; it is *R. megasperma*.

It is evident, from the description and specimens cited by Schulz (1933), that he was guided by Polakowsky's determinations. Schulz's interpretation of *N. mexicanum* was a plant with petals ca. 0.6 mm. long (shorter than the sepals), siliques 4-8 mm. long, seeds ca. 0.75 mm. long, and leaves with wide lobes. He cited Polakowsky *48* and specimens which correctly are *R. megasperma* or *R. pinnata*, species he did not distinguish. Schulz's treatment of *N. plebejum* was based on plants with petals over 1.2 mm. long (longer than the sepals), siliques 5-9 mm. long, seeds ca. 0.6 mm. long, and leaves with narrow lobes. He cited Polakowsky *534* and specimens which properly are *R. mexicana* and *R. teres*.

DISTRIBUTION: Map 8; 20-I.

Morphological data suggest that *R. mexicana* originated in uplands of northern Mexico and migrated south through these uplands, reaching as far as central Costa Rica. The species grows at elevations from ca. 600-2000(2600) meters in moist or wet sand or gravel along streams, pastures or cultivated fields, meadows of volcanoes, and often as a weed in gardens, streets, and waste ground. Its association with artificially disturbed habitats appears to be more common in Guatemala and Costa Rica.

11. RORIPPA TERES (Michaux) Stuckey, Sida 2: 409. 1966.

Cardamine teres Michaux, Fl. Bor. Am. 2: 29. 1803. ("Hab[itat] in Nova Anglica." Holotype: "Etat de Vermont Lac Champlain," *s.d.*, [*A. Michaux s.n.*], P. Photo at GH! Isotype, GH!)

Sisymbrium tanacetifolium? [sensu] Walter, Fl. Carol. 174. 1788. Non Linnaeus 1753.

Nasturtium palustre ("Leysser" [Linnaeus]) A. P. DeCandolle δ *?tanacetifolium* (Walter) A. P. DeCandolle, Syst. Nat. 2: 192. 1821.

Sisymbrium walteri Elliott, Sketch 2: 145. 1824.

Erysimum walteri (Elliott) Eaton, Man. Bot. N. Am. ed. 5, 213. 1829.

Nasturtium tanacetifolium ("Walter") Hooker et Arnott, Hook. Jour. Bot. 1: 190. 1834.

Nasturtium micropetalum Fischer et Meyer, Ind. Sem. Hort. Petrop. 3: 41. 1837. ("Hab[itat] in Americae septentrionalis provincia New Orleans dicta . . ." Type not seen.)

Nasturtium obtusum Nuttall in Torrey et Gray, Fl. N. Am. 1: 74. 1838. ("Banks of the Mississipsi [sic] [River]." Holotype: LOUISIANA: [Jefferson Parish]: In abundance in the borders of a cultivated field on the western side of the Mississippi [River]—opposite the city of N[ew] Orleans, 2 Mar *s.d.*, *H[enry] Little s.n.*, PH! Photo at MICH! OS! Sida 2: 412. 1966.)

Sisymbrium? teres (Michaux) Torrey et Gray, Fl. N. Am. 1: 93. 1838.

Nasturtium walteri (Elliott) Wood, Class Book. 228. 1861.

Cardamine indica (Linnaeus) O. Kuntze δ *tanacetifolia* ("Walter") O. Kuntze, Rev. Gen. 1: 24. 1891.

Cardamine palustris ("Leysser" [Linnaeus]) O. Kuntze α *brevipes* (A. P. DeCandolle) O. Kuntze 2. *obtusa* (Nuttall in Torrey et Gray) O. Kuntze, Rev. Gen. 1: 24. 1891.

Roripa [sic] *obtusa* (Nuttall in Torrey et Gray) Britton, Mem. Torrey Club 5: 169. 1894.

Roripa [sic] *tanacetifolia* ("Walter") Heller, Contr. Herb. Franklin & Marshall College 1: 40. 1895.

Roripa [sic] *walteri* (Elliott) Mohr, Bull. Torrey Club 24: 23. 1897.

Radicula obtusa (Nuttall in Torrey et Gray) Greene, Leafl. Bot. Obs. & Crit. 1: 113. 1905.

Radicula walteri (Elliott) Greene, Leafl. Bot. Obs. & Crit. 1: 114. 1905.

Nasturtium plebejum Polakowsky f. *latifolia* O. E. Schulz, Repert. Sp. Nov. 34: 133. 1933. ("Mexico: chiefly in the valley of the Rio Grande, below Donana C. C. Parry, J. M. Bigelow, Charles Wright, A. Schott in Mexic[an] Boundary Survey, under the direction of Major W. H. Emory." Holotype: Presumably at B. In addition to the printed data on the labels as cited by Schulz, I find isotypes as follows:

[Probably TEXAS: Maverick Co.]: Near Eagle Pass, s.d., *[J. M.] Bigelow 27*, NY! US! Photo of NY specimen at MICH! OS!)

Fall and spring annual, possibly a biennial; stems 1-4 dm. long, decumbent or prostrate, occasionally erect, single to much branched from the base, glabrous throughout or moderately covered with hemispherical obovate, to clavate vesicular trichomes; basal and lower cauline leaves short-petiolate, slightly auriculate to non-auriculate, non-clasping, oblong, oblanceolate, to broadly oblanceolate, (2)4-11 cm. long, 1-3.5(5) cm. wide, pinnately divided to the midrib, lower surface glabrous, upper surface glabrous or with hemispherical, obovate, or clavate vesicular trichomes; the middle lobes oblong to elliptic, 4-15(25) mm. long, (0.2)1-10(15) mm. wide, their margins minutely to deeply toothed, the terminal lobe narrow, obtuse to acute at the apex; racemes lateral, 0.5-2(3) dm. long, developing during stem elongation in the axils of the lower leaves and progressing upward, without the formation of a true terminal raceme, the oldest siliques therefore on the lower axillary racemes; pedicels (1.4)2.5-4.5(5.2) mm. long, ascending, glabrous or rough with hyaline ridges or vesicular trichomes; sepals ovate, oblong or oblanceolate, 1.7-2.6 mm. long, 0.6-1 mm. wide, flat to slightly saccate, caducous in fruit; petals spatulate, 1-1.7(2) mm. long, 0.4-0.6 mm. wide, slightly longer than, equal to, or as much as 0.6 mm. shorter than the sepals; siliques elongate-cylindrical, straight to slightly curved upward toward the raceme axis, acute to somewhat cuneate below, slightly tapering toward the apex, (5.2)8.5-12.5(20.4) mm. long, (0.6)1-2.2 mm. wide, ca. (4)6-9(10) times as long as wide, ca. (2)3-6(7) times as long as the pedicels, the valves smooth to rough with minute hyaline ridges or with hemispherical vesicular trichomes; replum narrowly oblong to linear, the margin straight to concave and glabrous or sparingly with vesicular trichomes; style (0.3)0.5-1.5 mm. long, ca. 0.3-0.5 mm. wide in fruit, straight to expanded below the stigma, gradually merging into the acute silique apex; stigma unexpanded to expanded in fruit; seeds regularly cordiform, ca. 0.4-0.5 mm. long, ca. 100-150 per silique, the surface dark reddish brown, deeply or shallowly foveolate; flowering and fruiting December-May and rarely at other times.

The typical variety of *R. teres* is distinctive with its somewhat obovate to clavate vesicular trichomes on the lower portion of the stems and on the upper surface of the basal and lower cauline leaves and minute (ca. 0.4-0.5 mm. long) cordiform seeds with a dark reddish brown, foveolate coat. Its closest morphological relationship is with *R. portoricensis* of the West Indies. Rollins (1960) stated that *R. teres* and *R. mexicana* are related; the two are similar in that the oldest racemes are in the lower leaf axils and the styles in fruit are expanded below the stigma, more strongly so in *R. teres*. In addition, *R. teres* has ascending and somewhat shorter pedicels, smaller petals slightly longer to considerably shorter than the sepals, and often wider leaf lobes, which separate it from *R. mexicana*.

Plants of the typical variety of *R. teres* from Mexico and the western part of its range in the United States show a tendency for long petals (ca. 1.5-2 mm.) and long siliques (ca. 9-17 mm.), whereas in the eastern part of its range the petals and siliques often are shorter (ca. 1-1.5 mm. and ca. 5-9 mm., respectively).

For a detailed discussion of the nomenclatural history, see Stuckey (1966c).

DISTRIBUTION: Map 8; 20-J.

Rorippa teres is distributed on the southern portion of the Atlantic and throughout the Gulf Coastal Plain of the United States. The species is disjunct from the Rio Grande to southern Veracruz, where it is known sparingly there and southward near the coast. It recurs on the Coastal Plain of western Mexico. Morphological and geographical data suggest an origin in the Mexican uplands from a plant much like *R. mexicana*, evolutionarily diverging into two slightly morphologically different populations, with one migrating onto the Mexican Coastal Plain to the west and the other one migrating in two directions, one toward Veracruz and southward and the other northeastward across Texas and onto the Gulf Coastal Plain sometime during the late Tertiary and early Quaternary periods. The tendency toward shorter petals and siliques in the eastern portion of its range in the United States further suggests this history.

Key to Varieties of Rorippa teres

1. Vesicular trichomes present on the lower portion of the stem and upper surface of basal and lower cauline leaves; siliques and pedicels glabrous, smooth or slightly rough with minute hyaline ridges; seeds prominently deeply pitted; southern Atlantic and Gulf Coastal Plain of the United States and Mexico. . . . . 11a. *var. teres*
1. Vesicular trichomes absent from the lower portion of the stem and upper surface of basal and lower cauline leaves; siliques and pedicels with vesicular trichomes; seeds inconspicuously shallowly pitted; western coast of Mexico and the east coast of Honduras and Nicaragua. . . . . 11b. var. *rollinsii*

11a. RORIPPA TERES (Michaux) Stuckey var. TERES

ILLUSTRATIONS: Gleason (1952, p. 241), as *R. obtusa*—stem, racemes, and siliques, and the long silique to the left; Small (1933, p. 557), as *Radicula walteri*—petals slightly longer than sepals (only flowering and fruiting parts are shown); Stuckey (1966c, p. 412), photograph of a portion of the holotype of *Nasturtium obtusum*.

The synonymy for the typical variety is presented before the description of the species.

DISTRIBUTION: Map 8.

11b. RORIPPA TERES (Michaux) Stuckey var. **rollinsii** Stuckey, var. nov. (Holotype: MEXICO: SINALOA: Sandy field, vicinity of Fuerte, 27

Mar 1910, *J. N. Rose, P. C. Standley, P. G. Russell 13599*, US! Photo at MICH!, Fig. 5. Isotypes, MO! NY!)

Herba annua decumbens; caulibus foliisque glabris; siliquis pedicellisque vesiculo-pubescentibus; seminibus superficialiter foveolatis.

ILLUSTRATION: Fig. 5.

Rollins (1961) pointed out some differences between plants of *R. teres* of the United States and eastern Mexico and those of the west coast of Mexico and suggested that with additional knowledge there might well be recognition of a new taxon. The segregates are geographically isolated, although one collection of var. *teres* is known from the west coast of Mexico: Manzanillo, Colima, Palmer *1344* (US). It appears to be out of its natural range. Rollins (1961) wrote that "it is possible that *R. walteri* [*R. teres*] has been carried by man somewhat outside of its natural range in Mexico and Central America because it is used as a salad plant, and may be seen in the local markets of western Mexico." There is no indication of such distribution in Rose's (1895) report on Palmer's collections. I refer specimens from Nicaragua and Honduras to var. *rollinsii* with hesitation. In addition to having trichomes on the valves and pedicels, these plants have trichomes on the upper surface of the lower cauline and basal leaves and on the lower portion of the stem. The siliques are more straight and erect and, with the leaves, take on the appearance of those of *R. portoricensis*. In fact, Standley (1931) considered the Honduran plant to belong to the West Indian species.

DISTRIBUTION: Map 8.

12. RORIPPA PORTORICENSIS (Sprengel) Stehlé, Revue Bot. Appl. Agr. Trop. 26: 103. 1946.

Nasturtium portoricense Sprengel, Syst. 2: 882. 1825. ("Portorico. Hispaniola. Bertero." Type not seen.).

Nasturtium palustre ("Leysser" [Linnaeus]) A. P. DeCandolle ?*brevipes* A. P. DeCandolle, Syst. Nat. 2: 192. 1821. ("quam in Porto-Ricco [sic] ad vias locis inundatis exsiccatisque legit cl. Bertero," Holotype: PUERTO RICO: PONCE: Porto Ricco, Apr 1820, *Balbis* [Bertero was the collector, *fide* Urban (1902, p. 19)] *s.n.*, G-DC. Microfiche 1:137.4, card no. 63, MICH!)

Nasturtium brevipes (A. P. DeCandolle) Grisebach, Mem. Am. Acad. n.s. 8: 154. 1861. (When Grisebach made this combination, he had the following collection: CUBA: [ORIENTE]: In Cuba Orientali, ["In humidis ad vias prope Santa Catalina de Guantanamo, Jan-Feb," (Grisebach, 1861, p. 154)] 1860, *C. Wright 1562*. This material later became the type of *Nasturtium brevipes* (A. P. DeCandolle) Grisebach var. *pumilum* O. E. Schulz.)

Cardamine palustris ("Leysser" [Linnaeus]) O. Kuntze α *brevipes* (A. P. DeCandolle) O. Kuntze, Rev. Gen. 1: 24. 1891.

Nasturtium tanacetifolium Hooker et Arnott var. *insularum* S. Watson in Gray, Syn. Fl. N. Am. 1: 149. 1895. [Substitute name proposed for

Fig. 5. Photograph of a portion of an isotype of *Rorippa teres* (Michaux) Stuckey var. *rollinsii* Stuckey. (*J.N. Rose, P.C. Standley, P.G. Russell 13599*, MO). Univ. Mich. Neg. No. 1713.

Nasturtium brevipes (A. P. DeCandolle) Grisebach]
Radicula brevipes (A. P. DeCandolle) Britton, Torreya 6: 30. 1906.
Radicula portoricensis (Sprengel) Britton, Sci. Surv. Porto Rico & Virgin Isl. 5: 328. 1924.

Fall and spring annual, possibly a biennial; stems 0.5-3.5 dm. long, decumbent or prostrate, occasionally erect, single to much branched from the base, glabrous throughout or moderately covered with hemispherical vesicular trichomes below; basal and lower cauline leaves short-petiolate, slightly auriculate to non-auriculate, non-clasping, oblong to oblanceolate, 2-10 cm. long, 1-1.5(2.2) cm. wide, pinnately divided nearly to the midrib, lower surface glabrous, upper surface glabrous or with vesicular trichomes, the middle lobes oblong to elliptic, 3-7(15) mm. long, 2-5(10) mm. wide, their margins entire, deeply crenate to angularly toothed, the terminal lobe narrow to broad, rounded at the apex; racemes lateral, 0.5-1.5(2) dm. long, developing during stem elongation in the axils of the lower leaves and progressing upward without the formation of a true terminal raceme, the oldest siliques therefore on the lower axillary racemes; pedicels (0.6)1-2.2(3) mm. long, ascending, glabrous or rough with hyaline ridges or vesicular trichomes; sepals ovate to oblong, 1-1.5 mm. long, 0.3-0.5 mm. wide, the outer ones saccate, the inner ones flat, caducous in fruit; petals absent or present and oblong to narrowly spatulate, 0.8-1.2 mm. long, 0.2-0.4 mm. wide, as much as 0.3 mm. shorter than the sepals; siliques elongate-cylindrical, straight, obtuse to somewhat acute below, not at all or only slightly tapering toward the apex, (3)4.5-9(12) mm. long, 1.2-1.8 mm. wide, ca. 3-5 times as long as wide, ca. (2)3-7(9) times as long as the pedicels, the valves smooth to rough with hyaline ridges or hemispherical vesicular trichomes throughout or only on the edges; replum narrowly oblong, the margin straight and glabrous or with sparse vesicular trichomes; style absent to 0.5 mm. long, straight to expanded below the stigma, gradually merging into the obtuse to somewhat acute silique apex; stigma expanded in fruit; seeds regularly cordiform, ca. 0.4-0.6 mm. long, ca. 50-100 per silique, the surface dark reddish-brown, somewhat reticulate to shallowly foveolate; flowering and fruiting (November)January-April.

Rorippa portoricensis is unique in that petals may be present or absent, even on the same plant. Rollins (1961) pointed out that the relationship between *R. walteri* [*R. teres*] and *R. portoricensis* is very close and that whether to maintain them as two species or as varieties of one species is uncertain. The basic differences are the shorter more slender styles and pedicels in fruit of *R. portoricensis*. *Rorippa portoricensis* tends to have shorter, somewhat straighter siliques, and the margins of the leaf-lobe margins more crenately divided rather than sharply toothed. The seeds of *R. portoricensis* are shallowly pitted to somewhat reticulate, like those of *R. teres* var. *rollinsii* but different from the deeply pitted ones of var. *teres*.

DISTRIBUTION: Map 8; 20-K.

A stream and river bank plant, *R. portoricensis* is endemic to the West Indies: Bahama Islands (Andros), Cuba, Puerto Rico, and Dominican Republic. Within *R. portoricensis*, as in *R. teres*, there are slight divergences in morphology and trichome distribution in geographically segregated plants.

Key to Varieties of Rorippa portoricensis

1. Vesicular trichomes absent from the lower portion of the stem, and basal and lower cauline leaves; stigma sessile, rarely on style up to 0.5 mm. long; siliques (4.5)7-11(12) mm. long; Puerto Rico and the Dominican Republic. . . . . 12a. var. *portoricensis*
1. Vesicular trichomes present on the lower portion of the stem and the upper surface of basal and lower cauline leaves; stigma on a style up to 0.5 mm. long, rarely sessile; siliques (3)4.5-8(9) mm. long; Cuba and on Andros in the Bahama Islands. . . . . 12b. var. *pumilum*

12a. RORIPPA PORTORICENSIS (Sprengel) Stehlé var. PORTORICENSIS

The synonymy for the nomenclatural typical variety is presented before the description of the species.

DISTRIBUTION: Map 8.

12b. RORIPPA PORTORICENSIS (Sprengel) Stehlé var. **pumilum** (O. E. Schulz) Stuckey, comb. nov.

Nasturtium brevipes (A. P. DeCandolle) Grisebach var. *pumilum* O. E. Schulz, Symb. Antill. 3: 517. 1903. ("Hab[itat] in Cuba: Wright n. 1562, in Yumury valle: Rugel n. 235." Lectotype: CUBA: [ORIENTE]: In Cuba Orientali, ["In humidis ad vias prope Santa Catalina de Guantanamo, Jan-Feb," (Grisebach, Mem. Am. Acad. n. ser. 8: 154. 1861] 1860, *Charles Wright 1562*, presumably at B. Isolectotypes, GH! MO! NY! PH! US! Photo of MO specimen at MICH! OS!)

Nasturtium brevipes (A. P. DeCandolle) Grisebach var. *jackianum* O. E. Schulz, Repert. Sp. Nov. 34: 135. 1933. (Holotype: CUBA: SANTA CLARA: On shore of Arimao River, Vega, Soledad, Cienfuegos, 20 Mar 1930, *J. G. Jack 7805*, presumably at B. Isotype, US!)

DISTRIBUTION: Map 8.

13. RORIPPA SESSILIFLORA (Nuttall in Torrey et Gray) A. S. Hitchcock, Spring Fl. Manhattan 18. 1894.

Nasturtium sessiliflorum Nuttall in Torrey et Gray, Fl. N. Am. 1: 73. 1838. ("Banks of the Mississippi [River]." Holotype: [?ARKANSAS: county unknown]: Arkansas, [ca. 1819, *fide* Pennell (Bartonia 18: 27-28. 1936), *Thomas Nuttall s.n.*], BM. Neg. no. BM 2129, BM. Isotype, Mississippi [River], PH! Photo at MICH!, OS! [The specimens were originally labeled "Nasturtium *sessiliflorum S. amphibium affine fruit subsess."])

Nasturtium limosum Nuttall in Torrey et Gray, Fl. N. Am. 1: 74. 1838. ("Banks of the Mississippi [River], near New Orleans." Holotype:

LOUISIANA: [Orleans Parish]: Near the bank of the [Mississippi] River below the city, N[ew] Orleans, 24 Feb *s.d.*, *H[enry] Little s.n.*, PH! Photo at MICH!, OS! [The specimen was originally labeled "N[asturtium] *limosum" by Nuttall. No duplicate was found at BM by Dr. Rogers McVaugh.])

Cardamine palustris ("Leysser" [Linnaeus] O. Kuntze α *brevipes* (A. P. DeCandolle) O. Kuntze 1. *sessiliflora* (Nuttall in Torrey et Gray) O. Kuntze, Rev. Gen. 1: 24. 1891.

Radicula sessiflora [sic] (Nuttall in Torrey et Gray) Greene, Leafl. Bot. Obs. & Crit. 1: 113. 1905.

Radicula limosa (Nuttall in Torrey et Gray) Greene, Leafl. Bot. Obs. & Crit. 1: 113. 1905.

Glabrous summer, fall, or winter annual, possibly a biennial; stems (1)2-5 dm. tall, erect, single to much branched from the base; basal and lower cauline leaves short-petiolate to cuneate and sessile, slightly auriculate to non-auriculate, non-clasping, oblong, obovate, oblanceolate, to spatulate, 1.5-6(11) cm. long, (0.5)1-2(4) cm. wide, the margins entire, crenate, irregularly serrate, to repand, broadly obtuse to somewhat acute at the apex; racemes terminal and axillary, ca. 0.5-1(2) dm. long, forming during stem elongation, the siliques therefore nearly equal in age at corresponding points on the racemes; pedicels 0.5-1.5(2) mm. long, ascending, smooth to rough with hyaline ridges; sepals ovate to lanceolate, 1.3-2 mm. long, 0.4-0.8 mm. wide, strongly saccate, caducous in fruit; petals absent; siliques elongate cylindrical, straight to slightly curved inward toward the raceme axis, acute to cuneate below and becoming slightly wider toward the apex, (3)5.4-8.5(10.2) mm. long, (1.4)1.8-2.6(3.3) mm. wide, ca. 3-5 times as long as wide, ca. (4)6-9 times as long as the pedicels, the valves smooth to rough with minute hyaline ridges; replum oblong to slightly obovate in outline, the margin straight to concave and glabrous; style absent to 0.4 mm. long, ca. 0.3-0.5 mm. wide in fruit, strongly expanded below the stigma, occasionally straight, gradually merging into the obtuse silique apex; stigma expanded in fruit; seeds regularly cordiform, ca. 0.4-0.5 mm. long, ca. 150-200 per silique, the surface light yellowish-brown, deeply foveolate; flowering and fruiting March-October.

ILLUSTRATIONS: Britton & Brown (1897, p. 126, fig. 1720; 1913, p. 162, fig. 2032); Fassett (1940, p. 232, fig. 12, 13), plant & seed; Gleason (1952, p. 241); Gray (1849a, p. 132, pl. 53, fig. 6-8), entire plant—an excellent drawing!; Murley (1951, p. 72, fig. 24), seed; Steyermark (1963, p. 759, pl. 185, no. 2).

Rorippa sessiliflora is one of the most distinctive of North American *Rorippa*. The siliques are very thick, often over 2 mm. wide, obliquely wedge-shaped at the base, and on very short (0.5-1.5 mm.) pedicels. More striking is the absence of petals. Stamens are 3 to 6, even in different flowers on a plant, and sometimes the filaments are fused. The extremely small (to 0.5 mm. long), numerous (ca. 150-200 per silique), light yellowish-brown seeds are deeply pitted.

The species is most closely related to *R. teres* and *R. portoricensis*. This alliance is suggested by very small numerous seeds, short styles expanded below the stigma, short pedicels, tiny flowers, and often rough valves with minute hyaline ridges. The very short pedicels and styles and absence of petals recall *R. portoricensis*; style shape, the deeply pitted seeds, and the cuneate-based siliques recall *R. teres*. *Rorippa sessiliflora* differs from *R. teres* and *R. portoricensis* in growth habit, in being glabrous, and in having strongly saccate sepals and obovate to oblanceolate entire, repand, or somewhat toothed leaves.

The type of Nuttall's *Nasturtium limosum* is an extreme variation within *R. sessiliflora* in having basal and cauline leaves lacinate-divided to coarsely toothed on the upper portion of the plant, leaf apex acute, and longer pedicels (1.5)1.8-3.2 mm. long. In addition to the type of *N. limosum*, five similar specimens are known (ILLINOIS: Alexander Co., *Palmer 14898*, PH, MO; Bellville, May 1835, *Engelmann s.n.*, MO; Sangamon Co., *Stearns 270*, WIS. MISSOURI: St. Louis Co., *Muehlenbach 1498*, MO, OS. TEXAS: Smith Co., *Kral 627*, FSU.) These may be shade forms of *R. sessiliflora*. Plants grown in the greenhouse from seed of my *1604* from Schuyler County, Illinois, when cultivated during winter (short days), had basal leaves much more dissected and acute at the tip than did plants collected in the field or grown in the greenhouse during summer (long days). Some herbarium specimens from Arkansas also have leaves of this type. These variants may also represent occasional natural hybrids between *R. sessiliflora* and *R. palustris* var. *fernaldiana*, the ranges and habitats of which overlap. In seven of nine localities where I found *R. sessiliflora* with *R. palustris* var. *fernaldiana*, I did not find this extreme variant or any plant suggesting a hybrid between the two taxa.

DISTRIBUTION: Map 9; 20-L.

Rorippa sessiliflora is the only species of *Rorippa* confined to central United States in the Mississippi embayment, extending northward to the southern limit of Wisconsin glaciation, and occurring sparingly in southeastern United States. It inhabits muddy places along rivers, streams, creeks, and ponds and in low wet fields. Most specimens are from localities along rivers and streams of the Mississippi embayment. The seeds germinate in open, moist bare sand or mud, and because the water level may fluctuate during the season, plants in all stages of vegetative growth, flowering, and fruit maturation may be found at a locality throughout the growing period. This behavior, though found in other species, appears to be most common in *R. sessiliflora*, largely because of its frequent and close association with rivers and streams. The seeds float and are easily dispersed. I placed seeds in water 10 December 1964; they floated until 10 February 1965.

The limitation of *R. sessiliflora* on the north by the southern limit of Wisconsin glaciation is striking. Its occasional occurrence in glaciated territory is not surprising since the species could have been spread northward by agricultural practices. Over (1932) listed it as "sparingly in old creek beds" from South Dakota. I have not seen specimens from South Dakota, but the species would be expected in the state's southeastern corner. Strausbaugh and Core (1953) do not have it from West Virginia; it is probably absent from this mountainous region. Harris (1958) reported *R. sessiliflora* from Essex County, Massachusetts; the collection was made in 1859, "a weed in garden and seen there for many years past" (PM). I have not seen the specimen. If correctly identified, it doubtless is an introduction. Reports for the District of Columbia area (Hitchcock and Standley, 1919), Virginia (Massey, 1961), and Georgia (Thorne, 1954) are all apparently correct.

Summary of the species of southeastern affinity. Rorippa teres, R. portoricensis, and *R. sessiliflora* are a culmination of one line of development that probably arose from a plant in the Mexican uplands similar to *R. mexicana* and migrated onto the Coastal Plain. These three species are allied by character combinations not found in other North American *Rorippa*, most importantly the small flowers; numerous, small seeds, mostly foveolate; thick styles expanded below the stigma in fruit; and short pedicels. *Rorippa sessiliflora* is the most highly evolved member, especially with its loss of petals, extremely short pedicels, modifications in stamen number, and the most seeds per silique. Plants somewhat intermediate between *R. teres* and *R. portoricensis* indicate the close relationship of these species, but no intermediates between either of these and *R. sessiliflora* have been found. The data certainly suggest a southern origin for *R. sessiliflora* with migration northward up the river valleys of the Mississippi basin and eastward nearly to the Atlantic. Was its northward penetration halted by ice-filled river valleys, or was its northern range trimmed by the glacier? Nearly all the other native species that exhibit correlation and movement along a river system seem to show downriver migration. In contrast, *R. sessiliflora* has apparently traveled upriver.

14. RORIPPA **megasperma** Stuckey, sp. nov. (Holotype: COSTA RICA: PROV. CARTAGO: Cartago, 4250 pp, Nov 1887, *Juan J. Cooper 5708*, GH! Photo at MICH!, Fig. 6. Isotype, US!).

Glabrous fall and winter annual, possibly a biennial; stems 3-5 dm. long, decumbent to erect, simple to sparingly branched from the base, glabrous to sparingly hirsute on the lower portion; basal and lower cauline leaves short-petiolate, auriculate to non-auriculate, non-clasping, oblong to broadly oblanceolate, 5-10 cm. long, 1.8-3 cm. wide, pinnately divided to the midrib, both surfaces smooth, glabrous, the middle lobes oblong to elliptic, 5-18(22) mm. long, 3-7 mm. wide, their margins deeply crenate to angularly toothed, the terminal lobe as wide as or occasionally wider than the laterals, acute at the apex; racemes terminal and axillary, ca. 0.5-1 dm. long, forming during stem elongation, the siliques therefore nearly equal in age at corresponding points on the racemes; pedicels 2-3.7 mm. long, divergent to recurved; sepals oblong to oblanceolate, 0.8-1.6 mm. long, 0.3-0.6 mm. wide, flat to slightly saccate, caducous in fruit; petals oblong to narrowly spatulate, 0.6-1.1 mm. long, 0.2-0.4 mm. wide, as much as ca. 0.5 mm. shorter than the sepals; siliques elongate-cylindrical, slightly curved upward, obtuse below and becoming strongly clavate toward the apex, 6.7-11 mm. long, (0.8)1-1.5 mm. wide, ca. 5-8(11) times as long as wide, ca. 2-4 times as long as the pedicels, the valves smooth to slightly rough with hyaline ridges; replum narrowly oblong in outline, slightly twisted, the margin straight; style nearly absent to 0.5 mm. long, ca. 0.1-0.4 mm. wide, straight, abruptly attached to the obtuse to truncate silique apex; stigma unexpanded in fruit; seeds regularly cordiform, 0.8-1.1 mm. long, ca. 20-30 per silique, the surface light brown, coarsely colliculate; flowering and fruiting November-April(June).

Herba annua glabra; caulibus 3-5 dm. longis decumbentibus vel erectis unicis vel numerosis glabris vel sparse hirsutis; foliis radicalibus caulinisque petiolatis vel sessilibus auriculatis vel non-auriculatis oblongis vel late oblanceolatis 5-10 cm. longis, 1.8-3 cm. latis pinnatilobatis; pedicellis 2-3.7 mm. longis diversis vel recurvatis; sepalis oblongis vel oblanceolatis 0.8-1.6 mm. longis, 0.3-0.6 mm. latis planis; petalis flavis oblongis vel anguste spathulatis 0.6-1.1 mm. longis, 0.2-0.4 mm. latis; siliquis elongato-cylindricis clavatis 6.7-11 mm. longis, (0.8)1-1.5 mm. latis; stylis fere absentibus vel 0.5 mm. longis; seminibus cordiformibus colliculatis 0.8-1.1 mm. longis.

ILLUSTRATION: Fig. 6.

Rorippa megasperma is a glabrous plant with pinnately divided leaves. The seeds, coarsely colliculate, usually are over 0.8 mm. long and are the largest among the species in this alliance. Another distinguishing feature of *R. megasperma* is its long fruits, usually clavate at the apex, 2-4 times as long as the pedicels. The silique surface is often undulate with ridges and depressions formed by close contact of the valves with the seeds. This species is most closely related to *R. pinnata* and *R. intermedia.*

DISTRIBUTION: Map 10; 20-M.

Rorippa megasperma is known from four localities in the mountains of central Costa Rica and from one in Guatemala. Its northern limit is obscure. More collections are needed from Central America to clarify the ranges of various *Rorippa* species there.

15. RORIPPA PINNATA (Sessé et Mociño) Rollins, Rhodora 62: 18. 1960.
Arabis pinnata Sessé et Mociño, La Naturaleza, ser. 2, I; appendix p. 104. 1889. ("Habitat ad margines rivulorum Quahunahuacensium." According to Rollins (1960), "The original label reads '15-2 Arabis pinnata N. Habitat ad margines rivulorum Guaunahuacae.' [Cuernavaca, state of Morelos, Mexico] The newly assigned number is 3345." Specimen at MA.)

Glabrous fall and winter annual, possibly a biennial; stems 3-6 dm. long, decumbent to erect, single to sparingly branched from the base, glabrous to moderately hirsute on the lower portion; basal and lower cauline leaves short-petiolate, auriculate to non-auriculate, non-clasping, oblong to broadly oblanceolate, 3-11 cm. long, 1.2-3 cm. wide, pinnately divided to the midrib, both surfaces smooth, glabrous, the middle lobes oblong to elliptic, (7)10-20 mm. long, 3-7 mm. wide, their margins crenate to sharply toothed,

Fig. 6. Photograph of a portion of the holotype of *Rorippa megasperma* Stuckey. (*J.J. Cooper 5708*, GH). Univ. Mich. Neg. No. 1718.

the terminal lobe as wide as or wider than the laterals, obtuse at the apex; racemes terminal and axillary, ca. 0.5-1.5 dm. long, forming after or during stem elongation, the oldest siliques therefore on the lower portion of the terminal raceme or siliques nearly equal in age at corresponding points on the racemes; pedicels 2.4-4.5(5.8) mm. long, recurved; sepals broadly ovate to oblong, 0.8-1.2 mm. long, 0.5-0.8 mm. wide, flat to slightly saccate; petals oblong to narrowly spatulate, 0.5-0.7 mm. long, 0.1-0.2 mm. wide, as much as 0.5 mm. shorter than the sepals; siliques short-cylindrical, slightly curved upward, obtuse below, gradually tapering toward the apex, slightly constricted at the center, 2.8-6.5(7.4) mm. long, (1.1)1.4-2.3 mm. wide, ca. 1.5-4 times as long as wide, ca. 0.8-2 times as long as the pedicels, the valves smooth or occasionally with minute hyaline ridges; replum narrowly oblong to somewhat triangular in outline, occasionally twisted, the margin concave; style 0.1-0.5 mm. long, ca. 0.2-0.5 mm. wide, straight to slightly tapering, abruptly attached to somewhat merging into the acute, obtuse, or rarely truncate silique apex; stigma unexpanded in fruit; seeds regularly cordiform, ca. 0.7-0.8 mm. long, ca. 25-50 per silique, the surface light brown, finely colliculate; flowering and fruiting November-March.

ILLUSTRATION: Rollins (1960, p. 17).

Rorippa pinnata is a pinnate-leaved plant with usually a sparingly hirsute stem. The short, rather thick, concave-margined siliques acute at the apex and on strongly recurved pedicels distinguish it from its relatives, *R. megasperma* and *R. intermedia*.

In interpreting *R. pinnata*, I have followed Rollins (1960). All specimens he cited belong to this taxon. Schulz (1933) included specimens of *R. pinnata* under *N. mexicanum*. Previous to Rollins' work, most specimens of *R. pinnata* were undetermined or referred to *R. mexicana*.

DISTRIBUTION: Map 10; 20-N.

Apparently *R. pinnata* is a species of disjunct distribution. I have seen specimens from Colombia; from the states of México, Michoacan, Morelos, Puebla, and the Federal District of Mexico; and from Guatemala. The southern limit of its North American range is probably northern Guatemala or southern Mexico. The species apparently does not reach Costa Rica, where it is replaced by *R. megasperma*.

16. RORIPPA **intermedia** (O. Kuntze) Stuckey, comb. nov.

Cardamine palustris ("Leysser" [Linnaeus]) O. Kuntze δ *mexicana* (A. P. DeCandolle) O. Kuntze 2. *intermedia* O. Kuntze, Rev. Gen. 1: 25. 1891. ("Costarica!!" Type: COSTA RICA: PROV. CARTAGO: Cartago, *s.d.*, *Herbarium Otto Kuntze 17.74-2167*, NY! Photo at MICH! OS!) [The specimen was originally labeled "Nasturtium palustre sp[?] mexicanum (M. S.) var. intermedium n."])

Glabrous winter annual, possibly a biennial; stems 1.5-6 dm. tall, erect to occasionally decumbent, single to sparingly branched from the base, glabrous or very sparingly hirsute; basal and lower cauline leaves short-petiolate, auriculate to non-auriculate, non-clasping, oblong to broadly lanceolate, 4-10 cm. long, 1-3 cm. wide, pinnately divided to the midrib, lower surface rough with hyaline ridges on the midrib, upper surface smooth and glabrous or sparingly hirsute on the midrib, the middle lobes oblong to elliptic, (4)8-20 mm. long, (2)4-7(10) mm. wide, their margins minutely to deeply, sharply toothed, the terminal lobe as wide as the laterals, acute at the apex; racemes terminal and axillary, ca. 0.4-1 dm. long, forming after or during stem elongation, the oldest siliques therefore on the lower portion of the terminal raceme or siliques nearly equal in age at corresponding points on the racemes; pedicels 2-5.2(7) mm. long, divergent to ascending; sepals ovate to oblong, 0.7-1.6 mm. long, 0.3-0.8 mm. wide, flat to slightly saccate, caducous in fruit; petals oblong to narrowly spatulate, 0.5-1.1 mm. long, 0.1-0.4 mm. wide, as much as 0.5 mm. shorter than the sepals; siliques short-cylindrical, straight to very slightly curved upward, obtuse below and tapering toward the apex, 2.7-4.5 mm. long, 0.7-1.3 mm. wide, ca. 3-5 times as long as wide, (0.6)0.8-1.5(1.8) times as long as the pedicels, the valves smooth to somewhat rough with hyaline ridges; replum very narrowly rectangular in outline, the margin straight to slightly concave; style 0.1-0.5 mm. long, ca. 0.2-0.4 mm. wide, straight throughout, gradually merging into the somewhat abruptly attached acute silique apex; stigma unexpanded, rarely expanded in fruit; seeds ca. 0.5-0.6 mm. long, ca. 10-20 per silique, the surface brown, finely colliculate; flowering and fruiting February-April.

Rorippa intermedia is another of the pinnate-leaved members of this alliance. The very slender, short siliques, ca. 0.6-1.8 times as long as the divergent to ascending pedicels; few, small, finely colliculate seeds; and the lower leaf surface covered with hyaline ridges especially on the midrib are distinctive. To the south, *R. intermedia* is allied with *R. pinnata* and *R. megasperma*; to the north, with *R. truncata*.

Rorippa intermedia is typified by a Kuntze specimen at NY (the basis for his *Cardamine palustris* δ *mexicana* 2. *intermedia*) from Cartago, Costa Rica, that exhibits well the silique, pedicel, and petal characters of those plants from the western coastal plain of Mexico and extreme southwestern United States. However, the type differs from these plants in having narrower leaf segments. Leaf lobes in the northern plants are ca. 5 mm. or more wide; those of the type are only up to ca. 3 mm. The narrow leaf lobes suggest *R. mexicana*, but in contrast to that species, the type of *R. intermedia* has small petals shorter than the sepals, much shorter and narrower siliques, divergent to ascending pedicels, and smaller and fewer seeds.

DISTRIBUTION: Map 10; 20-0.

Rorippa intermedia is known from Costa Rica, western Mexico, and north to extreme southwestern United States and Lower California.

Summary of the pinnate-leaved species of Mexico and Central America. *Rorippa megasperma, R. pinnata,* and *R. intermedia* are allied by their deeply pinnate-divided basal and both upper and lower cauline leaves. The oblong to elliptic lobes mostly over 5 mm. in width have deeply crenate to sharply toothed margins. The essential differences among the three taxa are given in the key. Growth aspects are not well known in the species, and the few herbarium specimens are of little help. *Rorippa megasperma* appears to be a decumbent plant flowering and fruiting during stem elongation. Some specimens of *R. pinnata* and *R. intermedia* appear to have had the stem elongate before flower and fruit formation, much as in *R. palustris*; other specimens appear to have developed like *R. megasperma*. The strong, stout stems suggest that *R. pinnata* and *R. intermedia* grow erect or perhaps only somewhat decumbent.

I picture, for the three species, a pinnate-leaved prototype that probably arose out of the *R. curvipes* complex of western United States and extended southward as far as Costa Rica. Geographical isolation and morphological differentiation, particularly in fruit and seed size and shape, became manifest. The ultimate differentiation in this evolutionary line is reflected in *R. megasperma*, with the largest fruits and seeds of the alliance. That the three are distinct species is shown not only morphologically but also geographically. Specimens intermediate between the taxa are not known to me. Because of varying topography and the wide separation of similar habitats (e.g. lake shores) considerable endemism is to be expected in the region where the species occur.

17. RORIPPA TRUNCATA (Jepson) Stuckey, Sida 2: 414. 1966.

Radicula sinuata (Nuttall in Torrey et Gray) Greene var. *truncata* Jepson, Man. Flowering Pl. Calif. 424. 1925. (Holotype: CALIFORNIA: [Los Angeles Co.]: Crystal Lake—North Fork San Gabriel Riv[er], San Gabriel Mountains, 5500 ft, 19 Jun 1921, *Frank W. Peirson 2450*, JEPS! Photo at OS! Sida 2: 415. 1966.)

Glabrous summer and fall, rarely winter annual; stems 1-3(5) dm. long, decumbent to prostrate, much branched from the base; basal and lower cauline leaves short-petiolate, slightly auriculate to non-auriculate, non-clasping, oblong to narrowly oblanceolate, 5-12(26) cm. long, 0.8-1.6(2.5) cm. wide, pinnately divided to the midrib, lower surface smooth or occasionally with hyaline ridges on the midrib, upper surface smooth, glabrous or occasionally sparingly hirsute on the midrib, the middle lobes oblong to elliptic, 3-12(20) mm. long, 1-6(12) mm. wide, their margins entire to angularly toothed, the terminal lobe as wide or wider than the laterals, mostly obtuse at the apex; racemes lateral, 0.4-1 dm. long, developing during stem elongation in the axils of the lower leaves and progressing upward, without the formation of a true terminal raceme, the oldest siliques therefore on the lower axillary racemes; pedicels (1)1.5-3.5(4) mm. long, divergent to ascending; sepals ovate to oblong, 0.8-1.5 mm. long, 0.4-0.6 mm. wide, flat to slightly saccate, caducous in fruit; petals oblong to narrowly spatulate, 0.7-1.2 mm. long, 0.2-0.4 mm. wide, as much as 0.4 mm. shorter than the sepals; siliques short-cylindrical, straight, obtuse to broadly cuneate below and not at all or only slightly tapering toward the apex, constricted at the center, (2.3)3-5(8.2) mm. long, (0.7)1.2-2 mm. wide, ca. 2-4.2(6) times as long as wide, 1.5-2.8(6) times as long as the pedicels, the valves smooth to occasionally slightly rough with minute hyaline ridges; replum narrowly oblong to sub-rectangular in outline, often twisted, the margin concave; style nearly absent to 0.8(1) mm. long, ca. 0.1-0.3 mm. wide, straight throughout, abruptly attached to the obtuse to truncate silique apex; stigma expanded to unexpanded in fruit; seeds regularly cordiform, 0.5-0.6 mm. long, ca. 30-70 per silique, the surface brown, finely colliculate; flowering and fruiting (April-May)June-October.

ILLUSTRATIONS: Gleason (1952, p. 241), as *R. obtusa*—the basal leaves and the single, separate short fruit to the right; Steyermark (1963, p. 759, pl. 185, no. 4); Stuckey (1966c, p. 415), photograph of portion of the type.

Rorippa truncata, like *R. tenerrima*, forms a massive, decumbent to prostrate, glabrous-stemmed, much-branched plant with deeply pinnatifid, angularly toothed basal and cauline leaves. The short, slender, ascending pedicels bear short cylindrical siliques constricted at the middle, with an obtuse to truncate apex, to which is abruptly attached a slender style sometimes with an expanded stigma. The replum has a concave margin and often becomes twisted when dry. *Rorippa truncata* can further be distinguished from its closest allies, the pinnate-leaved plants of Mexico and Central America, and from *R. curvipes*, in that the racemes are entirely lateral, developing first in the axils of the lower cauline leaves and progressing upward. Occasional plants have quite narrow (up to ca. 3 mm. wide) leaf lobes and extremely truncate fruits: Solano County, California (*Koch 1338*, FSU, MSC, WIS) and Dona Ana County, New Mexico (*Thurber 302*, GH, MO). This variation apparently has no taxonomic significance at the infraspecific level.

Rorippa truncata is closely related to *R. intermedia* in having similar leaves, silique size, and seed surface and size, but differs in growth behavior, more often smooth lower surface of the leaf, oldest siliques on lower axillary racemes, shorter pedicels, ca. 3 times as many seeds per silique, and flowering and fruiting usually in summer and fall instead of spring. The specimen of *R. intermedia* from Arizona (*Peebles & Harrison 1659*, NY) approaches *R. truncata* in petal length and silique shape with apex nearly truncate, thereby illustrating the morphological and geographical relationship between the species.

I grew *R. truncata* from my collection *1968* (San Bernardino County, California). Seeds were planted in August, September, and March and in all instances the plants began to flower within the third week after the seedlings emerged. The plants did not form a thick taproot. After about 2 months from the time of flowering some of the plants died, while others remained alive, flowered a second time, and then died. Flowering occurred irrespective of day length, as it did in *R. teres* in culture. The other species in culture, the winter annuals or perennials, required a longer growing period before flowering. They would not flower during short days of winter (November to March), and the rosettes usually continued to live after flowering and fruiting. These comparative observations suggest that *R. truncata*, a small, rather delicate plant with slender roots, is a short-lived annual. This species is usually collected from June to October in flower and fruit, further suggesting a summer or fall annual although in the Rio Grande valley, where the climate is milder compared to other areas of the species' range, fruiting collections have been made in spring. A few quite sturdy, tall plants with terminal racemes, similar to those of *R. intermedia*, were collected in spring by Suksdorf (*2464*, 27 May 1896, GH) in Washington, and by Eggert (1874, MO; 3 Jun 1877, GH, NY) and Engelmann (May 1845, MO; 26 Jun 1877, MO) in Missouri. These may be plants that persist over winter; by maturing the following spring, they behave more like winter annuals such as *R. curvipes*, *R. curvisiliqua*, and *R. palustris*.

There has been considerable confusion in distinguishing *R. truncata* and *R. teres* (*R. obtusa*) because of morphological similarities that have probably come about by parallelism in two separate evolutionary lines in section *Rorippa*. The two species are distinguished in Stuckey (1966c). *Rorippa truncata* also superficially resembles *R. tenerrima*. Both have essentially the same range although *R. tenerrima* grows in Nevada and Utah where *R. truncata* is absent; on the other hand, *R. truncata* seems to be more common in the Missouri River valley and in California northward from *R. tenerrima*. The two species are often found together, and many collections from the lower Missouri River valley, the Columbia River valley, and the Rio Grande contain mixtures of them. Some of our best naturalists—August Fendler, Charles Wright, Heinrich Eggert, George Engelmann, and William Suksdorf—made mixed collections. However, Engelmann, who never published his studies on *Rorippa* and was undoubtedly the most careful North American student of this genus, did notice the difference between these species, and he properly segregated some of his collections of *R. truncata* from *R. tenerrima*. The former he called "N. obtusum"; the latter, "N. obtusum umbrosum."

DISTRIBUTION: Map 11; 14; 20-P.

Rorippa truncata has a very odd distribution. Absent from the central Rocky Mountains, it occurs sparingly in the northern Rockies. Outward from here, it is nearly confined to the major river valleys—the Rio Grande, Columbia, Platte, and Missouri. It occurs in isolated situations in Arizona and California.

18. RORIPPA CURVIPES Greene, Pittonia 3: 97. 1896. [as "*Roripa*"]. ("Rather frequent in the mountains of southern Colorado at middle elevations," Lectotype: COLORADO: [Montrose Co.]: Near Cimaron, 30 Aug 1896, *E. L. Greene s.n.*, ND-G 5126! Isolectotype, ND-G 5125!)

Cardamine palustris ("Leysser" [Linnaeus]) O. Kuntze γ *jonesii* O. Kuntze, Rev. Gen. 1: 25. 1891. (Types: UTAH: [Salt Lake Co.]: City Creek Cañon, 27 Jul 1879, *Marcus E. Jones 1352*, GH! NY! Photo of the NY specimen at MICH! OS!).

Roripa [sic] *underwoodii* Rydberg, Bull. Torrey Club 29: 235. 1902. (Holotype: COLORADO: [Ouray Co.]: Red Mountain, s of Ouray, 3300 m, 11 Sep 1902, *L. M. Underwood 299a*, NY!)

Radicula curvipes (Greene) Greene, Leafl. Bot. Obs. & Crit. 1: 113. 1905.

Radicula underwoodii (Rydberg) Heller, Muhlenbergia 7: 124. 1912.

Radicula sinuata (Nuttall in Torrey et Gray) Greene var. *integra* Jepson, Man. Flowering Pl. Calif. 424. 1925. (Holotype: CALIFORNIA: Inyo Co.: Silver Cañon near Big Prospector Mdw, White Mts., 9700 ft, 30 Jul 1917, *W. L. Jepson 7354*, JEPS! Photo at OS!)

Glabrous summer or fall, usually winter annual, possibly a short-lived perennial; stems 1-5 dm. long, prostrate, decumbent, or erect, single or much branched from the base, sparingly to moderately hirsute on the lower portion; basal and lower cauline leaves short-petiolate to sessile, auriculate to non-auriculate, somewhat clasping to non-clasping, oblong, obovate, spatulate, or oblanceolate (2)4-8(12) cm. long, (0.3)0.6-1.5(3) cm. wide, the margins entire, crenate, irregularly serrate to repand, the apex obtuse to acute, or basal leaves occasionally pinnately divided to the midrib with middle lobes oblong to elliptic, the margins entire or slightly irregularly toothed and the terminal lobe acute to obtuse; lower surface of the leaves smooth and glabrous, upper surface smooth and glabrous to occasionally sparingly hirsute; racemes terminal and axillary, ca. 0.4-1.5 dm. long, forming during or somewhat after stem elongation, the siliques therefore nearly equal in age at corresponding points on the racemes or somewhat older on the lower portion of the terminal raceme; pedicels (1.6)2-5.1(8) mm. long, divergent, ascending, or strongly recurved, often in the same direction and giving the siliques the appearance of being borne unilaterally; sepals ovate to oblong, 0.8-1.7 mm. long, 0.4-1 mm. wide, flat to slightly saccate, caducous in fruit; petals oblong to narrowly or broadly spatulate, 0.5-2.4(2.8) mm. long, 0.2-1 mm. wide, equal to the sepals, or as much as ca. 0.5 mm. shorter than or ca. 1 mm. longer than them; siliques short- to elongate-cylindrical, straight to strongly curved upward and often inward toward the raceme axis, acute to obtuse below, not at all to strongly tapering upward, not at all or somewhat constricted in the center, (1.4)1.8-8.7 mm. long, 0.6-2.3 mm. wide, ca. 1.5-6(7) times as long as wide, ca. 0.5-2.2 times as long as the pedicels, the valves smooth; replum oblong to triangular in outline, seldom twisted, the margin straight to concave; style 0.2-1(1.3) mm. long, ca. 0.1-0.3 mm. wide in fruit, straight throughout, abruptly attached or gradually merging into the obtuse, acute, or pointed silique apex; stigma unexpanded in fruit; seeds regularly cordiform, ca. 0.5-0.7 mm. long, ca. 20-80 per silique, the surface brown, finely colliculate; flowering and fruiting May-September.

Rorippa curvipes is variable in growth habit, petal length, pedicel position and length, and silique shape and length. Although its leaves are variable in shape and lobing, the cauline leaves are never regularly pinnately divided or never regularly toothed, thus distinguishing it from *R. truncata* and the pinnate-leaved relatives in Mexico and Central America.

Rorippa curvipes appears adapted for survival as a short-lived perennial. In the greenhouse, when the plants became pot-bound, the roots formed new plants (basal rosettes) along the edge of the pot. The phenomenon of root propagation, common in *Sinuatae* and such European species as *R. sylvestris*, is apparently rare or uncommon in section *Rorippa*.

DISTRIBUTION: Map 12; 13; 14; 20-Q; 20-R.

Key to Varieties of Rorippa curvipes

1. Petals large, broadly spatulate, 1.2-2.3 mm. long, longer than the sepals; siliques usually acute at the apex; cauline leaves usually fewer than 10; plants decumbent to prostrate. . . . . 18b. var. *alpina*
1. Petals small, oblong to narrowly spatulate, 0.5-1.2(1.5) mm. long, shorter than or equal to the sepals; siliques pointed, acute to obtuse at the apex; cauline leaves usually more than 10; plants erect, decumbent, or prostrate (2)
   2. Siliques small, 1.4-5 mm. long, 1.5-2.5 times as long as wide, pointed, acute, or somewhat obtuse at the apex; pedicels usually recurved in plants from Arizona, Colorado, and New Mexico, usually ascending in those from Utah, Nevada, Oregon, Washington, Idaho, and Montana; petals 0.5-1 mm. long, mostly shorter than the sepals; plants decumbent to prostrate, occasionally erect. 18a. var. *curvipes*
   2. Siliques large, (3.5)5-8.1 mm. long, 2-3.5 times as long as wide, obtuse at the apex; pedicels divergent to ascending; petals 1-1.5 mm. long, mostly equal to the sepals; plants erect to somewhat decumbent. . . . . 18c. var. *integra*

18a. RORIPPA CURVIPES Greene var. CURVIPES

ILLUSTRATION: Fassett (1940, p. 232, fig. 14, 15), as *R. obtusa*—fruits excellent in being acute at the apex and on ascending pedicels; leaves somewhat atypical in being quite deeply divided.

As Greene (1896) pointed out in his original description, a distinguishing character of this variety is the strongly recurved pedicels that often bend back over the raceme axis to such an extent that the arrangement of pods on the raceme appears one-sided. The siliques are somewhat falcate and taper upward, the apex is strongly acute, and the very slender style has an unexpanded stigma in fruit. These features are common in plants from New Mexico and Colorado and sparingly northward into Utah, southern Idaho, and Montana. Through Wyoming and Utah, plants with acute siliques are common, but the pedicels are often ascending. Westward into Nevada and northward into Idaho and Montana are plants with fruits less tapering, somewhat to rather strongly obtuse at the apex, and on ascending pedicels. In these characters the variety is quite heterogeneous and geographical segregation is not well defined.

Rorippa curvipes and *R. truncata* are closely allied. They differ in longevity, manner of growth and raceme formation, leaf shape, silique shape, and replum characters. In *R. truncata* the ascending pedicels and obtuse to truncate fruit apex are distinctive; plants of var. *curvipes* have recurved pedicels and an acute silique apex. That the two species are related is shown by two specimens from southern Colorado: San Miguel Co., 15 Aug 1924, *E. B. and L. B. Payson* (GH, MO, MSC); Gunnison Co., *Stuckey 1666C* (MICH). The former has the growth pattern and somewhat pinnatifid leaves of *R. truncata*, but the pedicels are recurved and the siliques are strongly acute at the apex—features of var. *curvipes*. The specimen at MSC, however, agrees in all characters with var. *curvipes*. My collection resembles *R. truncata* in leaf morphology only. Several specimens from the northern portion of the range of var. *curvipes* have siliques similar to those of *R. truncata*. Most striking among plants with this fruit type are: ALBERTA: *Brinkman 3* (NY). MONTANA: Gallatin Co.: *Blankinship 59* (PH, US); Lewis & Clark Co.: *Kelsey yr. 1891* (NY); Treasure Co.: *Hayden s.n.* Aug 1859 (MO). IDAHO: Ada Co.: *Clark 299* (GH). These are placed in var. *curvipes* and are mapped (map 12).

The synonymy given before the species description applies to var. *curvipes*. Greene (1896) cited no specimens when he named this taxon, but of the material in his herbarium at Notre Dame, I found his collections ND-G 5125 and ND-G 5126 to be the only ones he labeled *R. curvipes* and collected before the publication date of *R. curvipes*. The lectotype comes from near Cimaron, Colorado, the type locality, and agrees perfectly with the original description.

Kuntze's (1891) var. *jonesii* under *Cardamine palustris* was based on specimens very similar to that of Greene's *R. curvipes*. The specimen at NY cannot be considered a holotype, since it was not part of Kuntze's original herbarium. It bears the stamp "Columbia College Herbarium New York." Kuntze apparently saw one of Jones' specimens in a private collection when he toured America in 1874.

Variety *curvipes* has often been misidentified as *R. obtusa*, *R. alpina*, *R. curvisiliqua*, or *R. palustris* and its synonyms. Most United States manuals not recognizing *R. curvipes* or *R. alpina* have included this taxon under *R. obtusa*.

DISTRIBUTION: Map 12; 14; 20-Q.

Variety *curvipes* occurs along irrigation ditches, streams, rivers, and lake shores at elevations between 7000–9000 (–11000) feet in the Central Rocky Mountains. Elsewhere it grows at lower elevations. There has apparently been natural migration eastward in the upper Missouri River valley, as a specimen from South Dakota was collected very early (1839). The collection from Michigan has the datum "common weed along edge of cultivated field." It undoubtedly is an introduction.

18b. RORIPPA CURVIPES Greene var. **alpina** (S. Watson) Stuckey, comb. nov.

Nasturtium obtusum Nuttall in Torrey et Gray var. (?) *alpinum* S. Watson, Bot. King's Exped. 15. 1871. (Holotype: UTAH: [Summit Co.]: Head of Bear River Cañon, Uintas, 10500 ft, Aug 1869, *Sereno Watson 60*, GH! Isotypes, NY! US! Photo of NY specimen at MICH! OS!)

Roripa [sic] *obtusa* (Nuttall in Torrey et Gray) Britton var. *alpina*

(S. Watson) Britton, Bull. Herb. Boiss. 3: 207. 1895.

Roripa [sic] *alpina* (S. Watson) Rydberg, Mem. N. Y. Bot. Gard. 1: 176. 1900.

Radicula alpina (S. Watson) Greene, Leafl. Bot. Obs. & Crit. 1: 114. 1905.

ILLUSTRATION: Hitchcock & Cronquist (1964, p. 540), as *R. obtusa* var. *alpina.*

Variety *alpina*, distinctive in having large petals longer than the sepals, is a short, compact plant with a stem which is mostly an inflorescence, that grows out laterally from the base of the plant. The stem usually has fewer than 10 leaves. The siliques may be quite long and pointed at the apex, or, especially in northeastern Utah, quite short and more obtuse. Long-fruited plants tend to have unlobed leaves with entire to irregularly crenate or serrate margins; short-fruited plants have leaves quite deeply, irregularly divided. On the few collections of plants of the latter morphology, mature fruits are often not available, and it is not yet possible to determine if silique size and leaf shape are correlated. The type specimen has large petals, over 2 mm. long, and unlobed entire leaves.

Western United States manuals have not recognized this taxon or have included it as a species or as a variety of *R. obtusa*. For reasons given below I cannot maintain it as a distinct species.

DISTRIBUTION: Map 13; 14.

Variety *alpina* represents a segregate confined to wet places at high altitudes in the central Rocky Mountains of the United States. In Colorado and Utah it is usually found above 10,000 feet, but in Wyoming and Montana it occurs down to about 7500 feet. Usually at lower elevations (8000–10000 feet in Utah and Colorado) is a transition zone where plants intermediate between var. *alpina* and var. *curvipes* occur. In these specimens, the petals are equal to or slightly longer than the sepals, mostly about 1.0-1.2 (1.5) mm. long, and the cauline leaf number is ca. 8-12. The localities of these intermediates are designated by "stars" in map 13. The intermediates are usually found at the outer limits of the range of var. *alpina*. From my collections in Gunnison County, Colorado (var. *curvipes, Stuckey 1666C, 1670, 1695*; var. *alpina, Stuckey 1666A, 1672, 1673*) I have grown both varieties in the greenhouse. The distinguishing characters of petal length and cauline leaf number were maintained when the plants were grown under similar conditions. However, in view of the many intermediates in an altitudinal transition zone between the two taxa, it is best to designate these taxa as varieties of the same species.

18c. RORIPPA CURVIPES Greene var. **integra** (Rydberg) Stuckey, comb. nov.

Roripa [sic] *integra* Rydberg, Bull. Torrey Club 29: 236. 1902. (Holotype: UTAH [probably Wasatch Co.]: Wahsatch [sic] Mts., 9000 ft, Aug 1869, *Sereno Watson 64*, NY! Isotypes, GH! US! Photo of GH specimen at MICH! OS!)

Radicula integra (Rydberg) Heller, Muhlenbergia 7: 124. 1912.
Rorippa obtusa (Nuttall in Torrey et Gray) Britton var. *integra* (Rydberg) Marie-Victorin, Contr. Inst. Bot. Univ. Montréal, 17: 9.t.6. 1930.

ILLUSTRATION: Marie-Victorin (1930, p. 10, fig. 6; 1947, p. 264) as *R. obtusa* var. *integra*—The latter is very poor!

Variety *integra* is an erect to somewhat decumbent plant usually single-stemmed or sparingly branched at the base. The leaves are obovate to broadly oblanceolate, unlobed, and entire, crenate, or somewhat serrate. The pedicels are divergent to ascending and bear long (usually over 5 mm.), slightly incurved siliques obtuse at the apex. This variety represents a morphological transition between *R. curvipes*, *R. curvisiliqua*, and *R. palustris*. It seems most closely allied to *R. curvipes*. There are specimens transitional to the other varieties of *R. curvipes*: Specimens from Bingham County, Idaho (*Davis 721*, GH) and from Beaver County, Utah (*Maguire 19837*, GH) have the strongly recurved pedicels of var. *curvipes*. A collection from Wyoming (*Payson 2744*, GH, MO, NY, PH, US) although good in fruit characters, consists of short, compact, decumbent plants with cauline leaves fewer than 10 and petals longer than the sepals. They are certainly close to var. *alpina*. The type specimen (*Watson 64*) has quite long petals (ca. 1.5-2.0 mm.) longer than the sepals, and young fruits acute at the apex. In these respects it approaches var. *alpina*. The upright growth, numerous oblanceolate leaves, and pedicel position are good characters for var. *integra*. Two Utah specimens (*Jones 1198*, NY, stamped Morong Herb.; *Hawkins*, 3 Aug 1919, WIS) are completely intermediate between all three varieties. The plants probably grew erect; the leaves are few and unlobed; the siliques, ca. 4-5 mm. long, acute at the apex, are on mostly ascending pedicels; and the petals—mostly fallen off—are 1-1.5 mm. long. The occurrence of all three varieties and a number of intermediates in northern Utah and adjacent areas makes this region the center of morphological diversity for *R. curvipes*.

A plant from Boise Basin, Idaho (*Mulford*, MO) is intermediate between var. *integra* and *R. curvisiliqua*. The short pedicels (ca. 2 mm.) and the style merging into the silique apex link this specimen to *R. curvisiliqua*. The silique shape and length and the leaf morphology are of var. *integra*.

The over-all aspect of var. *integra* is much like *R. palustris* var. *fernaldiana*. There is similarity in fruit shape, style attachment, and often in pedicel position. Variety *integra*, a delicate plant, has an unexpanded stigma in fruit, upper leaf surface usually glabrous, and leaves undivided and more rounded at the apex. In contrast, var. *fernaldiana*, a sturdy plant, has an expanded stigma in fruit, hirsute upper leaf surface, and often quite lacinate-divided leaves acute at the apex.

Marie-Victorin (1930) misidentified specimens of *R. palustris* when he made the combination *R. obtusa* var. *integra* and applied that name to plants from the St. Lawrence River. His illustration, however, is a fair representation of var. *integra*.

DISTRIBUTION: Map 13; 14; 20-R.

Variety *integra* is distributed northwest of var. *alpina* and of the greatest concentration of var. *curvipes* (Utah and southeastward). Variety *curvipes* does occur sparingly, however, throughout most of the range of var. *integra*. The latter would be expected to appear most frequently in northern and western Utah, northern Nevada, and northward through Idaho and western Montana. Its occurrence westward from Idaho is along the Columbia River —the result of downriver migration from northern Idaho and northeastern Washington.

Not only is var. *integra* morphologically intermediate between *R. curvisiliqua*, *R. palustris*, and the other varieties of *R. curvipes*, but it also lies between or partially within their ranges. That it is not an occasional hybrid between any of these taxa is supported by specimens from northwestern Utah and northern Nevada—areas where only one of these allies is known.

19. RORIPPA SPHAEROCARPA (Gray) Britton, Mem. Torrey Club 5: 170. 1894. [as "*Roripa*"].

Nasturtium sphaerocarpum Gray, Mem. Am. Acad. n.s. 4: 6. 1849; Pl. Fendl. 6. 1849. ("Low places along Santa Fe Creek." Holotype: NEW MEXICO: [Santa Fe Co.]: [Santa Fe], 1847, *A. Fendler 31* [Gray's no. 21], GH! Isotypes, MO! PH! Photo of MO specimen at MICH! OS!)

Cardamine globosa (Turczaninow) O. Kuntze 3. *sphaerocarpa* (A. Gray) O. Kuntze, Rev. Gen. 1: 25. 1891.

Nasturtium obtusum Nuttall in Torrey et Gray var. *sphaerocarpum* (Gray) Watson ex Allen, Check-list Gray's Man. 123. 1893.

Radicula sphaerocarpa (Gray) Greene, Leafl. Bot. Obs. & Crit. 1: 113. 1905.

Radicula obtusa (Nuttall in Torrey et Gray) Greene var. *sphaerocarpa* (Gray) Robinson, Rhodora 10: 32. 1908.

R. [i.e. *Roripa*] *obtusa* (Nuttall in Torrey et Gray) Britton var. *sphaerocarpa* (Gray) "Robinson" Britton et Brown, Ill. Fl. 2nd. ed. 2: 161. 1913, pro syn. [Combination made by error for *Radicula obtusa* var. *sphaerocarpa*, but invalid because published in synonymy.]

Rorippa obtusa (Nuttall in Torrey et Gray) Britton var. *sphaerocarpa* (Gray) Cory, Rhodora 38: 406. 1936.

Glabrous summer, fall, or usually winter annual; stems 1-4 dm. long, decumbent to erect, single or much branched from the base, sparingly hirsute on the lower portion; basal and cauline leaves short-petiolate to sessile, auriculate to non-auriculate and non-clasping, oblong to oblanceolate, 4-10 cm. long, 0.7-1.3(3) cm. wide with the margins entire, crenate, irregularly serrate to repand and the apex obtuse to acute, or pinnately divided to the midrib with middle lobes oblong to elliptic, 3-7 mm. long, 2-5 mm. wide, their margins toothed to somewhat entire and the terminal lobe as wide or wider than the laterals, acute to obtuse at the apex; racemes terminal and axillary, ca. 0.5-1 dm. long, forming simultaneously during stem elongation, the siliques therefore nearly equal in age at corresponding points on the racemes, or racemes lateral, developing during stem elongation in the axils of the lower leaves and progressing upward, without the formation of a true terminal raceme, the oldest siliques therefore on the lower axillary racemes; pedicels (1.5)2-4.2 mm. long, ascending or strongly recurved, often in the same direction and giving the siliques the appearance of being borne unilaterally; sepals ovate to oblong, 0.8-1.3 mm. wide, flat to slightly saccate, caducous in fruit; petals oblong to narrowly spatulate, 0.6-1.2 mm. long, 0.2-0.5 mm. wide, as much as 0.5 mm. shorter than the sepals; siliques globose, (0.8)1-2.5 mm. long, 1-2.5 mm. wide, ca. 1-1.3 times as long as wide, ca. 0.5-1 times as long as the pedicels, the valves smooth; replum circular in outline; style 0.1-1 mm. long, ca. 0.1-0.2 mm. wide in fruit, straight throughout, abruptly attached to the rounded silique apex; stigma unexpanded in fruit; seeds regularly cordiform, ca. 0.5-0.7 mm. long, ca. 10-20 per silique, the surface brown, finely colliculate; flowering and fruiting May-August(September).

ILLUSTRATION: Britton & Brown (1897, p. 125, fig. 1716; 1913, p. 161, fig. 2029)

The globose fruit is the only significant character separating *R. sphaerocarpa* from *R. curvipes* and *R. truncata*, but it is a perfectly distinct one. That this species is most closely related to *R. curvipes* var. *curvipes* is shown by specimens collected in Utah by Jones (*5445b*, NY, US) and Beck and Tanner (*8203*, US). I identify both as *R. curvipes* var. *curvipes*, but some siliques are nearly globose.

In leaf and growth characteristics, *R. sphaerocarpa* is somewhat heterogeneous. Specimens from Colorado and New Mexico resemble *R. curvipes* in raceme formation, strongly recurved pedicels, and cauline leaves mostly unlobed or irregularly divided (not pinnatifid); specimens from Arizona and California approach *R. truncata* in that the oldest siliques are on the lower lateral racemes, the pedicels are very short and ascending, and the cauline leaves are pinnatifid and toothed.

Plants of *R. sphaerocarpa* grown in the greenhouse from seed of my collection *1732A*, obtained in Boulder County, Colorado, had globose siliques on strongly recurved pedicels, matching plants collected in the field. Some offspring from one greenhouse plant produced lateral racemes beginning in the lower leaf axils and progressing upward without forming a true terminal raceme; other offspring produced both a terminal and lateral racemes simultaneously. The former condition is found in plants from Arizona and California; the latter, in plants from New Mexico and Colorado. Greenhouse observations confirm that both types of raceme formation occur in the species.

Britton and Brown (1913), Winter (1936), and Hitchcock and Cronquist (1964) suggested these globose-fruited plants might be a minor variant or race of what they called *R. obtusa*. Because plants with long pods (*R. cur-*

vipes) and plants with globose pods (*R. sphaerocarpa*) retain their pod shape under similar conditions in the greenhouse, I maintain the two as separate taxa.

Rorippa sphaerocarpa has not adequately been understood. The Kansas report by Holzinger (1892) is based on a specimen of *R. curvipes* var. *curvipes*. Fassett (1940), recording the species as "mostly in the Mississippi Valley, n. to Wis.," confused it with *R. truncata* and possibly *R. palustris*. Gleason (1952) thought plants of *R. truncata* were *R. sphaerocarpa* (Stuckey, 1966c). Globose-fruited specimens of *R. palustris* from Idaho, often labeled *R. sphaerocarpa*, were the basis of Greene's idea of *R. sphaerocarpa*. Howell's (1897) description of *R. sphaerocarpa* characterizes the globose-fruited, hirsute members of *R. palustris*. *Rorippa sphaerocarpa* does not occur in the Mississippi River valley or the Pacific Northwest. Jones and Fuller (1955) correctly stated that it does not occur east of the Mississippi.

DISTRIBUTION: Map 13; 14.

Rorippa sphaerocarpa occurs locally along streams, ditches, and lake shores in mountains of southwestern United States at elevations below 9000 feet. The exact limits of its range are still somewhat in doubt. The northern limit as given in map 13 is probably accurate, as this area has been more collected than many others on the edge of its range. The eastern edge of the Rocky Mountains is the natural "cut-off" on the east. This is the limit of 16 or more inches of rainfall per year (map 14).

Summary of the Rorippa curvipes complex. The *R. curvipes* complex consists of *R. curvipes* and its varieties, *R. truncata*, and *R. sphaerocarpa*. Plants of these taxa, often misidentified as *R. obtusa*, form the incorrect concept of *R. obtusa* presented in most current manuals. The diffusely branched, glabrous, prostrate to decumbent plants usually with short petals (less than 1.2 mm. except in var. *alpina*), and the relatively small, readily dehiscent siliques with a slender abruptly attached style are features uniting this group.

In the discussion under each species, I pointed out specimens intermediate between these taxa. These intermediates come from northern Utah or adjacent states—nearly the center of range of members of this complex. Radiating from this center is a short, slender, somewhat falcate-fruited plant with numerous cauline leaves (*R. curvipes* var. *curvipes*). To the south the pedicels are strongly recurved and the siliques are shorter and sharply acute to pointed at the apex. North and west, the pedicels are ascending and the fruit apex is more obtuse. Because of intergradation throughout the population, assigning these variants to separate taxa is not justified. From this center and northeast at high elevations, plants with long petals and few cauline leaves are found (var. *alpina*); and radiating northwest is a more robust plant, mostly with large undivided leaves and long obtuse fruits (var. *integra*). These two intergrade with *R. curvipes* and are therefore treated as varieties of it. The globose-fruited *R. sphaerocarpa* of southwestern United States is divergent in fruit shape from other members of the complex and is therefore accorded species rank.

Rorippa truncata shows much morphological deviation from other taxa of this complex. It found its way into major drainage avenues of the United States, far down the Rio Grande, Columbia, Platte, and Missouri rivers, where it successfully exists without the immediate influence of other members of the complex. If it ever existed in the mountains, it has died out in the central Rockies but has held on in northern Idaho and western Montana. Elsewhere it is nearly confined to outlying river valleys, except for isolated occurrences in Arizona and California. The plants of *R. curvipes* var. *curvipes* having a few characters of *R. truncata* may represent the few surviving members whose ancestors were probably prototypes of *R. truncata*.

Map 14 shows the entire *R. curvipes* complex in western United States in relation to 16-inch annual rainfall isohyet. As in *R. curvisiliqua* and *R. microtitis*, the plants come mainly from areas of more than 16 inches of rainfall.

20. RORIPPA PALUSTRIS (Linnaeus) Besser, Enum. Pl. Volh. 27. 1822. [as "Roripa"].

[In European literature, there are several taxonomic synonyms for this species, but they are not taken into consideration here because the types have not been seen. For example, see A. P. DeCandolle (Syst. Nat. 2: 191. 1821), Wannenmacher (Hegi Ill. Fl. von Mittel-Europa. ed. 2. 4(2): 172. 1960), and Jonsell (Symb. Bot. Upsal. 19: 157. 1968).]

Sisymbrium amphibium α *palustre* Linnaeus, Sp. Pl. 657, 1753. ("Habitat in Europae septentrionalioris aquosis." Lectotype: Suecia (?), "Lapponica," *C. Linnaeus s.n.*, Institut de France, *fide* Jonsell, 1968, p. 157).

Sisymbrium palustre (Linnaeus) Pollich, Hist. Pl. Palat. 2: 230. 1777. Non Garsault 1767.

Sisymbrium palustre (Linnaeus) Leysser, Fl. Hal. ed. 2. no. 679. p. 166. 1783.

Myagrum palustre [(Linnaeus)] Lamarck, Encycl. Meth. Bot. 1, pt. 2. 572. 1785.

Sisymbrium terrestre Withering, Bot. Arr. Brit. Pl. ed. 2. 2: 692. 1787. [Based on *Sisymbrium amphibium* α *palustre* Linnaeus]

Caroli-Gmelina palustris (Linnaeus) Gaertner, Meyer, & Scherbius, Fl. Wett. 2: 470. 1800.

Radicula palustris ("Pollich" [Linnaeus]) Moench, Meth. 263. 1794. [Since Moench cites Pollich (an illegitimate homonym), this name would be treated as new according to Art. 72, if we did not assume it was actually based on the Linnaean epithet.]

Brachyolobos palustris Clairville, Man. Herb. 218. 1811. [Clairville does not cite any author for his epithet. Presumably it is based on Linnaeus.]

Nasturtium terrestre (Withering) R. Brown in Aiton, Hort. Kew. ed. 2.

4: 110. 1812.

Nasturtium palustre ("Leysser" [Linnaeus]) A. P. DeCandolle, Syst. Nat. 2: 191. 1821. [Since DeCandolle cites Leysser (an illegitimate homonym), this name would be treated as new according to Art. 72, if we did not assume it was actually based on the Linnaean epithet.]

Roripa [sic] *terrestris* (Withering) Fuss, Fl. Transsilv. Exc. 47. 1866.

Cardamine palustris ("Leysser" [Linnaeus]) O. Kuntze, Rev. Gen. 1: 24. 1891.

Roripa [sic] *terrestris* ("R. Brown in Aiton" [Withering]) A. Nelson, Bot. Gaz. 52: 264. 1911.

Radicula terrestris ("R. Brown in Aiton" [Withering]) Wooton et Standley, Contr. U. S. Natl. Herb. 19: 284. 1915.

Summer, fall, or winter annual, occasionally biennial or short-lived perennial stems (1)3-10(14) dm. long, erect, rarely decumbent or prostrate, single or much branched from the base, glabrous throughout or sparingly to densely hirsute below and becoming sparingly hirsute to glabrous above; basal and lower cauline leaves short-petiolate to sessile, slightly auriculate and clasping or non-auriculate and non-clasping, oblong to oblanceolate, (4)6-20(30) cm. long, 1-5(8) cm. wide, both surfaces glabrous or sparingly to densely hirsute, the margins irregularly serrate, incised, deeply cleft, repand, or variously pinnate-divided, the apex narrowly to broadly acute or somewhat attenuate; racemes terminal and axillary, ca. 0.3-2 dm. long, forming after stem elongation, the oldest siliques therefore on the lower portion of the terminal raceme; pedicels 1.9-13.8 mm. long, glabrous to sparingly hirsute, slightly to strongly recurved, divergent, or ascending; sepals ovate to oblong, 1.2-2.5 mm. long, 0.4-1.4 mm. wide, flat to somewhat saccate, caducous in fruit; petals oblong to broadly spatulate, 0.8-3.5 mm. long, 0.5-2.2 mm. wide, shorter than or equal to the sepals or occasionally longer than the sepals; siliques globose, subglobose, oblong, ellipsoid, or short- to elongate-cylindrical, straight to somewhat curved upward and inward toward the raceme axis, acute to obtuse below, not at all to slightly tapering, or becoming clavate toward the apex, 2.2-14 mm. long, 0.8-3.7 mm. wide, ca. 1-8 times as long as wide, ca. 0.2-2 times as long as the pedicels, the valves smooth, glabrous; replum narrowly elongate-oblong, elliptic, or circular in outline, sometimes twisted, the margin concave, straight, or strongly convex and glabrous; style 0.2-1.2 mm. long, ca. 1-3(5) mm. wide in fruit, straight throughout, mostly abruptly attached to the truncate, obtuse, or acute silique apex; stigma expanded or unexpanded in fruit; seeds regularly cordiform, 0.5-0.9 mm. long, ca. 20-80 per silique, the surface brown to reddish-brown, colliculate; flowering and fruiting May-October.

Rorippa palustris is extremely variable, especially in leaf lobing and texture, fruit size and shape, pedicel length and position, and trichome distribution. It is distinctive in that it is the only native North American *Rorippa* that combines bivalved siliques, erect growth, and terminal and lateral racemes formed after the stem has elongated. Two possible exceptions to the growth feature are found in *R. pinnata* and *R. intermedia* of Mexico and Central America. In this character *R. palustris* does merge, via var. *fernaldiana*, with its closest relative, *R. curvipes* var. *integra*, in the Rocky Mountains of western Montana. Variety *integra* grows erect or somewhat decumbent and forms its racemes after the stem has partially elongated. It is a somewhat delicate plant, whereas *R. palustris* is a stout, thick-stemmed, sturdy, and often very tall plant with coarse, heavy foliage and is taller than any other native North American species.

Because *R. palustris* is extremely variable, recent North American accounts of it have differed. Some recognize one species, under the name *R. palustris* or *R. islandica*, with two or more varieties (e.g. Marie-Victorin, 1930; Deam, 1940; Fernald, 1940, 1950; Gleason, 1952; Gleason & Cronquist, 1963; Hitchcock & Cronquist, 1964; Steyermark, 1963); others recognize two, a glabrous one, *R. palustris* or *R. islandica*, and a hirsute one, *R. hispida* (e.g., Fernald, 1928; Abrams, 1944; Harrington, 1954; Hultén, 1945; Jones & Fuller, 1955; Jones, 1963; Kearney & Peebles, 1951; Mason, 1957). I regard *R. palustris* as one highly polymorphic species as did Butters and Abbe (1940) and have sorted the complex into several morphological and geographical segregates. By using both the subspecific and varietal ranks, I attempt to portray levels of morphological complexity and geographical segregation.

Jonsell (1968) presented the taxonomic distinctions and elucidated the nomenclature for *R. palustris* and *R. islandica*, concluding that the two are separate species. Table 1 gives the major characteristics of these taxa in northwestern Europe as summarized from his work.

Rorippa islandica occurs in coastal southern Greenland, Iceland, northern Norway, and the British Isles; in the Alps and Pyrenees; and along some large Russian and Siberian rivers. Jonsell (1968) gives an illustration of the plant (fig. 6, p. 55) and a map of its distribution (fig. 7, p. 56).

Rorippa islandica is not known from the North American continent. A specimen from Anticosti Island (*Marie-Victorin & Rolland-Germain 27265*, GH, PH!, WIS!; fig. 8, p. 14 in Marie-Victorin, 1930; fig. 2, p. 229 in Fassett, 1940) is very similar to European *R. islandica*. Jonsell (1968) noted that its habit, flower size, and foliage suggested European *R. islandica* but that the leaflets were more dissected and the petioles possessed distinct basal auricles. He concluded it was separate from *R. islandica*. The Anticosti specimen is a delicate, decumbent plant with the oldest siliques on lower axillary racemes; a terminal raceme is absent; and the stigma is unexpanded in fruit. In these characters it is distinct from North American *R. palustris* but closely resembles *R. truncata*, differing from it in slightly thicker siliques on somewhat longer pedicels. This plant's identity is doubtful but it may be a variant of *R. islandica* from Europe or of *R. truncata* and its relatives.

As Jonsell (1968) explained, the basionym of *R. islandica* is *Sisymbrium islandicum* Oeder (Flora Danica 3: pl. no. 409. 1768). He stated that this

TABLE 1. CHARACTERISTICS SEPARATING RORIPPA PALUSTRIS AND RORIPPA ISLANDICA.

CHARACTER	*R. palustris*	*R. islandica*
Chromosomes	tetraploid ($2n=32$)	diploid ($2n=16$)
Sepal length in mm.	long (ca. 1.4-2.4)	short (ca. 1.2-1.7)
Petal length in mm.	long (ca. 1.5-2.6)	short (ca. 1-1.7)
Pollen grain, equatorial diameter in microns	ca. 23-27	ca. 18-23
Silique length in relation to pedicel length	not longer than twice the length of the pedicels	about twice the length of the pedicels
Base of silique	widens only gradually from the point of attachment; valves do not reach fully down to the pedicel, therefore separated by a sterile portion of the silique usually ca. 0.2-0.3 (0.5) mm. long	widens more abruptly from the point of attachment; valves reach down to the pedicel, therefore separated by a sterile portion of the silique not longer than ca. 0.1 mm.
Valve texture	thick and firm	thin and transparent
Petioles of middle cauline leaves	distinctly winged and with auricles, making the leaves appear sessile	inconspicuously winged and without auricles, making the leaves appear stalked
Stems	erect	prostrate

illustration shows many features distinguishing *R. islandica* from *R. palustris*; he did not elaborate on these. The plant shown is from Iceland where Oeder obtained seeds collected by Koenig during 1764-65. In Copenhagen, plants were grown from these seeds, and Oeder's plate apparently was prepared from one of these plants. Jonsell found no herbarium specimens connected with Oeder's plate.

References to *R. islandica* in my papers (Stuckey, 1966a, 1966b, 1966c) should be referred to *R. palustris*.

Key to Subspecies of Rorippa palustris

1. Leaves hirsute on the lower surface; stems hirsute usually up to the terminal raceme. . . . . 20. iv. subsp. *hispida*
1. Leaves glabrous on the lower surface; stems glabrous or sparingly hirsute below (2)
   2. Plants short, mostly 1-4 dm., often with a purplish cast to the stem and foliage; stems slender, mostly under 3 mm. in diameter; leaves thin-textured. . . . . 20. i. subsp. *palustris*

2. Plants tall, mostly over 4 dm., often with a reddish cast to the stem and foliage; stems thick, mostly over 3 mm. in diameter; leaves thick-textured (3)

3. Siliques mostly longer than 7 mm.; stigma unexpanded in fruit. . . . . 20. ii. subsp. *occidentalis*

3. Siliques mostly shorter than 7 mm.; stigma expanded or unexpanded in fruit. . . . . 20. iii. subsp. *glabra*

20i. RORIPPA PALUSTRIS (Linnaeus) Besser subsp. PALUSTRIS

Plants delicate, mostly 1-4 dm. tall, entirely glabrous except occasionally hirsute on the upper surface of the leaves; stems slender, mostly under 3 mm. in diameter; petals 1.3-2.5 mm. long, shorter than the sepals; pedicels 4.8-9 mm. long, mostly divergent; siliques ellipsoid or elongate-cylindrical, 4-8.7 mm. long, 1-2.7 mm. wide; stigma strongly expanded in fruit.

Key to Varieties of Subspecies palustris

1. Apex of basal leaves obtuse with angle of ca. (60°)80°-120°; apex of middle cauline leaves with angle of ca. (40°)60°-120°; siliques acute or pointed at the apex. . . . . 20a. var. *palustris*

1. Apex of basal leaves acute with angle of ca. 40°-80°(100°); apex of middle cauline leaves with angle of ca. 30°-60°(70°); siliques obtuse at the apex. 20b. var. *williamsii*

20a. RORIPPA PALUSTRIS (Linnaeus) Besser subsp. PALUSTRIS var. PALUSTRIS

ILLUSTRATIONS: Butcher (1961, p. 336, no. 223), portion of plant, flower, silique, seed, as *R. islandica*; Clapham, Tutin, and Warburg (1962, p. 173, fig. 23, B), silique, as *R. islandica*; Jonsell (1968, plate V, fig. B), photograph of siliques; Jonsell (1968, plate V, fig. E, F), photographs of entire plants.

The typical variety is a short, slender-stemmed thin-leaved plant with ellipsoid or elongate-cylindrical siliques somewhat pointed near the apex, and a style with a strongly expanded stigma.

Synonymy for the nomenclaturally typical subspecies and variety is given before the species description.

Fernald (1928) was doubtful whether var. *palustris* [his *R. islandica*] is native in eastern North America. On the basis of the specimens he cited (except *Marie-Victorin* and *Rolland-German 27265*, GH, PH, WIS), we agree on the concept of this taxon. Plants from the vicinity of New York, the Delaware River valley, and the Washington, D.C., area, usually from waste places, probably are introductions from Europe. Plants of upper and central New York and New England coming primarily from river banks and lake shores may be native populations extending eastward from those of the western part of the continent. Specimens from Alberta and Saskatchewan have the upper leaf surface sparingly hirsute, like var. *fernaldiana*—one aspect of introgression between these varieties.

The typical variety of *R. palustris* occurs throughout Europe except in the Mediterranean region (Jonsell, 1968). It is absent from Iceland, the type locality of *R. islandica.*

DISTRIBUTION: NORTHERN NORTH AMERICA: Map 15. NORTHWESTERN EUROPE: Hultén (1950, p. 237, map 925), as *R. islandica*; Jonsell (1968, p. 67, fig. 8).

20b. RORIPPA PALUSTRIS (Linnaeus) Besser subsp. PALUSTRIS var. WILLIAMSII (Britton) Hultén, Fl. Alaska & Yukon 5: (Lunds Univ. Arssk. II. Sect. 2. 41:) 828. 1945.

Rorippa williamsii Britton, Bull. N. Y. Bot. Gard. 2: 171. 1901. (Holotype: CANADA: YUKON: Near mouth of Bonanza Creek, 18 Jun 1899, *R. S. Williams s.n.*, NY! Photo at MICH! OS!)

Radicula williamsii (Britton) Heller, Muhlenbergia 7: 124. 1912.

Nasturtium williamsii (Britton) Standley, Field Mus. Publ. Bot. [Fieldiana Bot.] 8: 312. 1931.

The range of var. *williamsii* extends from unglaciated central Alaska onto glaciated northern Alaska, across the Yukon and Mackenzie to Churchill, Manitoba. The variety is absent from glaciated southeastern Alaska. A few specimens at US from eastern Asia are similar to this variety.

DISTRIBUTION: Map 15.

20. ii. RORIPPA PALUSTRIS (Linnaeus) Besser subsp. OCCIDENTALIS (S. Watson in Gray) Abrams, Ill. Fl. Pacific States 2: 278. 1944.

Nasturtium terrestre [(Withering)] R. Brown in Aiton var. *occidentale* S. Watson in Gray, Syn. Fl. 1: 148. 1895. ("Shumagin Islands, Alaska, *Dall,* to Brit. Columbia, *Lyall, Macoun,* and the Lower Columbia Valley, *Hall, Suksdorf, Howell.*" Lectotype: ALASKA: Popoff Strait, Shumagin I[slan]ds, 15 Oct 1873, *W. T. Dall s.n.*, GH!)

Roripa [sic] *pacifica* Howell, Fl. N. W. Am. 1: 40. 1897. [Based on *Nasturtium terrestre* [(Withering)] R. Brown in Aiton var. *occidentale* S. Watson in Gray]

Radicula pacifica (Howell) Greene, Leafl. Bot. Obs. & Crit. 1: 114. 1905.

Rorippa palustris (Linnaeus) Besser var. *pacifica* (Howell) G. N. Jones, Univ. Wash. Publ. Biol. 5: 161. 1936.

Rorippa islandica (Oeder ex Murray) Borbás var. *occidentalis* (S. Watson in Gray) Butters et Abbe, Rhodora 42: 27. 1940.

Plants stout, mostly 4-10(14) dm. tall, entirely glabrous; stems thick, mostly over 3 mm. in diameter; petals 1.2-3.5 mm. long, equal to or slightly longer than the sepals; pedicels (4.5)6-11(13.8) mm. long; siliques elongate-cylindrical, (6.2)7-14 mm. long, 1.6-3.7 mm. wide; stigma unexpanded in fruit.

Key to Varieties of Subspecies occidentalis

1. Siliques straight, not at all or slightly tapering upward with apex acute to obtuse; pedicels ascending or occasionally divergent. . . . . 20c. var. *occidentalis*
1. Siliques curved upward, becoming clavate upward with apex obtuse to truncate; pedicels divergent or somewhat recurved. . 20d. var. *clavata*

20c. RORIPPA PALUSTRIS (Linnaeus) Besser subsp. OCCIDENTALIS (S. Watson in A. Gray) Abrams var. OCCIDENTALIS

ILLUSTRATION: Anderson (1959, p. 275, fig. 536), silique, seed, leaf—poor!

Variety *occidentalis* is known from two regions of western North America. The first extends from northern Idaho (one of the centers of morphological diversity) to the California mountains, the lower Colorado River valley, the Rio Grande valley, and Mexico City. Some specimens from the California coast are somewhat transitional toward var. *clavata* in the slightly longer, more upcurved siliques tending to be more obtuse at the apex. The pedicels are more divergent—often at right angles to the axis.

The second region is coastal Alaska where plants are shorter (up to ca. 4 dm. in contrast to those of the first region, which reach over 7 dm.) and the siliques are mostly obtuse at the apex.

DISTRIBUTION: Map 15.

20d. RORIPPA PALUSTRIS (Linnaeus) Besser subsp. OCCIDENTALIS (S. Watson in Gray) Abrams var. **clavata** (Rydberg) Stuckey, comb. nov.

Roripa [sic] *clavata* Rydberg, Bull. Torrey Club 29: 235. 1902. (Holotype: WASHINGTON: Chelis Co.: [Gray's Harbor Co.]: Hoquiam, 29 Jun 1897, *F. H. Lamb 1221,* NY! Isotypes, MO! PH! US! Photo of PH specimen at MICH! OS!)

Radicula clavata (Rydberg) Macoun, Ottawa Nat. 20: 142. 1906.

Nasturtium clavatum (Rydberg) Standley, Field Mus. Pub. Bot. [Fieldiana Bot.] 8: 312. 1931.

The curved siliques gradually widening apically are distinctive. The ultimate in silique length (ca. 14 mm.) is reached in var. *clavata*. This variety grows in coastal southeastern Alaska south to western Washington, and along the lower Columbia River.

I grew plants of var. *occidentalis* from California (*Piehl 631136*, MICH) and var. *clavata* from Oregon (*Stuckey 1926A*) under similar conditions in the greenhouse; the distinguishing characters were retained.

20. iii. RORIPPA PALUSTRIS (Linnaeus) Besser subsp. **glabra** (O. E. Schulz) Stuckey, comb. nov.

Nasturtium palustre ("Leysser" [Linnaeus]) A. P. DeCandolle subsp. *hispidum* (Desvaux) "Fischer et Meyer" [O. E. Schulz] var. *glabra* O. E. Schulz, Symb. Antill. 3. 516. 1903.("Hab[itat] in Cuba: Wright n. 1862." Holotype: CUBA: [ORIENTE]: [Without locality], 1860-1864, *C. Wright 1862*, presumably at B. Isotypes, GH! MO! Photo of MO specimen at MICH! OS!)

Radicula glabra (O. E. Schultz [sic] Britton, Torreya 6: 30. 1906.

Roripa [sic] *terristris* [sic] ("R. Brown in Aiton" [Withering]) A. Nelson var. *globosa* A. Nelson, Bot. Gaz. 52: 264. 1911. ("Macbride 275 is typical . . .; also by Aven Nelson, Head of Wood's Creek, Albany Co., Wyoming, August 1910." Lectotype: IDAHO: Canyon Co.: Swampy land, Falk's Store, 22 Jun 1910, *J. Francis McBride 275*, US! Photo at MICH! OS! Isolectotype, NY! [Since I have not seen the specimen that A. Nelson apparently had (presumably at RM), I am selecting the specimen at US as the lectotype. A duplicate at MO! is hirsute on the lower surface of the leaves and belongs to *Rorippa palustris* subsp. *hispida* var. *hispida*.])

Plants stout, mostly 4-10 dm. tall; stems thick, mostly over 3 mm. in diameter, glabrous to sparingly hirsute below, glabrous above; leaves glabrous on the lower surface, sparingly hirsute to glabrous on the upper surface; petals 0.8-2 mm. long, equal to or shorter than the sepals; pedicels (1.9)2.7-5.5(7.6) mm. long; siliques globose, subglobose, oblong, short- to elongate-cylindrical, (0.8)1.2-3.4 mm. wide.

Key to Varieties of Subspecies glabra

1. Stigma expanded in fruit; replum margin concave, becoming twisted with age and upon drying (except in var. *dictyota*) (2)
1. Stigma unexpanded in fruit; replum margin straight or convex, remaining flat with age and upon drying (3)
   2. Siliques mostly elongate-cylindrical, straight throughout, (3.8) 4.7-7 mm. long; basal and lower cauline leaves sinuate-lobed or unlobed with irregularly serrate margins; upper cauline leaves glabrous on the upper surface; pedicels divergent to ascending. . . . . 20f. var. *dictyota*
   2. Siliques mostly short-cylindrical, constricted at the center, 2.5-4.3(5.6) mm. long; basal and lower cauline leaves lacininate or pinnate-divided; upper cauline leaves hirsute on the upper surface; pedicels divergent to slightly recurved. . . . . . . 20g. var. *fernaldiana*
3. Siliques globose to subglobose, 2.2-4 mm. long; cauline leaves usually sparingly hirsute on the upper surface; pedicels divergent to ascending. . . . . 20e. var. *glabra*
3. Siliques oblong or elongate-cylindrical, 4.7-7 mm. long; cauline leaves glabrous or sparingly hirsute only on the midrib on the upper surface; pedicels divergent to strongly recurved (4)
   4. Pedicels divergent; siliques as wide at the apex as at the base. . . . . 20h. var. *glabrata*
   4. Pedicels strongly recurved; siliques usually wider at the apex than at the base. . . . . 20i. var. *cernua*

20e. RORIPPA PALUSTRIS (Linnaeus) Besser subsp. GLABRA (O. E. Schulz) Stuckey var. GLABRA

ILLUSTRATION: Fernald (1940, opposite p. 261, pl. 605, fig. 3), photograph of silique.

Plants of var. *glabra* are similar in having globose to subglobose siliques, an unexpanded stigma, mostly divergent pedicels, and the upper leaf surface glabrous to sparingly hirsute, but genetically and evolutionarily they may have different origins. Specimens from southern Idaho, Utah, and northern New Mexico are similar (except for trichome distribution) to var. *hispida*, the only other *R. palustris* segregate growing there. These glabrous plants and var. *hispida* apparently grow together west of the Continental Divide. East of the Divide (except in Montana) such glabrous plants are not known. Variety *glabra* may be isolated from var. *hispida* in the Glacier National Park area of Montana where the latter appears to be rare or absent. A few plants from western Montana and northern Idaho look like var. *fernaldiana* but have the short fruit and unexpanded stigma of var. *glabra*. All Cuban specimens of *R. palustris* belong to var. *glabra;* the occurrence and disjunction there are difficult to explain; It is unlikely that plants would have been introduced from the central Rocky Mountains. Wright's collection of ca. 1860 is an old one; certainly at that period, when the Rocky Mountains were little explored, there would have been slight chance of an inland United States plant being brought to Cuba.

DISTRIBUTION: Map 16; 20-S

20f. RORIPPA PALUSTRIS (Linnaeus) Besser subsp. GLABRA (O. E. Schulz) Stuckey var. **dictyota** (Greene) Stuckey, comb. nov.

Nasturtium dictyotum Greene, Fl. Franciscana 2: 268. 1891. (Holotype: CALIFORNIA: [Probably Solano Co.]: Grand Island, Lower Sacramento River, 17 Sep 1891, *W. Jepson s.n.*, ND-G 5136!)

Roripa [sic] *dictyota* (Greene) Greene, Man. Bot. San Francisco Bay 20. 1894.

Radicula dictyota (Greene) Greene, Leafl. Bot. Obs. & Crit. 1: 113. 1905.

Variety *dictyota* is distinctive in being glabrous and in having rather long fruits, ascending pedicels, and a much-branched often extremely hard, stout, and sturdy stem. It is unique in having leaves either unlobed (though irregularly serrate) or regularly sinuate-lobed. I found it to be common in the lower Columbia River valley. Seeds from unlobed-leaved plants produced plants with unlobed leaves, and those from lobed-leaved plants produced plants with lobed leaves. No other morphological features to separate plants of the leaf types could be found. Furthermore, they have the same range. The plants are morphologically diverse in northern Idaho and western Montana, as shown by the few specimens from Idaho and some of the plants of my mass collection *1887* from Montana. Introgression of var. *dictyota* with var. *clavata* may occur: two collections of the latter, from Gray's Harbor County, Washington, (*Heller 4015,* US) and from Juneau, Alaska, (*Anderson 469*, NY) have the unlobed, irregularly serrate-margined leaves of var. *dictyota*.

Jepson's specimen (ND-G 5136), the holotype and only collection of this variety from the Lower Sacramento River in California, is a very stout, branched individual having a few badly withered leaves. Its fruits and pedicels match perfectly the Leiberg specimens from Idaho. Whether var. *dictyota* has a natural range from the Columbia River to the Sacramento Valley is unknown. This distribution is likely since some segregates of *R. curvisiliqua* extend from the lower Columbia to the Central Valley of California. Variety *dictyota* may also represent an introduction into the San Francisco area.

DISTRIBUTION: Map 16; 20-T.

20g. RORIPPA PALUSTRIS (Linnaeus) Besser subsp. GLABRA (O. E. Schulz) Stuckey var. **fernaldiana** (Butters et Abbe) Stuckey, comb. nov.

Rorippa islandica (Oeder ex Murray) Borbás var. *fernaldiana* Butters et Abbe, Rhodora 42: 28. 1940. (Holotype: MAINE: [Aroostook Co.]: Wet places about the mouth of Aroostook River, Ft. Fairfield, 6 Jul 1893, *M. L. Fernald s.n.*, MIN. Isotype NEBC! Photo at MICH! OS!)

Rorippa palustris (Linnaeus) Besser var. *glabrata* (Lunell) Marie-Victorin f. *aquatica* Marie-Victorin, Contr. Inst. Bot. Univ. Montréal 17: 15. 1930. (Holotype: QUEBEC: Wet shores of Lake Champlain, Philipsburg, 10-11 Aug 1923, *C. H. Knowlton s.n.*, GH.)

Rorippa islandica (Oeder ex Murray) Borbás subsp. *fernaldiana* (Butters et Abbe) Hultén, Arkiv för Botanik 7: 61. 1968.

Rorippa palustris (Linnaeus) Besser subsp. *fernaldiana* (Butters et Abbe) Jonsell, Symb. Bot. Upsal. 19: 158. 1968.

ILLUSTRATIONS: Fassett (1940, p. 229, fig. 4); Fernald (1940, opposite p. 26, pl. 605, fig. 2) photograph of siliques; Fernald (1950, p. 715, fig. 1109), siliques; Gleason (1952, p. 239), as *R. islandica* and as var. *fernaldiana*; Gray (1849a, p. 132, pl. 53, fig. 1-5), flower parts; Hitchcock & Cronquist (1964, p. 538), as var. *glabrata;* Marie-Victorin (1930, p. 14, fig. 8), as *R. palustris* var. *glabrata*—probably drawn from one of the intermediates between var. *fernaldiana* and var. *glabrata*; Marie-Victorin (1947, p. 264), as *R. palustris* var. *glabrata*; Muenscher (1942, p. 272, fig. 50, E-F); Murley (1951, p. 72, fig. 20), seed; Pammel & King (1926, p. 166, fig. 90), photograph; Pammel & King (1926, p. 464, fig. 298), seed—poor!; Pammel, King & Hayden (1930, p. 158, fig. 1, p. 159, fig. 2, p. 160, fig. 3), photographs of rosette and plants; Steyermark (1963, p. 759, pl. 185, no. 5); Strausbaugh & Core (1953, p. 433), as *R. islandica*.

Variety *fernaldiana* is distinct with its short-cylindrical to ellipsoid siliques constricted at the center. Because of the constricted fruit, the replum has a concave margin and when dry becomes twisted. The expanded stigma is usually well developed. In the northern part of the range of var. *fernaldiana*, especially where it overlaps var. *hispida*, the lower stem and upper leaf surface are sparingly to quite hirsute. Southward in the United States, away from var. *hispida*, the leaves and stem tend to become glabrous. In this character there is apparent introgression between the varieties.

Early eastern North American literature did not distinguish between the European plant and the eastern North American segregates prior to Fernald (1928), Marie-Victorin (1930), and Butters and Abbe (1940). Thus there has been confusion between var. *palustris* and var. *fernaldiana*, not only as to distinguishing characters, but also which plants were native and which introduced. Britton (1891) wrote that var. *hispida* was common in eastern United States, and that "*N. palustre* is rarely met with and occurs only in situations where it has been introduced." Later, he (1901) wrote of *Roripa* [sic] *palustris*: "nearly throughout N. Am. . . Apparently nat. from Europe." He doubtlessly had plants of both var. *palustris* and var. *fernaldiana* in mind. There is no evidence that var. *fernaldiana*, although widespread and abundant in many artificially disturbed habitats in eastern North America, is introduced from Europe. According to Jonsell (in litt., 5 Oct 1964), var. *fernaldiana* has "never been reported from among European *R. islandica* [*R. palustris*]." Two very early specimens from western United States certainly suggest the plant was not introduced there from Europe or even from eastern United States: TEXAS: [Bexar Co.], San Antonio, Apr 1853, *G. Thurber s.n.* (NY, PH). WYOMING: [Converse Co.], mouth of Deer Creek, 26 Jul 1842, *Fremont s.n.* (NY). Furthermore, var. *fernaldiana* merges with var. *dictyota*, var. *glabra*, and var. *glabrata* in western Montana, and with var. *glabrata* in the St. Lawrence River valley. Variety *fernaldiana* may have originated out of the morphologically diverse complex in western Montana. With the Missouri and Platte rivers as avenues for migration, it moved east until now it is common in the Mississippi valley and the Great Lakes area, east to New England. This distribution appears to have come about by both natural and artificial means. There are many old (ca. 1830-1860) collections of this variety from eastern United States. In those days var. *fernaldiana* probably was confined to naturally disturbed areas about ponds and along rivers. However, with more man-created disturbed sites, this plant has very probably spread and become more abundant and aggressive in eastern United States. Pammel, King, and Hayden (1929, 1930) discussed the behavior and occurrence of this variety in Iowa grain fields. In a field study in the Douglas Lake region, of Michigan, I showed, by using a differential phytosociological table, that var. *fernaldiana* grows primarily with both introduced and native annual and introduced perennial plants in artificially disturbed habitats; in contrast, var. *hispida* grows almost entirely with native perennial plants in naturally disturbed habitats such as creek banks and sandy beaches (Stuckey, 1966a). This evidence suggests that man has aided in the spread (and perhaps the original introduction) of var. *fernaldiana* in the Douglas Lake region. Where var. *fernaldiana* is established in disturbed habitats where var. *hispida* grows, hybridization between the two occurs. This is discussed in the section on hybridization in *R. palustris*.

The disjunct distribution of var. *fernaldiana* in Florida leads me to suspect that the plants from the southern tip may represent introductions. Collections from Puerto Rico, Central America, and Colombia apparently are introductions, as they often are from roadsides, gardens, or along railroads.

DISTRIBUTION: Map 16; 20-U.

20h. RORIPPA PALUSTRIS (Linnaeus) Besser subsp. GLABRA (O. E. Schulz) Stuckey var. **glabrata** (Lunell) Stuckey, comb. nov.

Rorippa hispida (Desvaux) Britton var. *glabrata* Lunell, Bull. Leeds Herb. 2: 6. 1908. ("Stem creeping on the ground. Found near Dunseith, Rolette Co., N[orth] D[akota]." Butters and Abbe apparently selected a lectotype from Lunell's collections at MIN, Rhodora 42: t.588. 1940. Lectotype: NORTH DAKOTA: Benson Co.: Leeds, 1 Jul 1907, *J. Lunell s.n.*, MIN 496. Topotypes, Leeds, 1 Jul 1908 & 27 Jun 1909, both *J. Lunell s.n.*, NY!)

Rorippa palustris (Linnaeus) Besser var. *glabrata* (Lunell) Marie-Victorin, Contr. Inst. Bot. Univ. Montréal 17: 15. 1930.

Rorippa islandica (Oeder ex Murray) Borbás var. *glabrata* (Lunell) Butters et Abbe, Rhodora 42: 28. 1940.

ILLUSTRATIONS: Butters & Abbe (1940, opposite p. 25, pl. 588), photograph of lectotype; Hitchcock & Cronquist (1964, p. 538), as var. *occidentale*.

My interpretation of var. *glabrata* differs from that of Butters and Abbe (1940). They interpreted Lunell's var. *glabrata* as a nearly glabrous segregate of var. *hispida* and included in it Nelson's concept of var. *globosa* and also a specimen from Santa Fe, New Mexico (*Heller 3743*, MO, MSC, NY, OC, US). The New Mexico plant has hirsute lower leaf surfaces and so is var. *hispida*. Fernald (1940) argued he could not maintain var. *glabrata* separate from var. *hispida*; var. *glabrata* has not been used since.

Variety *glabrata* differs from var. *glabra* and Nelson's var. *globosa* in having longer and wider fruits, and leaves rather thick, glossy textured, and glabrous on the upper surface (except for sometimes being slightly hirsute on the midrib). The photograph of the apparent lectotype selected by Butters and Abbe and their descriptions of it closely resemble the topotypes I saw in NY.

Variety *glabrata* is found in western Montana, where the basal leaves are quite large and greatly dissected. The uppermost cauline leaves are oblong and mostly entire, a feature not met elsewhere in North American *R. palustris*. In eastern Canada, the basal leaves and lower cauline leaves are less divided, often being unlobed or sinuate and irregularly serrate. The uppermost cauline leaves here are more lanceolate and are serrate. Specimens from the St. Lawrence River valley have the trichome distribution, the more slender silique constricted at the center, and the concave replum of var. *fernaldiana*; and the unexpanded stigma, glossy thick-textured glabrous leaves, and somewhat longer fruits of var. *glabrata*. They are indicated by "half circles" on map 16. Marie-Victorin's (1930) concept of *R. palustris* var. *glabrata* was founded on these intermediate plants. He misinterpreted an isotype of Rydberg's *R. integra*, took up this epithet in varietal rank under *R. obtusa*, and applied this name to some of the St. Lawrence plants. Fernald (1950) then included Marie-Victorin's *R. obtusa* var. *integra* as a valid member of the eastern North American flora.

DISTRIBUTION: Map 16; 22-V.

20i. RORIPPA PALUSTRIS (Linnaeus) Besser subsp. GLABRA (O. E. Schulz) Stuckey var. **cernua** (Nuttall in Torrey et Gray) Stuckey, comb. nov.

Nasturtium cernuum Nuttall in Torrey et Gray, Fl. N. Am. 1: 74. 1838. ("Ponds of Wappatoo [Sauvies] Island at the junction of the Wahlamet [River] with the Oregon [River]." Holotype: OREGON: [Multnomah Co.]: Wappatoo Island, [ca. 1834, *fide* Pennell (Bartonia 18: 36. 1936), *Thomas Nuttall s.n.*], BM. Photo no. BM 2126, GH! PH! Isotype, PH! [The specimen was originally labeled "Nasturtium *cernuum N. amphibium affin."]

Variety *cernua* is very similar to var. *glabrata*, except that it is unique in its strongly recurved pedicels and very thick silique usually wider at the apex than the base. It occurs sparingly in northwestern United States and British Columbia but is more common in coastal Alaska, especially in the Aleutians. Collections from Banff, Alberta, and from Field, British Columbia, have siliques and basal leaves more nearly like those of var. *glabrata* of that region, but the pedicels are somewhat to rather strongly recurved. These collections are transitional between the varieties; they are designated as "open stars" on map 16. The var. *cernua* also intergrades with var. *clavata* in that some siliques, usually long for var. *cernua*, are quite clavate at the apex, and the pedicels are more nearly at right angles to the axis. A collection (*Anderson 6266*, PH) from Juneau, Alaska, represents this condition.

In a footnote in Watson's (1895) treatment of the genus, *N. cernuum* was cited as a synonym of *R. curvisiliqua*. All authors since have copied this error. That *N. cernuum* has recurved pedicels is evidence it does not belong to *R. curvisiliqua*, because the latter is one of the few species complexes in which such pedicels are not developed. Examination of both an isotype and a photograph of the holotype leaves no doubt that Nuttall described a plant with strongly recurved pedicels and a short thick fruit wider toward the apex. The type does differ somewhat from Alaskan specimens in having leaves more deeply divided and less thick; in these features it tends to approach var. *clavata*.

DISTRIBUTION: Map 16; 22-W.

20. iv. RORIPPA PALUSTRIS (Linnaeus) Besser subsp. HISPIDA (Desvaux) Jonsell, Symb. Bot. Upsal. 19: 159. 1968.

Brachilobus [sic] *hispidus* Desvaux, Jour. Bot. 3: 183. 1814. ("Hab[itat] in Pennsylvania. Je n'ai observé cette plante que dans l'herbier de M. de Beauvois." Type not seen.)

Sisymbrium hispidum (Desvaux) Poiret in Lamarck, Encyc. Suppl. 5: 161. 1817.

Nasturtium hispidum (Desvaux) A. P. DeCandolle, Syst. Nat. 2: 202. 1821.

Nasturtium palustre β *hispidum* Fischer et Meyer, Ind. Sem. Hort. Petrop. 3: 41. 1837. [Fischer et Meyer do not cite any author for their epithet. Presumably it is based on Desvaux.]

Nasturtium palustre ("Leysser" [Linnaeus]) A. P. DeCandolle var. *hispidum* (Desvaux) Gray, Man. ed. 2. 30. 1856.

Cardamine palustris ("Leysser" [Linnaeus]) O. Kuntze ζ *hispida* ("A. P. DeCandolle" [Desvaux]) "Fischer et Meyer" [O. Kuntze], Rev. Gen. 1: 25. 1891.

Roripa [sic] *hispida* (Desvaux) Britton, Mem. Torrey Club 5: 169. 1894.

Roripa [sic] *palustris* [(Linnaeus) Besser var.] *hispida* (Desvaux) Rydberg, Bot. Surv. Neb. 3: 26. 1894; reprint, Contr. U. S. Natl. Herb. 3: 149. 1895.

Nasturtium terrestre (Withering) R. Brown in Aiton var. *hispidum* (Fischer et Meyer) B. L. Robinson in Gray, Syn. Fl. N. Am. 1: 148. 1895.

Nasturtium palustre ("Leysser" [Linnaeus]) A. P. DeCandolle subsp. *hispidum* (Desvaux) "Fischer et Meyer" [O. E. Schulz], Symb. Antill. 3: 515. 1903.

Radicula hispida (Desvaux) Britton, Torreya 6: 30. 1906.

Radicula palustris (Pollich) Moench var. *hispida* (Desvaux) B. L. Robinson, Rhodora 10: 32. 1908.

Roripa [sic] *terrestris* ("R. Brown in Aiton" [Withering]) A. Nelson [var.] *hispida* (Desvaux) A. Nelson, Bot. Gaz. 52: 264. 1911.

Nasturtium hispidum (Desvaux) A. P. DeCandolle f. *genuinum* N. Busch, Fl. Sib. et Orient. Extr. 15: 207. 1915.

Rorippa palustris (Linnaeus) Besser var. *hispida* (Desvaux) Rydberg f. *inundata* Marie-Victorin, Contr. Inst. Bot. Univ. Montréal 17: 16. 1930. (Holotype: MAINE [Penobscot Co.]: Gravelly shores, Piscataquis River Valley, Foxcroft, 5 Sep 1894, *M. L. Fernald s.n.*, GH. Isotype, NEBC! Photo at MICH! OS!)

Rorippa islandica (Oeder ex Murray) Borbás var. *hispida* (Desvaux) Butters et Abbe, Rhodora 42: 26. 1940.

Plants stout, 4-10 dm. tall, stems thick, mostly over 3 mm. in diameter, densely to sparingly hirsute below, becoming sparingly hirsute to glabrous above; leaves hirsute on both surfaces; petals shorter or longer than the sepals; stigma usually unexpanded.

Key to Varieties of Subspecies hispida

1. Siliques globose to subglobose, (2.2)2.6-5(6.7) mm. long, 1.3-2.6(3.1) mm. wide, ca. 1-2 times as long as wide; replum circular to elliptic in outline;

petals 1-1.5(2) mm. long; pedicels 2.7-5.5(8.6) mm. long, usually divergent to ascending; stem usually densely hirsute below. . 20j. var. *hispida*

1. Siliques elongate-cylindrical, (3)5.2-7.8(8.5) mm. long, (1.4)2.1-3.1 mm. wide, ca. 2 or more times as long as wide; replum oblong in outline; petals 1.5-2(2.8) mm. long (if siliques less than 5 mm. long, then petals 1.7-2.5 mm. long); pedicels (3.8)4.2-7.8(12) mm. long, usually divergent to recurved; stem usually sparingly hirsute below. . 20k. var. *elongata*

20j. RORIPPA PALUSTRIS (Linnaeus) Besser subsp. HISPIDA (Desvaux) Jonsell var. HISPIDA

ILLUSTRATIONS: Abrams (1944, p. 281, fig. 2028); Britton & Brown (1897, p. 125, fig. 1718; 1913, p. 161, fig. 2031); Fassett (1940, p. 229, fig. 1, 3); Fernald (1940, opposite p. 261, pl. 605, fig. 4-8), photographs of siliques; Fernald (1950, p. 715, fig. 1110), siliques; Gleason (1952, p. 239), as var. *hispida*; Hitchcock & Cronquist (1964, p. 538), as var. *hispida*; Marie-Victorin (1947, p. 264), as var. *hispida*.

Globose to subglobose siliques, slender style with an unexpanded stigma in fruit, and the basal and cauline leaves hirsute on the lower surface distinguish var. *hispida*. In eastern United States, particularly Wisconsin and Michigan, the stigmas are often somewhat expanded in fruit, perhaps through introgression from var. *fernaldiana*. In the southern Rocky Mountains, where var. *hispida* grows in the absence of var. *fernaldiana*, the stigma is definitely unexpanded. I previously pointed out distinctions between the two varieties (Stuckey, 1966a).

Variety *hispida*, common in the Rocky Mountains, becomes scattered southward to Dona Ana County, New Mexico, and westward to northeastern California and southern Oregon. I have not seen specimens forming the basis for attributing this entity to Arizona (Kearney and Peebles, 1951) and to the Sonoran Desert (Shreve and Wiggins, 1964). In eastern United States, var. *hispida* is almost confined to north of the southern limit of Wisconsin glaciation. Contrary to eastern North American manuals (Fernald, 1950; Gleason, 1952), var. *hispida* does not grow as far south as Florida and Texas. It is evident, from Fernald's annotations on specimens at GH, he did not know the differences between var. *hispida* and var. *fernaldiana*. All specimens seen from Florida, Missouri, West Virginia, and Texas, misidentified as var. *hispida*, are var. *fernaldiana*. Steyermark's (1963) discussion and map of var. *hispida* and his specimens at MO labeled var. *hispida* should be referred to var. *fernaldiana*. The map of var. *hispida* in Patman and Iltis (1961) is correct except that vouchers for LaCrosse and Wood counties are var. *fernaldiana*, as are the vouchers for Clermont and Noble counties in Ohio on Easterly's map (1964). Records for West Virginia (Strausbaugh and Core, 1953) based on specimens at WVA are var. *fernaldiana*. I have not checked the vouchers for Deam's (1940) Indiana map and Jones and Fuller's (1955) Illinois records. These records are probably correct, although Deam lists a Coulter collection from Jefferson County, south of the glacial border. If correctly identified it may represent either a migrant from upstream on one of the tributaries of the Ohio River or an introduction.

DISTRIBUTION: Map 17.

20k. RORIPPA PALUSTRIS (Linnaeus) Besser subsp. HISPIDA (Desvaux) Jonsell var. **elongata** Stuckey, var. nov. (Holotype: MONTANA: Deer Lodge Co.: Locally common in wet field adjacent to creek bank and railroad track along U. S. highway 10, ca. 9 mi s of Deer Lodge, ca. 4700 ft [ca. 1410 m], 13 Jul 1963, *R. L. Stuckey 1882*, MICH! Fig. 7. Isotypes to be distributed.)

Herba annua erecta; siliquis elongato-cylindricis (3)5.2-7.8(8.5) mm. longis, (1.4)2.1-3.1 mm. latis; replis elongato-oblongis; petalis 1.5-2(2.8) mm. longis; pedicellis (3.8)4.2-7.8(12) mm. longis diversis vel recurvatis; caulibus infra vulgo sparse hirsutis.

ILLUSTRATION: Fig. 7.

Previous authors (Busch, 1915; Hultén, 1945) treated these plants under a combination of the name *hispida* based on Desvaux's type. It is evident from characters and measurements given by Rydberg (1922) and from his annotations on specimens at NY that he was using the name *Radicula pacifica* (Howell) Greene for these plants. Howell (1897) proposed the epithet *pacifica* to replace *occidentalis*, a name based on a type representing a different segregate in *R. palustris*, when he wanted to raise *occidentalis* to specific rank—thus avoiding creation of a later homonym of *Roripa* [sic] *occidentalis* (Greene) Greene.

Variety *elongata* is characterized by those plants from the Pacific coastal United States, across to Montana, North Dakota, and along the Gulf of the St. Lawrence. These have siliques over 6 mm. long, mostly equal to the length of the divergent to recurved pedicels. Included also are plants very similar in fruit size from northwestern Canada. In this area there also occur a few plants with siliques much shorter (down to 3 mm.). These short-fruited plants differ in several ways from var. *hispida*: the siliques are cylindrical rather than globose and are on much longer pedicels (ca. 6-12 mm. long, ca. 2-4 times as long as the siliques); and the petals are extremely long (ca. 1.7-2.5 mm.). They perhaps represent another segregate in *R. palustris* radiating from a center of diversity in Alaska or Asia. Until we know more about limits and total range of these variations in Alaska and eastern Asia, I have temporarily identified these short-fruited plants as var. *elongata*. Their localities are designated by "half-solid circles" on map 17.

Variety *hispida* occurs sparingly north to Alaska; var. *elongata*, sparingly south into the Rocky Mountains. These rare occurrences of one variety deep in the range of the other may be the result of unusual genetic combinations in the population, producing a plant with characteristics of the geographically distant variety.

Another problem is that several specimens, particularly those from areas where var. *williamsii* occurs in Alaska, have an expanded stigma. Throughout subsp. *hispida*, the stigma is unexpanded, except where influenced by hybridization and apparent introgression with var. *fernaldiana*. In Alaska,

Fig. 7. Photograph of a portion of the holotype of *Rorippa palustris* (Linnaeus) Besser subsp. *hispida* (Desvaux) Jonsell var. *elongata* Stuckey. (*R.L. Stuckey 1882*, MICH). Univ. Mich. Neg. No. 1885.

then, there may be hybridization or introgression between var. *elongata* and var. *williamsii.* Hultén (1945) cited three specimens he thought to be hybrids. I have not seen them. Based on evidence of hybridization in the eastern North American segregates of *R. palustris,* we might expect a hybrid plant to combine fruit characters of var. *williamsii* with trichome characters of var. *elongata.* Thus hirsute plants with an expanded stigma may very well be hybrids between these Alaskan inland segregates. That var. *williamsii* and var. *elongata* have similar-shaped fruits makes detection of hybrids more difficult than between taxa of different fruit types (e.g., var. *hispida* × var. *fernaldiana* or var. *hispida* × var. *palustris*). Some Alaskan plants I identified and mapped as var. *elongata* may represent hybrids. The following are examples of plants with expanded stigmas: ALASKA: *Hultén,* 20-22 Aug 1960, US; *Layden 24,* US; *Muller 1137, 1138,* US; *Raup 545,* US. YUKON: *Malte 35,* US. Only with many more specimens from areas where the two grow together and do not grow together, field work, and experimental crosses can this problem be attacked. Porsild (1951) wrote that "totally glabrous and moderately hispid plants may be seen growing side by side." We need population samples from these situations.

The occurrence of var. *elongata* in eastern North America requires discussion. Fernald (1940) reported, under the name *R. barbareaefolia,* two specimens from the Gulf of St. Lawrence that properly are var. *elongata.* He stated that this taxon was another one common to the floras of the Gulf of St. Lawrence and of the northern Pacific. I have seen duplicates of one of the collections he cited (*Marie-Victorin & Rolland-Germain 21439,* PH, US); Fernald correctly interpreted the plant as being like one of the *R. palustris* segregates of the Pacific Northwest. A collection of this variety from Labrador (*Waghorne 19,* US) matches perfectly a specimen from Washington, (*Sandberg & Leiberg 509,* US).

I grew plants of var. *hispida* from Michigan (including *Stuckey 1068*) and var. *elongata* from Montana (*Stuckey 1882*) under similar greenhouse conditions; characters distinguishing the two were maintained.

DISTRIBUTION: Map 17.

HYBRIDIZATION IN RORIPPA PALUSTRIS

From observation and experimentation on *R. palustris* var. *hispida* and var. *fernaldiana* grown at The University of Michigan Biological Station and at The University of Michigan Botanical Gardens in 1962, I determined that these varieties of *R. palustris* are self-pollinating and self-fertile. Seeds of var. *hispida* from Burt Lake, Cheboygan County, Michigan (*Stuckey 1068*) and seeds of var. *fernaldiana* from 4 miles north of Pellston, Emmet County, Michigan (*Stuckey 1099*) were planted in February 1963. By August the plants were in flower. I removed the anthers from several flower buds about to open on a plant of var. *hispida,* took off all other young buds and opened flowers, transferred pollen from var. *fernaldiana* to the stigmas of the emasculated flowers, and covered the inflorescence with a 4 × 10 cm. fine muslin bag fitted with a draw thread to keep out insects and foreign pollen. The bag was removed February 6, 1964; about 60 seeds had formed. These were planted in April 1964, and 35 young plants were grown until they flowered and fruited in summer 1964. All these F_1 hybrids were extremely hirsute on the lower stems, the lower leaf surface was hirsute, and the pedicels were ascending—distinguishing characters of var. *hispida*. The fruits were cylindrical and constricted at the middle, and the stigma, although less than in some plants of var. *fernaldiana*, was somewhat expanded—distinguishing characters of var. *fernaldiana*. The hybrid plants, self-fertile, set seed well.

Gleason (1952) pointed out that "numerous plants combine some degree of pubescence with cylindric fruit, or glabrous foliage with short ovoid fruits." I discussed plants of the latter type under var. *glabra*, but this variation has not been found in eastern North America. Plants of the former type are undoubtedly hybrids between var. *hispida* and var. *fernaldiana*. These specimens, with hirsute lower leaf surfaces and cylindrical fruits, occur only in eastern North America mostly north of the southern limit of Wisconsin glaciation (map 18), where both var. *hispida* and var. *fernaldiana* grow. Where var. *hispida* (in the Rocky Mountains) and var. *fernaldiana* (in southeastern United States and the lower Mississippi River valley) grow alone, pubescent plants with cylindrical fruits are not found. Because plants with the same character combination as the known hybrid occur only where both parents grow, a hybrid origin for these plants is almost certain.

Dr. James S. Pringle of the Royal Botanical Gardens, Hamilton, Ontario, called to my attention a population of extremely variable plants of the two varieties at Cornwall Lake, Cheboygan County, Michigan. Mr. Chester W. Laskowski made a mass collection from this population for me in summer 1964, and later (30 July 1964) we visited the lake and I obtained more specimens. Plants representing good var. *hispida* (*Stuckey 2382*) and good var. *fernaldiana* (*Stuckey 2383*) were abundant, but plants matching the artificial hybrid were also found (*Stuckey 2384*). Some plants, intermediate between parents and hybrid, indicated a hybrid swarm. On 4 August 1964, I found one plant (*Stuckey 2416*) at Duncan Bay, Cheboygan County, Michigan, like my artificial hybrid. It grew with var. *hispida* (*Stuckey 2415*) and var. *fernaldiana* (*Stuckey 2414*). From these observations, it appears that when the more aggressive and weedy var. *fernaldiana* reaches disturbed sites where var. *hispida* grows, hybrids may be formed.

In fall 1964 I planted seeds from the artificial hybrid and from collections *2416* and *2384*. Among the F_2 plants, 73 were from the artificial hybrid, 32 were from *2416*, and 36 were from *2384*. In the basal rosette stage, the lower leaf surfaces of some plants were glabrous, others were extremely hirsute, and still others possessed varying degrees of pubescence. The complete spectrum of variation was represented. Because these plants were grown in winter under short days when *Rorippa* does not flower, it was necessary to provide artificial light so they would receive at least 16 hours of light per day. Plants placed directly under the light produced well-formed inflorescences and fruits. Plants at some distance from it were stunted and "attempted" to flower and fruit—fruits were either poorly formed or not formed. Among plants receiving best direct light, fruit size and shape were extremely variable. The F_2 plants of each of the three hybrid groups possessed characters of good var. *hispida* through various intermediates to good var. *fernaldiana*. These plants were not further studied although vouchers exist (OS). These observations reveal that when offspring of two plants of suspected hybrid origin from different wild populations are grown, they form a series of variants similar to offspring of a known hybrid. Wild plants combining characters of both varieties are undoubtedly of hybrid origin.

Fernald (1948a) named a form (f. *reptabunda*) of *R. islandica* var. *microcarpa*. He used the epithet *microcarpa* in varietal rank for the plant previously described as var. *fernaldiana* (Butters and Abbe, 1940); later, he (1948b) corrected this error. I examined the type of this form at GH; it is a plant with hirsute lower leaf surfaces and cylindrical fruits with an expanded stigma. It is evidently of hybrid origin between var. *hispida* and var. *fernaldiana* and therefore should not be retained as a form of var. *fernaldiana* but designated a hybrid as follows: RORIPPA PALUSTRIS (Linnaeus) Besser subsp. HISPIDA (Desvaux) Jonsell var. HISPIDA × subsp. GLABRA (O. E. Schulz) Stuckey var. FERNALDIANA (Butters et Abbe) Stuckey, or designated as RORIPPA PALUSTRIS (Linnaeus) Besser var. × **reptabunda** (Fernald) Stuckey, hybr. var., comb. nov.

The synonymy is as follows:

Rorippa islandica (Oeder ex Murray) Borbás var. *microcarpa* (Regel) Fernald f. *reptabunda* Fernald, Rhodora 50: 35. 1948. (Holotype: NEW HAMPSHIRE: Coos Co.: Muddy shore of Nash Stream Bog, Odell, 27 Aug 1947, *A. S. Pease 33162*, GH! Isotype, US in part! Photo at MICH! OS!)

Rorippa islandica (Oeder ex Murray) Borbás var. *fernaldiana* Butters et Abbe *f. reptabunda* (Fernald) Fernald, Rhodora 50: 100. 1948.

Locations of hybrid plants are shown in map 18.

Where the ranges of var. *palustris* and var. *hispida* overlap in the Thunder Bay District, Ontario, a few plants combine the characters of the varieties. These plants have thin dissected leaves with purple cast and a slender purple stem—characters of var. *palustris*. The fruits are globose to subglobose (though sometimes stunted); the stigma is unexpanded; and the upper leaf surfaces are hirsute—characters of var. *hispida*. Because these plants combine characters of the varieties in a manner similar to that of the artificial hybrid var. *hispida* × var. *fernaldiana*, I conclude that they are also of hybrid origin: RORIPPA PALUSTRIS (Linnaeus) Besser subsp. PALUSTRIS var. PALUSTRIS × subsp. HISPIDA (Desvaux) Jonsell var. HISPIDA. Localities of these plants are shown in map 18.

A natural first generation hybrid has been reported between *R. palustris* ["*R. islandica*"] and *R. barbareifolia* (Mulligan & Porsild, 1968).

AN INTERPRETATION OF THE DISTRIBUTION OF RORIPPA PALUSTRIS

I have pointed out that there are areas in western United States where

Rorippa shows much morphological diversity, either within a species or among a group of closely related species. *Rorippa palustris* is morphologically diverse in the Rocky Mountains in western Montana, northern Idaho, southern British Columbia, and southern Alberta, and from there segregates radiate. However, this may not be the only center of diversity for *R. palustris*. Possible centers are in Alaska or elsewhere in the Bering Sea region and in Asia (see Butters and Abbe, 1940, p. 29, who comment that fruit distinctions break down in a region between Lake Baikal and the Pacific). The nature and location of such possible centers can hardly be discussed because I have not seen enough material and have not had field experience there. Because *R. palustris* is widespread throughout boreal regions, its distribution has doubtless been modified by glaciation, which may have obliterated any previous center or centers. The centers today may merely be subcenters which were survivia for various segregates during maximum glaciation; from these, northern North America may have been repopulated. However, I think that the Rocky Mountain center of northern United States may be an original one. My reasons follow.

(1) This center has contributed segregates that migrated into and populated areas far south of the southern limits of glaciation. These areas may have become populated when certain segregates in related species were invading and becoming established. A center in Asia or Alaska, more distant, would be less likely to contribute segregates to these areas.

(2) In the northern Rockies of the United States and southern Canada, nearly all the character combinations and therefore nearly all the taxonomic entities in North American *Rorippa* are found, as are plants morphologically intermediate and unassignable to any taxon (e.g., MONTANA: Sanders Co., Noxon, *Stuckey 1897*, MICH).

(3) That only one segregate is known in western Europe points to an origin elsewhere. The var. *palustris* of Europe is entirely different from other *Rorippa* of that region. A winter annual, it grows singly from a taproot, has petals shorter than the sepals, and has short globose anthers; whereas other species (except *R. islandica*) of western Europe, *R. amphibia*, *R. sylvestris*, and *R. prostrata*, are perennial, spread by roots and stems, have petals longer than the sepals, and have elongate anthers. From what we know about evolution in these characters in North American *Rorippa*, these European species are very different and probably represent another line of evolution. Therefore the origin of European var. *palustris* ought to be looked for in North America. One specimen of var. *palustris* is known from the Rocky Mountain center of diversity.

(4) Plants most similar morphologically to *R. palustris* or, in other words (based on the reasoning throughout this paper), its closest relatives, are in the mountains of western United States. *Rorippa curvipes* var. *integra* is most similar to *R. palustris*, and this variety is also very close to *R. curvisiliqua*. Thus the three well-developed centers of diversity in western United States are linked together morphologically by a taxon lying geographically among them.

(5) This Rocky Mountain center of diversity, geologically old, has been available for plants for millions of years. There have been sufficient time and available space for the segregates to come into existence. This area, at the southern limit of the continental ice sheet, was partially unglaciated, thereby providing a survivium for plants during the unfavorable eras of glaciation.

(6) The general drainage pattern is outward and away from this center of diversity. Thus an ideal avenue for migration does exist and has probably been a factor in producing the distribution patterns of today, not only in *R. palustris* but also in the varieties of *R. curvisiliqua* and members of the *R. curvipes* complex. In *R. palustris*, for example, the Columbia River has aided the westward spread of var. *dictyota* and var. *cernua*; the Missouri and its tributaries and then eventually the Mississippi have aided the eastward and southward spread of var. *fernaldiana*. The Saskatchewan River has doubtless aided the eastward movement of var. *palustris* and probably var. *glabrata*.

Whereas it seems probable that the segregates in western United States and var. *fernaldiana* in southeastern United States may have spread from the Rocky Mountain center at an early time, the segregates to the north were apparently influenced by glaciation, and this event has had a marked effect on distribution of these segregates. A plausible explanation for distribution patterns of the northern segregates as related to glaciation was advanced by Hultén (1937).

Upon mapping and comparing distributions of plants of northeastern Asia and northwestern North America, Hultén (p. 25) found several centers of distribution there. One of his centers in North America is in the state of Washington—nearly coincident with two centers of diversity in *Rorippa*. His centers coincide with areas totally or partially unglaciated; he found no centers in northern Europe, western Siberia, northeastern America, or between the Yukon valley and the Great Lakes—glaciated areas. According to Hultén, apparently no plants spread from these latter regions, which were covered with ice during maximum Pleistocene glaciation, but rather the plants spread over arctic and boreal regions from centers or refugia [survivia] close to the ice, where they possessed a small part of their earlier area and survived the severe conditions of maximum glaciation (p. 25).

With respect to boreal circumpolar plants, among which he included *Rorippa palustris* (*Nasturtium palustre*), Hultén assumed that the plants "already occupied at least the greater part of their present area earlier than the maximum glaciation and that this old area was split up into parts separated from one another by heavy glaciation or by districts with such severe climatic conditions during maximum glaciation that the species concerned were exterminated there" (p. 42). Boreal circumpolar plants "were so sensitive to cold that they were able to survive chiefly on the refugia [survivia] south of the ice" (p. 118). "Different races of a species must have been formed under the influence of the ice" (p. 47). Thus, great diversity of races or segregates in boreal circumpolar plants is natural because the glaciated area was filled by radiants from centers isolated from remnants of the old area; from these centers different races or segregates spread, completely or partially filling the gap between the centers. Hultén outlined on a northern hemisphere map the major elementary areas or refugia [survivia] (p. 119, fig. 11). These refugia [survivia] corresponded, at least in part, to the centers he had found and which were referred to earlier. In North America, Hultén had refugia [survivia] in the Aleutian Islands and southern coast of Alaska, the Rocky Mountains of northern United States and western Canada, the Great Lakes region, and around the mouth of the St. Lawrence River.

In using Hulten's hypothesis, one assumes that the species had a distribution throughout boreal North America before the last ice age. We may, indeed, infer from present distribution of subspecies *hispida* that *R. palustris*, at least in part, was widespread throughout boreal America before glaciation (subspecies *hispida* is found today on unglaciated areas in eastern and western North America; between these areas, it is virtually confined to glaciated territory). *Rorippa palustris* is tremendously variable in the Rocky Mountains of northern United States and southern Canada. This region of diversity corresponds to one of Hultén's elementary areas, and we may conclude that in it various segregates of North American *R. palustris* lived during glaciation as the surviving segregates of more widespread pre-glacial populations. Very possibly, new segregates arose through hybridization in the same area and habitats. Although portions of the Rocky Mountains were doubtless glaciated during Wisconsin glaciation, Hultén says that "glaciation was not heavy, and many plants were able to survive there" (p. 52).

What did *R. palustris* do during retreats of the continental glaciers? I would regard it as a "plastic species" (Hultén's term); many of its segregates would move outward from their center, filling available habitats. Thus in each area, natural selection apparently operated so that each segregate was able to migrate, colonize, and survive further outward from the center without the immediate influence of other biotypes. The ultimate, of course, is the present distribution of *R. palustris* in boreal North America.

On the whole, *Rorippa* is a genus of pioneer plants, often the first to colonize a low, wet, denuded area. In northern Ohio and Michigan var. *fernaldiana* is one of the first plants to colonize the edge of a new farm pond or cleaned-out drainage and roadside ditches. Quite common during the first couple of years in these habitats, var. *fernaldiana* is soon crowded out and eventually disappears. *Rorippa* seeds germinate most readily in moist, open, warm places. Rosettes and plants are usually not found in shaded areas or where vegetation is dense. The plants apparently do not compete well. Although such observations have been made mostly on var. *fernaldiana*, the same biological processes appear at work in other segregates of *R. palustris* as well as in other species of the genus (see also Jonsell, 1968, p. 3).

At the time of Wisconsin glacial retreat, streams and rivers were either enlarged or formed anew as the meltwater became abundant. Moraines and alluvial deposits dotted the landscape, but the soils were bare. Stranded bodies of water formed lakes. A perfect avenue for migration and colonization by pioneer plants had been created. Adjacent to these newly exposed areas were the survivia with the various segregates. *Rorippa palustris* was one of those species with many segregates. A short-lived pioneer plant, it doubtless spread rapidly as seeds, carried by wind and water to the fresh barren soils, germinated, and probably grew in abundance. The var. *hispida*, one of those segregates surviving glaciation in the Rocky Mountains, was extremely successful when its offspring began to colonize areas left newly vacant. Migration was probably outward through the region of the present upper Missouri River. That var. *hispida* is not found south of the southern limit of Wisconsin glaciation in central United States may in part be explained by saying that the area was already populated with plants, and habitats void of vegetation were few, much as they are today—mainly river banks and pond shores. Thus natural migration of a species poorly equipped to compete would be quite slow or non-existent through this region. The result is that var. *hispida* has penetrated only into Nebraska from the Rocky Mountains.

In glaciated territory, var. *hispida* had a nearly continuous avenue of exposed soil to colonize, and it was able to migrate across the continent from west to east. At the same time, other plants moved into the area and competition began and continued as part of succession. Higher lands were ultimately drained and much of the landscape became drier. The result was that var. *hispida*, no longer able to compete, died out in many places within its range, but it survives where soil is constantly being shifted and exposed, naturally-disturbed habitats where plants have difficulty in gaining a permanent foothold. In these habitats north of the southern limit of Wisconsin glaciation var. *hispida* survives—the last remnants of what must have been a much more abundant plant thousands of years ago. Today, var. *hispida* occasionally gets out of its natural habitat in eastern North America, probably with the help of man or other agents, and may be found in artificially disturbed sites.

Many collections of var. *hispida* from the Delaware River valley come from ballast or waste places; var. *hispida* may have been introduced there by migrating from the north. On the other hand, var. *hispida* was found in the mountains of eastern Pennsylvania at an early date when there was less disturbance and fewer chances for introduction, and it is certainly possible that it survived Wisconsin glaciation in the Appalachian Mountains or on the Atlantic Coastal Plain. Although it has been found in the Washington, D. C., area, it seems absent in other coastal areas in New Jersey, Delaware, and Maryland. If var. *hispida* survived in both eastern and western North America, it has remained essentially unchanged as I can find no differences between plants from the two areas except that some Colorado plants have slightly longer siliques. From a survivium in the Appalachians, it could have spread northward and westward. The occurrence of var. *hispida* south of the glacial boundary in Ohio and possibly Indiana (Deam, 1940, P. 495 map 1017) has apparently come about by migration of plants down river.

Variety *fernaldiana* would have survived glaciation in southeastern United States as well as in the Rocky Mountains. Upon the retreat of the Wisconsin glacier, plants of var. *fernaldiana* from these regions would have migrated onto territory once glaciated. Apparently in the glaciated region var. *hispida* and var. *fernaldiana* have been segregated ecologically and reproductively because they remain distinct. With the advent of European man in glaciated country, there were more disturbed habitats and more opportunity for the varieties to associate. Where the two occur together, hybrid plants are sometimes found, as discussed earlier and in Stuckey (1966a).

Since I wrote my thesis in 1965, Iltis (1965) discussed the idea of a western (Cordilleran) species migrating east onto glaciated territory and a southern (Appalachian) species migrating north onto it after the retreat of the Wisconsin glacier. He pointed out that a similar phenomenon has apparently occurred in *Gentianopsis* and other genera with east-west species pairs.

To return to the Rocky Mountain center of diversity, we can infer that var. *elongata* migrated west to the Pacific Coast in the United States and east at least to North Dakota. Variety *elongata* also occurs along the northeastern shore of the Gulf of St. Lawrence and on the Labrador coast. Fernald (1925) and Marie-Victorin (1938) would explain this disjunction by saying that before or during one of the interglacials, var. *elongata* had a continuous and uniform distribution from western to eastern North America, but it was obliterated by Wisconsin glaciation, surviving in the Rocky Mountains and on the limestone shelf that formerly existed, at least in part, along the north shore of the Gulf of St. Lawrence. Marie-Victorin (1938, p. 543) goes into some detail to explain his idea of the apparent habitats and conditions allowing these plants to survive. Marie-Victorin's idea is questionable on geological grounds, and some alternative ideas, particularly that of Wynne-Edwards (1937), who correlates distributions of this type with soil conditions, may bear further consideration.

One idea that Marie-Victorin (1938, p. 554) proposed, apparently in a passing reference, to explain the distribution of certain plants, particularly shore plants found in the Rocky Mountains and in isolated places on the northeast coast of the Gulf of St. Lawrence, was that these plants may have migrated along a "kind of side-walk." He wrote:

> But we can not round out all the facts without admitting more or less intricate and massive Pleistocene or post-Pleistocene migrations. Picturing the . . . unforested belt that must have existed along a receding ice-front, as a kind of side-walk extending from the Rockies to the Gulf of St. Lawrence, undoubtedly helps understand the presence of a good number of sea-level and highly isolated plants, of evident Cordilleran affinity.

I have not found anywhere that Marie-Victorin expanded upon this statement, but I think the west to east migration of var. *hispida* provides a good example of what he had in mind, and that var. *elongata* may have had a similar history.

Whether plants with similar distribution patterns have actually had a similar distributional history can be debated, especially if the plants belong to different ecological situations, vegetational types, or habitats. In my field work I noted several species that often grow with var. *hispida* on lake sandy shores. These associates often have a similar distribution pattern, although data are sometimes not complete or available. It seems that plants of similar habitats, ecological requirements, and distributions may likely have a similar distributional history. Study of the ecological requirements of these species may provide information to support the "side-walk hypothesis." The following show distributions or are believed to show distributions parallel to var. *hispida*, with which they have been found growing: *Juncus arcticus* subsp. *littoralis* [*Juncus balticus* var. *littoralis*] (E. Hultén, Sv. Vet-akad. Handl. IV. 8(5): 25. 1962); *J. alpinus* (E. Hultén, *ibid.*: 97. 1962); *Lycopus uniflorus* (N. C. Henderson, Am. Midl. Nat. 68: 108. 1962); and *Scirpus americanus*, *Potentilla anserina*, and *Solidago graminifolia* (no maps of their total distribution have been seen). These may be expected to occur with var. *hispida*: *Equisetum palustre*, *Carex viridula*, *C. aquatilis* subsp. *altior*, *C. diandra*, *Hierochloe odorata*, *Beckmannia eruciformis* [*B. syzigachne*] (E. Hultén, Sv. Vet-akad. Handl. IV. 8(5): 99, 171, 75, 129, 115, 173. 1962); *Lycopus asper* (N. C. Henderson, Am. Midl. Nat. 68: 127. 1962); and *Sagittaria cuneata* (C. Bogin, Mem. N. Y. Bot. Gard. 9: 226. 1955). A few strictly aquatic plants of similar distribution are: *Potamogeton zosteriformis*, *P. friesii*, *P. strictifolius* (M. L. Fernald, Mem. Am. Acad. 17: 37, 53, 56 and 58. 1932); and *P. natans*, *P. gramineus* var. *gramineus*, *P. praelongus*, and *P. richardsonii* (E. C. Ogden, Rhodora 45: 127, 147, 175. 1943).

Applying Hultén's (1937) idea to subsp. *palustris*, we would assume this taxon probably had a wide range in northern North America and eventually even found its way to Europe. The ice obliterated this earlier distribution in North America. One element survived in the Rocky Mountains. After the ice retreated, this element (var. *palustris*) then spread to eastern Canada and northeastern United States, but probably no farther south than New York. Another element survived in unglaciated Alaska. After the ice retreated, this element (var. *williamsii*) moved onto the glaciated area in northern Alaska, Yukon, and east to Churchill, Manitoba. Hultén included var. *williamsii* (*Nasturtium williamsii*) in a group of Northern Beringia radiants. He wrote that practically all species of this group are confined to Alaska and are only slightly differentiated. These are doubtless young species and must be expected to have become differentiated from isolated partial areas of widespread species, probably during the last interglacial (p. 54). We may then suspect that subsp. *palustris* was more uniform morphologically when it was widespread, but since it was split by the glacier, slight changes have occurred. Because var. *palustris* is in both Europe and America, it has the widest range, and has probably existed longer—it may represent the basic kind. The var. *williamsii*, being the younger, may have undergone slight morphological changes, and such differences are shown in the leaf and silique apices—characters now making this distinct from var.

palustris. Plants intermediate between the two varieties, to be expected in northern Canada, are not yet known.

Previously I mentioned that var. *cernua* probably spread onto the Alaskan coast from the Rocky Mountain center of diversity because plants are found in the latter area that are morphologically intermediate between it and var. *glabrata*. This migration has been implied as shown in map 20-W. I also pointed out that there is evidence for a center of diversity in Alaska. In the Aleutian Islands and the Alaskan Peninsula, one of Hultén's refugia [survivia], plants of *R. palustris* are found with nearly all the character combinations known for the Alaskan plants. Thus, it may have been from this subcenter that var. *clavata* and both the short- and elongate-cylindrical fruited members of var. *elongata* in Alaska radiated. I also commented that var. *occidentalis* in Alaska is morphologically somewhat different from the conterminous United States plants. Perhaps these represent segregates that, once connected with the Rocky Mountain center of diversity, were cut off by glaciation and have since further diverged morphologically. One major problem is that I saw virtually no material from British Columbia and thus do not know the situation today in that important region. The taxonomy and probable history of *R. palustris* in British Columbia, Alaska, and Asia definitely need further study.

Hultén (1937, p. 47) has further remarked that:

> The splitting up of the earlier areas by ice . . . must have had a very important influence on the number and character of the biotypes [segregates] remaining within the different elementary areas [survivia] . . . It is evident that the selection of biotypes within the northern elementary areas [e.g., Alaska] must be different from that within the southern [e.g., Rocky Mountains]. When the ice recedes and the plants start to migrate from the isolated spots where they were left, the populations in the different elementary areas must differ in their composition. At any rate those to the north must differ considerably from the original populations which had occupied the same stations during the preceding interglacial. In other words: different races [segregates] of the species must have been formed under the influence of the ice. As long as those races are separated from one another geographically they may possibly be distinguishable, but when the migration has proceeded so far that the radiants from two elementary areas meet, hybridization and thereby an intergradation of the differences must be expected to occur. It is presumed that plant populations from different parts of the old area, isolated in Asia and in America by the extermination of the northern part of their distributional arc, will not be exactly alike in biotypes and variation.

This statement very well summarizes the distributional phenomenon that has occurred in northern *R. palustris* since Wisconsin glaciation, and thereby provides some explanation for the numerous segregates in this species complex.

Examination of the maps of *R. palustris* reveals that outside the Rocky Mountain center of diversity, no more than two subspecies share the same area, except in eastern North America where subspecies *hispida, glabra,* and *palustris* occur. This situation can be explained in part by the fact that in coastal eastern United States (at least south of New York), var. *palustris* is believed introduced from Europe. In certain North American areas where each subspecies grows by itself, each is distinct and the characters distinguishing it are best defined (e.g., an unexpanded stigma in var. *hispida* is best developed in the Rocky Mountains of Colorado and New Mexico; an expanded stigma in var. *fernaldiana,* south of the southern limit of Wisconsin glaciation). Further, each variety of any particular subspecies also grows by itself (except that some varieties west of the Continental Divide may not grow alone). However, mountains and river valleys are quite numerous, and therefore more isolation of a local nature can be found. For example, comparison of map 15 with map 17 suggests that var. *elongata* may grow with var. *clavata.* Yet var. *elongata* is more coastal in distribution and has never been found along the Columbia River where var. *clavata* is well developed. The range of var. *palustris* overlaps that of other varieties in North America, but this variety grows by itself in Europe. Where ranges of two varieties of a subspecies meet, there are plants morphologically intermediate between the varieties. A good example of this phenomenon occurs in the St. Lawrence River valley, where plants are transitional between var. *fernaldiana* and var. *glabrata* of subsp. *glabra,* but plants that are pure var. *fernaldiana* or pure var. *glabrata* are not known to me from that area. Similarly, specimens from coastal California somewhat combine characters of var. *occidentalis* and var. *clavata,* although I included them under var. *occidentalis.* In these situations there appears to be considerable gene flow among plants of varieties within the subspecies.

A more rigorous genetic barrier seems to exist between subspecies. Only where plants of two different subspecies grow together are there found hybrids. I have shown that var. *hispida* of subsp. *hispida* can be hybridized with var. *fernaldiana* of subsp. *glabra* to produce a plant combining the characters of these subspecies. Herbarium specimens having characters of both subspecies have been collected only where the subspecies grow together. Plants combining the characters of subsp. *hispida* var. *hispida* and subsp. *palustris* var. *palustris* have been found where the ranges of these subspecies overlap. Because of the complexity of *R. palustris,* I use the categories of both subspecies and variety. Therefore, based on present data, one of the major differences between a subspecies and a variety is that in a subspecies, hybridization may produce a plant with the distinguishing characters of both subspecies; whereas differences between varieties of a subspecies appear to be of a clinal or transitional nature. The geographical pattern of this species complex suggests that the taxonomic hierarchy has validity. Experimental work would be desirable.

21. RORIPPA BARBAREIFOLIA (A. P. DeCandolle) Kitagawa, Jour. Jap. Bot. 13: 137. 1937. [orthographic correction by Kitagawa, cf. Art. 73].

Camelina barbareaefolia A. P. DeCandolle, Syst. Nat. 2: 517. 1821. ("Hab[itat] in Sibiriae orientalis provinciâ prope Doroninsk (Vlassov). [Perennial] (v.s.sp. comm. à cl. Fischer.") Holotype: Doroninsk Vlass[ov], 1819, *Mr. Fischer s.n.*, G-DC. Microfiche 1:201.5, card no. 101, MICH!; Delessert, Ic. Sel. Pl. 2: t.70. 1823.)

Tetrapoma barbareaefolium (A. P. DeCandolle) Turczaninow ex Fischer et Meyer, Ind. Sem. Hort. Petrop. 1: 39. 1835; Linnaea Litt.—Ber. 10: 104. 1836; Turczaninow, Fl. Baicalensi-Dahurica 147. 1842; Bull. Soc. Nat. Mosc. 15: 265. 1842.

Tetrapoma kruhsianum Fischer et Meyer, Ind. Sem. Hort. Petrop. 1: 39. 1835; *Tetrapoma krusianum* [sic] Fischer et Meyer, Linnaea Litt.-Ber. 10: 104. 1836. ("Hab[itat] in Sibiria orientali prope Ischiginsk." Type not seen.)

Tetrapoma pyriforme Seemann, Bot. Voy. Herald 24, t.2. 1852. [New name proposed for *Camelina barbareaefolia* A. P. DeCandolle]

Cardamine palustris ("Leysser" [Linnaeus]) O. Kuntze ε *normalis* O. Kuntze 3. *barbareaefolia* (A. P. DeCandolle) O. Kuntze, Rev. Gen. 1: 25. 1891.

Nasturtium barbareaefolium ("Turczaninow" [A. P. DeCandolle]) Fedtschenko, Acta Horti Petrop. 31: 7, 142. 1912. Non Baker 1877. Non Franchet 1888.

Nasturtium hispidum (Desvaux) A. P. DeCandolle f. *tetrapoma* (Turczaninow ex Fischer et Meyer) N. Busch, Fl. Sib. et Orient. Extr. 15: 207. 1915.

Radicula barbaraefolia [sic] (A. P. DeCandolle) Wight ex P. S. Smith, U. S. Geol. Surv. Bull. 655: 44. 1917.

Rorippa barbareaefolia (A. P. DeCandolle) Porsild, Rhodora 41: 232. 1939. [Intended new combination antedated by Kitagawa (1937)]

Rorippa hispida (Desvaux) Britton var. *barbareaefolia* (A. P. DeCandolle) Hultén, Fl. Alaska & Yukon 5: (Lunds Univ. Arssk. II. Sect. 2. 41:) 829. 1945.

Winter annual; stems 3-7(9) dm. tall, erect, single or much branched from the base, densely villous below, moderately villous to glabrous above; basal and cauline leaves sessile, slightly to strongly auriculate, clasping to non-clasping, oblong, narrowly oblanceolate or lanceolate, 2.5-10(15) cm. long, 0.4-1.5(2) cm. wide, both surfaces densely to sparingly villous to hirsute, the margin entire, irregularly serrate, lacinate-divided or repand, tapering to cuneate at the base, the apex acute; racemes terminal and axillary, 1-2 dm. long, forming after stem elongation, the oldest siliques therefore on the lower portion of the terminal raceme; pedicels (5)8-13.5 mm. long, ascending, densely to sparingly hirsute or glabrous, ca. 1.5-3 times as long as the siliques; sepals ovate to oblong, 1.7-2.7 mm. long, 0.6-1.3 mm. wide, flat, caducous in fruit; petals obovate to broadly spatulate, 1.8-3.5 mm. long, 0.8-2 mm. wide, slightly shorter than, equal to, or slightly longer than the sepals; siliques globose, subglobose, or pyriform, (3.2)4-5.7 mm. long, (2.3)2.7-4.1 mm. wide, ca. 1-2 times as long as wide, the valves 4, rarely up to 6, smooth, glabrous; replum circular to elliptic in outline, the margin convex and glabrous; style 0.6-1.4 mm. long, thick, ca. 0.5-1 mm. wide in fruit, straight throughout, abruptly attached to the rounded silique apex; stigma unexpanded; seeds oblong, ca. 0.5-0.7 mm. long, ca. 60-80 per silique, dark reddish brown, finely reticulate-foveolate; flowering and fruiting June-August.

ILLUSTRATIONS: Anderson (1959, p. 275, fig. 537), silique; Busch 1915, p. 208), as *N. hispidum* f. *tetrapoma*; Delessert (Ic. Sel. Pl. 2: t. 70. 1823); Fernald (1940, opposite p. 261, pl. 605, fig. 9), photograph; Seemann (1852, pl. 2), as *T. pyriforme*.

Rorippa barbareifolia is unique in having short, globose to pyriform, 4-valved, but sometimes 3-6-parted, siliques dehiscent at the apex. The anthers, unlike those in other species of section *Rorippa*, are elongate (3 times as long as wide), much like those of *Sinuatae*. The trichomes are usually extremely numerous on the stem, which is quite villous below. A short, thick style with an unexpanded stigma and quite long, stout, ascending pedicels are further distinctions. Specimens from the eastern Pacific coast of Alaska at Yes Bay (*Gorman 169*, US; *202*, ND-G 5139, NY, US; *Howell 1607*, MO, ND-G 5138, NY, US) and from Deer Mountain, Ketchikan (*Walker 985*, NY, US) approach *R. barbareifolia* very closely in having nearly all siliques 4-parted; however the fruits are mostly elongate-cylindrical, mostly over 6 mm. long, and the stem trichomes are very sparse. These plants have been referred to and mapped as R. *palustris* subsp. *hispida* var. *elongata*. Some fruits on specimens of var. *elongata* from the Pacific coast states of the United States are 4-valved, and in each variety of the *R. palustris* complex, occasional siliques not bivalved can be found. These occur most frequently in *R. palustris* subsp. *hispida* and subsp. *occidentalis*, rarely in subsp. *glabra* and subsp. *palustris*. In specimens of var. *elongata* from central Alaska, where *R. barbareifolia* grows, non-bivalved siliques do not occur. There appears to be no intergradation of *R. barbareifolia* with the varieties of *R. palustris* in that region. Morphologically, *R. barbareifolia* is most closely related to var. *elongata*, and it probably arose out of the variable *R. palustris* complex of the Pacific northwest of the United States via var. *elongata*.

On the basis of the globose fruits, DeCandolle (1821) first described this species in *Camelina*, but Fischer and Meyer (1835) transferred it to their new genus *Tetrapoma* because of the 4-valved siliques. Seemann (1852) could find no differences in fruit shape and style length among the plants; he further confused the situation by providing an unnecessary new name. More recently Hultén (1945) treated it as a variety of *R. hispida*, suggesting close alliance with the *R. palustris* complex.

Several *nomina nuda* have been published. They are as follows: (1). *Tetracellion ellipsoideum* Hort. Turczaninow ex Fischer et Meyer, Ind. Sem.

Hort. Petrop. 1: 39. 1835, pro syn. under *Tetrapoma barbareafolium* (A. P. DeCandolle) Turczaninow ex Fischer et Meyer. ("Hab[itat] in Dahuria."); (2). *Tetracellion ellipsoideum* Turczaninow *pl. exs. 1832.* in Flora Baicalensi-Dahurica 147. 1842; Bull. Soc. Nat. Mosc. 15: 265. 1842, both pro syn. under *Tetrapoma barbareaefolium* (A. P. DeCandolle) Turczaninow ex Fischer et Meyer; (3). *Tetracellium ellipsoideum* (Turczaninow) Steudel, Nom. Bot. 2: 669. 1841. [Steudel changed the spelling of *Tetracellion* to *Tetracellium*.]; (4). *Tetrapoma crusianum* ("Turczaninow" [Fischer et Meyer]) Walpers, Rep. 1: 154. 1842. [Walpers changed the spelling of the epithet *kruhsianum*.]; (5). *Tetrapoma sphaeroideum* Turczaninow *exs. 1834.* in N. Busch, Fl. Sib. et Orient. Extr. 15: 207. 1915. nom. nud., pro. syn.

DISTRIBUTION: Map 19. SIBERIA: Busch (1915, p. 209), as *N. hispidum* f. *tetrapoma*.

In North America, *R. barbareifolia* is virtually confined to central unglaciated Alaska. Seemann (1852) wrote: "The native country of the plant I believe to be Northern Asia. It has been found between Aldan and Ochotsk (*Turczaninow*), at Isinga, at Koragisk, and by me in Norton Sound [Alaska], where I have reason to believe it has been brought by the Russians, but where it is now perfectly wild." Rothrock (1868) agreed, on the basis that the plant had not been found elsewhere in North America; and so did Turner (1886), who copied from Rothrock.

Rorippa barbareifolia grows in alluvial sandy clay soil at recently disturbed sites along roadsides, burned-over spruce woods, gravel pits, and around dumps—habitats often harboring weedy plants introduced from other regions. However, I find a specimen collected in interior Alaska at Fort Youcon [sic] in 1866 by Ketchum (*s.n.*, NY). Although Fort Yukon was an important early trading center, it seems unlikely that a plant of Asia would have been introduced to interior Alaska at such an early date.

The reports of this species being introduced were written when central Alaska was virtually botanically unknown. With more collections available, with a distribution pattern that correlates with glaciation, and with a close morphological relationship to the North American *R. palustris* complex, *R. barbareifolia* certainly seems indigenous to Alaska.

Porsild (1939, p. 233) pointed out that *R. barbareifolia* forms an abundance of small light seed suitable for wind dispersal. The seeds germinate primarily on fresh mining dumps where there is no competition with the weedy perennials that in several years succeed *R. barbareifolia*. Further, he pointed out that *R. barbareifolia* "is not uncommon in suitable places in the Norton Sd. and Kotzebue Sd. regions, far from past and present human habitation. While it might perhaps have been introduced at St. Michaels, the species, no doubt, is indigenous to Alaska."

With respect to its possible relationship to glaciation, we can say that if *R. barbareifolia* were common elsewhere in areas where collectors have been (especially along the coast) it would likely have been found by now. Therefore, it must be absent (or very rare) on glaciated territory. Porsild (1951), who did extensive field work in southeastern Yukon, did not see specimens of this taxon. If we compare the distribution of *R. barbareifolia* in Siberia (Busch, 1915) with a map showing the glacial boundary in Siberia (Hultén, 1937), we find that *R. barbareifolia* in Siberia is also virtually confined to unglaciated territory except where it has apparently migrated northward along rivers into the glaciated region.

Three collections of *R. barbareifolia* need some comment. (1) The specimen from British Columbia (*Shetler & Stone 3054*, MICH) is clearly out of range. It was collected in the vicinity of the Alaska Highway, perhaps introduced there in recent years. (2) C. L. York's collection (*389*) at MO is labeled as coming from the Anchorage area. I did not map this locality because of the questionable label data. York used a printed label "Plants of the Anchorage Area," and his specimen of *R. palustris* subsp. *hispida* var. *elongata* (MO) has the typewritten datum "McKinley National Park." Since McKinley Park is some 150 miles north of Anchorage, there is contradiction here. His specimen of *R. barbareifolia*, a species known to grow in the McKinley Park area, contains no additional locality data. With this brief evidence, there seems to be a possibility of mixed labels or specimens. (3) Hultén (1945, p. 829) reports a collection from "Valdez Puer 7550a (H)," a locality along the central Pacific Alaskan coast on glaciated territory. It seems doubtful that he would have misidentified the plant.

With ever increasing settlement in Alaska, there have been more road building and mining and more soil disturbance, resulting in more habitats for *R. barbareifolia*. Thus *R. barbareifolia* may now be more common in central Alaska than 100 years ago; it may be spreading into disturbed sites in unglaciated areas (it has been found at Wiseman, Cantwell, and McKinley Park, which are near the unglaciated areas; and it may even be spreading into areas still farther removed from central Alaska, such as along the Alaska Highway.

Data suggest that *R. barbareifolia* arose out of the variable *R. palustris* complex of northwestern United States before glaciation, was cut off from these prototypes by the Cordilleran ice sheet of British Columbia, and survived and became morphologically distinct on unglaciated territory in central Alaska and Asia.

Summary of Section Rorippa. There are at least three lines of evolutionary development in native North American species of section *Rorippa*, based primarily on how the style is attached to the fruit.

One group has a style that gradually merges into the silique and is either straight throughout or tapers to the apex. The stigma is unexpanded. *Rorippa curvisiliqua, R. tenerrima*, and *R. microtitis* belong here (fig. 8-B 2, 3). In this character, the group is most closely allied to the long-fruited members of *Sinuatae*.

In a second group, the style gradually merges into the silique but instead of being straight or tapering, it expands below the stigma; the stigma itself may be expanded or unexpanded (fig. 8-B 1). The style, often quite thick, is extremely short in the most highly evolved members of this alliance. In this group there is also the development of numerous, small, pitted to nearly smooth seeds and a tendency toward reduction or absence of petals. The southeastern *R. sessiliflora*, *R. portoricensis*, and *R. teres*, as well as *R. mexicana* of the Central American and Mexican uplands, belong here.

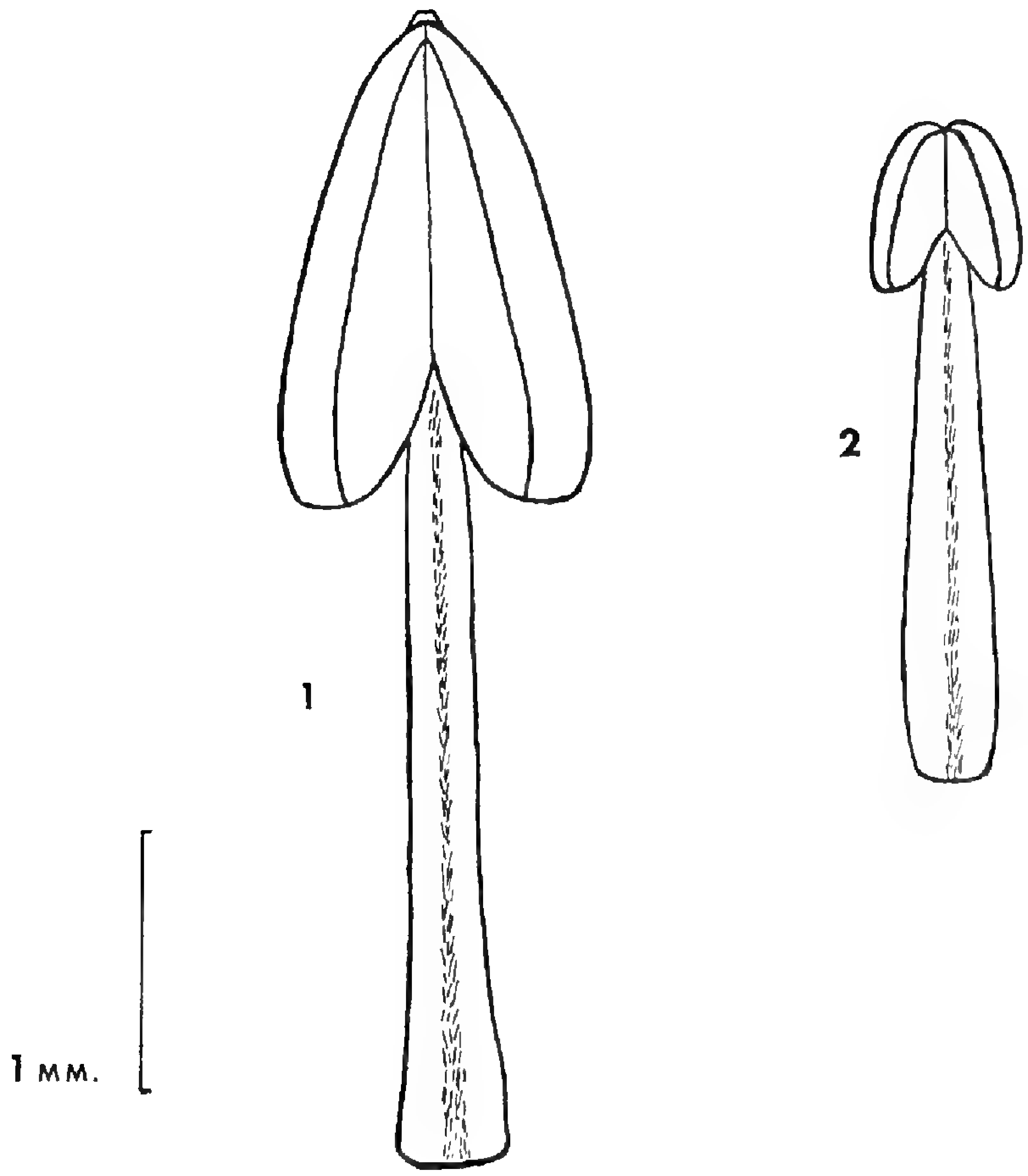
A third group is of plants whose styles are usually slender and attached to the obtuse or truncate silique. This character is best developed in *R. truncata* (fig. 8-B, 4). In *R. pinnata* and in certain segregates of *R. curvipes* with a pointed silique apex, it is difficult to assess the character. The stigma may be expanded or unexpanded. Included in this group are the pinnate-leaved members from Mexico and Central America, the *R. curvipes* complex, *R. palustris*, and *R. barbareifolia*. In the latter, the style is thick, however.

This section contains the young, rapidly evolving species of North American *Rorippa*. These have a number of morphological variations which have segregated geographically but have not progressed far enough to be considered Linnaean species. Members of this section often have characters considered derived (advanced), such as annual habit, plants growing singly from taproots, petals usually shorter than the sepals, short anthers notched at the apex, short styles, and usually numerous, small, mostly minutely colliculate to foveolate seeds. There is considerable fluctuation in some of these characters in section *Rorippa*.

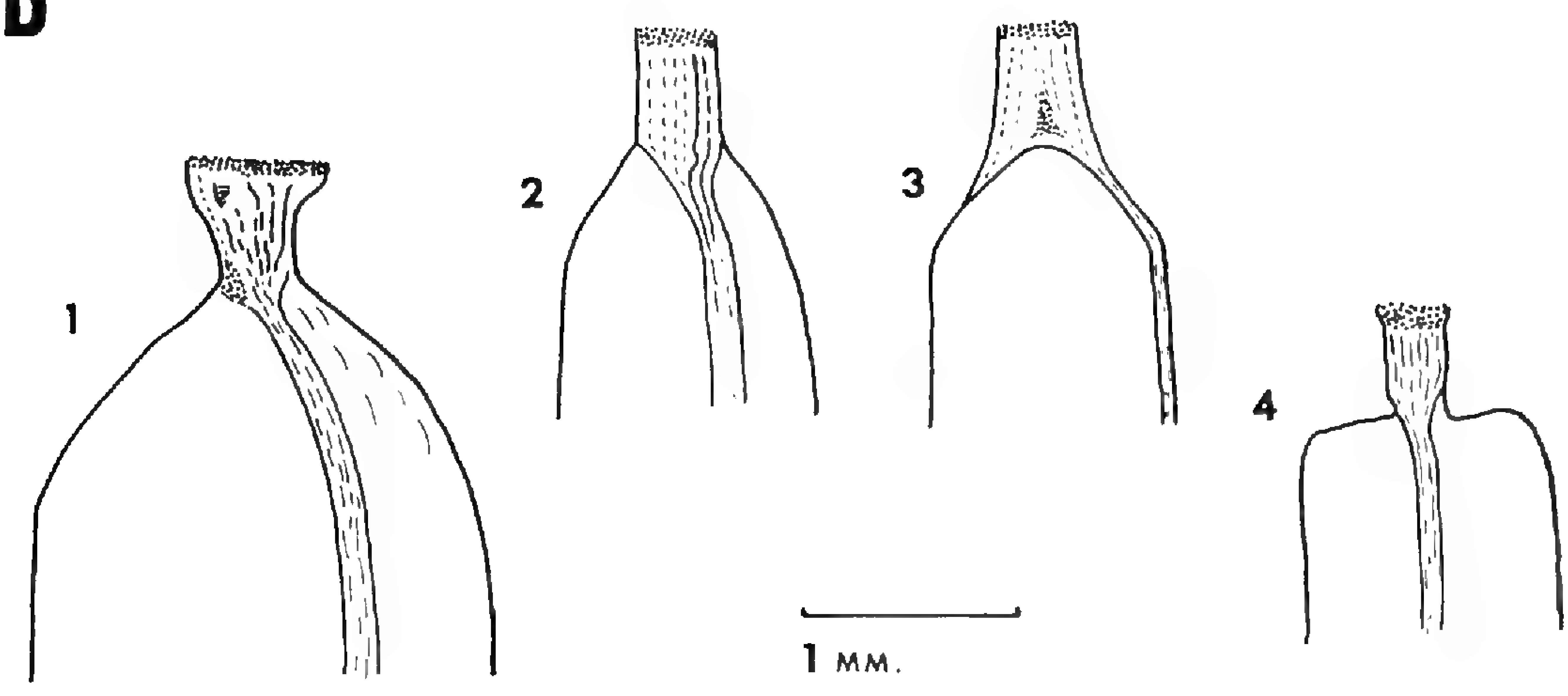
These annuals with taproots, basal rosettes, and thin leaves are apparently less adapted to dry regions for they are essentially absent from the Great Plains where clonal *R. sinuata* (section *Sinuatae*) grows. The other species of *Sinuatae* also usually grow in dry places. Members of section *Rorippa* grow in wetter regions, such as eastern North America, the mountains of western United States, and the uplands and mountains of Mexico and Central America. In the discussion of the distribution of *R. sinuata* and in the summary of *Sinuatae*, some distribution patterns of species from section *Rorippa* are compared to those of *Sinuatae* in these ecological and distributional differences.

Fig. 8. Anther and Style Types in North American *Rorippa*. A. The two kinds of anthers: 1. Stamen with elongate anther, ca. 1.5-3 times as long as wide, apiculate; the primitive condition; section *Sinuatae; R. sinuata (Stuckey 1634*, MICH). 2. Stamen with short anther, ca. 1-1.5 times as long as wide, notched at the apex; the derived condition; section *Rorippa; R. palustris* subsp. *hispida (Stuckey 1772*, MICH). B. The three basic style types in section *Rorippa*: 1. Style expanded below the stigma; style gradually merging into the silique apex; ventral view; *R. sessiliflora (Stuckey 1604*, MICH). 2.-3. Style straight throughout; style gradually merging into the silique apex; *R. curvisiliqua* var. *lyrata (Stuckey 1927*, MICH). (The style may be tapering to the apex in this type.) 2.—ventral view, 3.—lateral view. 4. Style straight throughout; style abruptly attached to the silique apex; ventral view; *R. truncata (Stuckey 1968*, MICH).

A



B



SUMMARY OF GEOGRAPHICAL AND EVOLUTIONARY RELATIONSHIPS IN NORTH AMERICAN RORIPPA

Within a species or among a group of closely related species in *Rorippa* are often well-defined centers of morphological diversity, that is, areas where all or nearly all the morphological variations in a species complex occur. Among the annual species (section *Rorippa*), there are three well-defined centers of diversity in the Rocky Mountains of the United States: (1) eastern Washington and northern Idaho for *R. curvisiliqua*, (2) northern Idaho and western Montana for *R. palustris*, and (3) northern Utah for *R. curvipes*. They are bridged morphologically and geographically by *R. curvipes* var. *integra*. These areas are somewhat centrally located in the range of each respective species complex. From the centers radiate several morphological segregates that may or may not be isolated geographically. Where overlap occurs in ranges or flowering time, intermediates are found. These segregates are the young, rapidly evolving taxa, and their distribution appears to be influenced by current factors, e.g., the amount of rainfall.

Rorippa curvisiliqua (maps 5, 6, 20-G) appears to be the most recent to undergo this phenomenon: its center is well-defined and its segregates are geographically close together, often showing considerable overlap. The distinguishing characters of one segregate usually merge with those of one or more of the adjacent segregates. *Rorippa palustris* subsp. *glabra* (map 20-S to W) has a well-defined center, but the segregates are much farther apart geographically and therefore are well-defined morphologically in the area away from the center. The *R. curvipes* complex (map 20-P to R) combines features of both of the above patterns. In the case of *R. truncata*, (map 20-P) the pattern has gone one step further. Apparently its center has become obliterated, leaving the surviving population fragments in several of the major river valleys. If these isolated populations were to diverge in different directions morphologically, isolated species might form, creating a situation similar to that of the isolated, oblong-fruited members of *Sinuatae*. These few well-defined species, *R. calycina* (map 20-A), *R. columbiae* (map 20-B), and *R. subumbellata* (map 20-C), are geographically isolated along the Yellowstone River, on the Columbia River lava plateau, and at Lake Tahoe, respectively. These three species are believed to be old, relic species, and they probably represent the fragments of a former more widespread and variable complex, but the morphological intermediates of the center have since died out. Such old species in old areas show characters considered primitive: perennial habit, long petals longer than the sepals, long anthers with the connective remaining at the apex, long pedicels, long styles in fruit, and few big seeds. *Rorippa sinuata* (map 20-D), a species with these primitive characters, is linked morphologically to these old relics (*R. calycina*) via the unique but very rare *R. coloradensis*. If we follow the gradual morphological changes that occur in these characters (Table 2, and map 20), we find a series of plants beginning with *R. sinuata* (map 20-D) (longest petals, longer than the sepals) of western United States,

TABLE 2. EVOLUTIONARY TRENDS OF CERTAIN CHARACTERS IN SOME RELATED SPECIES OF RORIPPA, SUGGESTING THE DIRECTION OF THEIR APPARENT MIGRATION (SEE MAP 20).

Species	Petal Length	Anthers	Pedicel Length	Style Length	Seed Length	Approximate No. Seeds Per Silique
(D.) *R. sinuata* (w. United States)	longer than the sepals, 3.5-5.5 mm.	elongate, apiculate	longest, 5-11.5 mm.	longest, 1-2 mm.	longest, 0.7-0.9 mm.	40-80
(H.) *R. microtitis* (s.w. United States, n. Mexico)	longer than the sepals, 2.5-3.7 mm.	elongate, apiculate	fluctuating, 3.5-10.5 mm.	0.5-1 mm.	mature ones not known, ? 0.6-0.7 mm.	?
(I.) *R. mexicana* (n. Mexico to Costa Rica)	longer than the sepals, 1.7-2.6 mm.	transitional	2.4-5.4 mm.	0.5-1.2 mm.	0.7-0.8 mm.	70-100
(J.) *R. teres* (Coastal Plain)	mostly equal to or shorter than the sepals, 1-1.7 mm.	short, notched	2.5-4.5 mm.	0.5-1.5 mm.	0.4-0.5 mm.	100-150
(K.) *R. portoricensis* (West Indies)	shorter than the sepals, 0.8-1.2 mm., or absent	short, notched	1-2.2 mm.	0-0.5 mm.	0.4-0.6 mm.	50-100
(L.) *R. sessiliflora* (Mississippi embayment and s.e. United States)	absent	short, notched	shortest, 0.5-1.5 mm.	shortest, 0-0.4 mm.	shortest, 0.4-0.5 mm.	150-200

moving south to *R. microtitis* (map 20-H) (long petals, longer than the sepals), moving still farther south to *R. mexicana* (map 20-I) (shorter petals, but longer than the sepals) of the uplands of Mexico and Central America, *R. teres* (map 20-J) (short petals, mostly equal to or shorter than the sepals) of the Coastal Plain, and *R. portoricensis* (map 20-K) (petals shorter than the sepals or absent) of the West Indies, and finally culminating in the apetalous *R. sessiliflora* (map 20-L) of the lower Mississippi valley and southeastern United States. Table 2 gives trends of the six characters.

In a rather recent and rapidly evolving family such as Cruciferae, it is possible to find a few morphological characters that show evolutionary trends from a primitive to a derived state, and these can be correlated with geographical distribution which suggests the apparent migration. However, within or among the species that have centers of diversity, I cannot decide which characters are primitive and which derived. Characters appear to be changing in at least two directions. For example, both long petals (longer than the sepals) and short petals (shorter than the sepals) or both long and short pedicels occur in *R. curvipes* and *R. curvisiliqua*. Whereas the presence of numerous small seeds in *R. sessiliflora* is a derived condition in the evolutionary line described above, the few seeds in *R. intermedia* and the big seeds in *R. megasperma* are considered derived in the pinnate-leaved group which represents a different evolutionary line that probably arose out of the *R. curvipes* complex. Other examples could be cited. It is evident that no one character can be considered primitive throughout the genus.

Some characters fluctuate. One of these is recurved pedicels, which occur in at least one taxon within every species complex (except in *R. curvisiliqua*) or in one of a group of closely related species. Recurved pedicels occur in *R. calycina* of the relic group, in *R. mexicana* of the group whose styles are expanded below the stigma, in *R. pinnata* of the pinnate-leaved group, in *R. curvipes* var. *curvipes* and *R. sphaerocarpa* of the *R. curvipes* complex, and in *R. palustris* subsp. *glabra* var. *cernua*. A similar situation occurs in the character of raceme position (all lateral racemes and no terminal raceme) found in *R. calycina* (p.p.), *R. columbiae* (p.p.), *R. ramosa*, *R. mexicana*, *R. teres*, *R. tenerrima* (p.p.), *R. truncata*, and *R. sphaerocarpa* (p.p.) but not in *R. palustris* and *R. curvisiliqua*. Other characters behave similarly. With this kind of behavior in the genus, the determination of which characters are primitive and which are derived is difficult.

Geographical and evolutionary relationships are summarized in map 20. The black arrows connect the most closely related species, and the direction of the arrow indicates the most probable line of morphological divergence and direction of migration. At various places in the text intermediate plants between certain species were pointed out. In those cases the position of the arrow is the approximate area where those plants are found. To read the chart in its entirety, one should begin with taxon D, *R. sinuata*, a species with characters considered primitive. From it can be traced the apparent evolutionary and distributional history of North American *Rorippa*. *Rorippa* *ramosa* (map 20-E) and *R. tenerrima* (map 20-F) are offshoots which have not developed further and are therefore abruptly terminated lines of development.

The closest relative of any one species of *Rorippa* is a species that lies geographically next to it. For example, *R. curvisiliqua* is adjacent to *R. sinuata*, which is adjacent to *R. microtitis*, which is adjacent to both *R. curvisiliqua* and *R. mexicana*, and the latter is adjacent to *R. teres*. Payson (1921, p. 129) found a similar phenomenon in *Lesquerella*. The situation in both genera appears to exemplify Jordan's Law (Jordan, 1905). Seeing what a variable complex like *R. curvisiliqua* is doing today is helpful in explaining and understanding what has apparently happened in the past to bring about such a distribution pattern. Morphologically similar and related species are adjacent to each other geographically, but morphologically diverse and unrelated species are sympatric. Good examples are *R. megasperma* sympatric with *R. mexicana*, and *R. sessiliflora* sympatric with *R. palustris*. In North America outside the United States Rocky Mountains, usually no more than three species, representing three different evolutionary lines, are in the same region. These species, often found together, are apparently kept separate by strong barriers to interbreeding. The plants are self-fertile, one factor keeping them isolated. Other factors and the details of such isolating mechanisms are not known.

One interesting question arises. How old is *Rorippa?* With present knowledge we can look to four points in time as possible markers for working in the time sequence. *Rorippa columbiae* is considered a relic species with primitive characters. Its distribution appears to be correlated with a very old soil type, the Columbia River lava plateau of the Tertiary. If *R. columbiae* was a pioneer plant on these soils when or soon after they were formed, it appears that *Rorippa*, at least this species, was in existence during the latter part of the Tertiary.

If we accept that *R. teres* originated in the uplands of Mexico and then migrated onto the coastal plain at the end of the Tertiary or beginning of the Quaternary, we then have a second point in time. Trends in the characters presented above reveal that *R. teres* arose out of a line of development related to the old relics of *Sinuatae*. Thus we would expect *R. teres* to be younger than these relics.

Rorippa sessiliflora is more divergent from *R. teres* in its characters and probably arose from a common ancestor slightly later than *R. teres*. It then migrated north in the lower Mississippi valley. Since it appears from the distribution map of *R. sessiliflora* (map 9) that its northward migration was strongly influenced by Wisconsin glaciation (the third point in time) of the late Pleistocene, this migration probably occurred slightly later than that of *R. teres* onto the coastal plain.

Rorippa palustris is considered one of the younger species. According to Hultén (1937, p. 118-119), boreal circumpolar plants, including *R. palustris*, were either widespread in boreal regions before glaciation or arose during the interglacials. This, the fourth point in time, is also recent geologically.

It appears from these markers that the North American species of *Rorippa* are properly placed, not only as to evolutionary divergence and migration, but also as to time. In this scheme, the time relationship of *R. curvisiliqua* and the *R. curvipes* complex is obscure. The former is believed to be an old species, since it seems most closely allied (at least geographically) with *R. sinuata*, but its divergence into a number of morphological and geographically close segregates suggests a more recent event. The *R. curvipes* complex may be as old as or slightly younger than *R. curvisiliqua* but is probably older than *R. palustris*. Map 20 portrays this sequence. The fragmented circular range of *R. truncata* (map 11) with an empty center, and its close alliance with the pinnate-leaved group of Mexico and Central America suggest an old age, at least late Tertiary.

I know of no fossil evidence to document this probable history. However, Godwin (1956) reported that two late-glacial seeds in the Reid collection closely resemble seeds of *R. palustris*.

APPENDIX I. THE PROBLEM OF RORIPPA CRYSTALLINA

22. RORIPPA CRYSTALLINA Rollins, Rhodora 64: 326. 1962. (Holotype: CANADA: MACKENZIE: Carex marsh with drying areas more or less bare of vegetation, Mile 23 N., Yellowknife Highway along the Mackenzie River, 10 Jul 1961, *J. W. Thieret, R. J. Reich 7512*, GH!)

Since no new data on *R. crystallina* are available, the reader is referred to Rollins (1962). I studied the same material that Rollins cited. He pointed out certain difficulties with regard to the genus to which this species belonged and finally concluded that it had more in common with *Rorippa*, even though no single species of *Rorippa* could readily be singled out for comparison. His decision to put it in *Rorippa* is justified, but I can not relate *R. crystallina* to any native North American species of the genus. Although a detailed search has not been made for calcium oxylate crystals, an important feature of this species, pustules formed by these crystals on leaves have not come to my attention in other North American species. The seeds of *R. crystallina* are extremely plump and broadly oblong and are much larger (1.5-2 mm. long) than in our native species. The finely reticulate-colliculate, buff colored seed coat with a mucilaginous sheath is also not found in North American *Rorippa*. Large white petals sometimes tinged below with light lavender are also different.

Rorippa crystallina has a morphological relationship to *Nasturtium barbareaefolium* Franchet (Bull. Bot. Soc. Fr. 33: 396. 1888.) of China. (The name *N. barbareaefolium* Franchet is actually an illegitimate later homonym of *Nasturtium barbareaefolium* Baker (Fl. Mauritius & Seychelles. 7. 1877.) Neither of these epithets can be transferred to *Rorippa* because of the existence of *R. barbareifolia* (A. P. DeCandolle) Kitagawa.) I examined two collections of this species: YUN-NAN: *Delavay 1840* (GH); and SZECHWAN: *Fang 4483* (GH). The former collection, cited by Franchet, is an isosyntype. Both species are very similar in overall appearance and in the shape of siliques and seeds. The leaves of the Asiatic plant sparingly bear pustules apparently of calcium oxylate. *Nasturtium barbareaefolium* differs from *R. crystallina* in having shorter (5-8 mm. long) pedicels, ascending to appressed pedicels and siliques, and sparingly to moderately hirsute leaf surfaces and stem. Thus, *R. crystallina* is related to Asiatic members of the genus, not North American ones. Perhaps the differences from the North American taxa would be sufficient to form a section within the genus based on the pustulate leaf condition and on differences in seeds and petals. Asiatic members of the genus are in need of study.

Phytogeographically, does *R. crystallina* represent the end of an evolutionary migrational line that existed across eastern Siberia, Alaska, and into Canada? Or has *R. crystallina* been introduced into North America?

APPENDIX II. SPECIES INTRODUCED INTO NORTH AMERICA

Seven species of *Rorippa* are considered introduced into North America. Their distributions, highly irregular and sporadic, do not correlate with natural physiographic or glacial features, as do those of native taxa. If there is doubt whether a particular species that grows in a large area (e.g., a continent) is native or introduced, the determination of its total range throughout the area in question may answer this question. The distribution of a native species should correlate with some natural feature such as glaciation, climate, soil, rainfall, rivers, mountains, deserts, etc.; whereas the introduced one will probably not show a correlation. Other criteria, such as actual date of introduction, historical records, field observations, morphological relationships, etc., are highly desirable. If the above idea has validity, then we may have another argument for believing that *R. barbareifolia* is native to Alaska and Yukon: it shows a relationship to glaciation not only there but throughout its range.

In interpreting the introduced species from Europe, I have followed Wannenmacher (1960). Selected references to descriptions, illustrations, and distribution maps are given for each introduced species. Only a few selected synonyms have been cited.

23. RORIPPA SYLVESTRIS (Linnaeus) Besser, Enum. Pl. Volh. 27. 1822.
    Sisymbrium sylvestre Linnaeus, Sp. Pl. 657. 1753.
    Nasturtium sylvestre (Linnaeus) R. Brown in Aiton, Hort. Kew. ed. 4: 110. 1812.
    Radicula sylvestris (Linnaeus) Druce, List Brit. Plants 4. 1908.

DESCRIPTIONS: Butcher (1961, p. 335); Clapham, Tutin, & Warburg (1962, p. 174); Jonsell (1968, p. 160); Valentine (1964, p. 283); Wannenmacher (1960, p. 177).

ILLUSTRATIONS: Britton & Brown (1897, p. 124, fig. 1713; 1913, p. 160, fig. 2026); Butcher (1961, p. 335); Clapham, Tutin, & Warburg (1962, p. 173, fig. 23, A), silique; Fassett (1940, p. 232, fig. 19); Gleason (1952, p. 239); Groh (1936, p. 33, fig. 1, A-D), taken from Muenscher (1942); Hitchcock & Cronquist (1964, p. 540); Jonsell (1968, plates IX-XI, photographs of plants; Marie-Victorin (1947, p. 264); Muenscher (1942, p. 272, fig. 50, A-D); Murley (1951, p. 72, fig. 21), seed; Musil (1963, pl. 32, fig. 255), seed; Steyermark

(1963, p. 759, pl. 185, no. 1); Wannenmacher (1960, opposite p. 169, Tafel 129, 5-5a, p. 179, fig. 94, e-g; p. 180, fig. 95, a).

DISTRIBUTION: NORTH AMERICA: Map 21; Stuckey (1966b, p. 364). NORTHWESTERN EUROPE: Hultén (1950, p. 238, fig. 927); Jonsell (1968, p. 99, fig. 13).

Rorippa sylvestris, creeping yellow cress, has been confused with several of the native North American species, in particular with *R. sinuata*, *R. palustris*, *R. teres*, and *R. microtitis*. The following single-couplet keys distinguish *R. sylvestris* from these species.

Key A

1. Plants glabrous or sparingly hirsute on the lower portion of the stem; leaves deeply divided, more than 2 cm. wide; basal rosettes present in young plants; style in fruit shorter than 1 mm. . . . . *R. sylvestris*
1. Plants pubescent only with vesicular trichomes on the stem and lower surface of the leaves; leaves sinuate-lobed, less than 2 cm. wide; basal rosettes absent even in young plants; style in fruit longer than 1 mm. . . . . *R. sinuata*

Key B

1. Petals over 3 mm. in length, longer than the sepals; plants clonal from spreading roots and stems; pedicels longer than 5 mm.; racemes terminal and lateral; plants glabrous or sparingly hirsute on the lower portion of the stem. . . . . *R. sylvestris*
1. Petals under 2 mm. in length, equal to or shorter than the sepals; plants solitary from a slender taproot; pedicels shorter than 5 mm.; racemes all lateral; plants pubescent only with vesicular trichomes on the lower portion of the stem and on the upper surface of the basal and lower cauline leaves. . . . . *R. teres*

Key C

1. Mature siliques usually lacking seeds; plants clonal from slender spreading roots and stems; petals over 3 mm. in length, longer than the sepals. . . . . *R. sylvestris*
1. Mature siliques with seeds; plants solitary from a vertical taproot; petals under 3 mm. long, mostly equal to or shorter than the sepals. . . . . *R. palustris*

Key D

1. Mature siliques usually lacking seeds; plants clonal from slender spreading roots and stems. . . . . *R. sylvestris*
1. Mature siliques with seeds; plants solitary from a vertical taproot. . . . . *R. microtitis*

I found no evidence that *R. sylvestris* hybridizes with native North American species, although Jonsell (1968, p. 136-138) reports the occurrence of hybrids and gives a short description (p. 160).

Rorippa sylvestris, introduced into North America from Europe, is quite common east of the Mississippi River in northeastern United States and southern Canada, where it grows along streams, rivers, and ditches, about ponds and dumps, and in gardens. For a history of its distribution and migration in North America, see Stuckey (1966b).

24. RORIPPA AUSTRIACA (Crantz) Besser, Enum. Pl. Volh. 103. 1822.
Nasturtium austriacum Crantz, Strip. Austr. ed. 1. 15. 1762.
Radicula austriaca (Crantz) Small, Torreya 23: 23. 1923.

DESCRIPTIONS: Butcher (1961, p. 338); Clapham, Tutin, & Warburg (1962, p. 174); Jonsell (1968, p. 163-164); Valentine (1964, p. 283); Wannenmacher (1960, p. 176).

ILLUSTRATIONS: Butcher (1961, p. 338); Clapham, Tutin, & Warburg (1962, p. 173, fig. 23, D), silique; Gleason (1952, p. 239); Groh (1936, p. 333, fig. 1, J-L), taken from Muenscher (1942); Hansen (1922, p. 76); Jensen (1955, p. 69); Marie-Victorin (1947, p. 264); Muenscher (1942, p. 272, fig. 50, J-L); Murley (1951, p. 72, fig. 23), seed; Musil (1963, pl. 32, fig. 254), seed; Wannenmacher (1960, p. 176, fig. 93, a-d).

DISTRIBUTION: NORTH AMERICA: Map 22.

Rorippa austriaca, field cress, comes from Europe and was first reported in North America by Hansen (1922), who observed it at Borderland Farm, New Milford, Orange County, New York. According to the proprietor of the farm, the field cress was introduced about 1910 in grass seed. At first the plant occurred merely as a small patch not spreading to any extent for a number of years. By the time Hansen observed it in June 1921, about 5 acres were infested; patches of the plant occurred 200-300 yards from the main area; and roadsides about the farm were infested.

Small (1923) reported *R. austriaca* from Wisconsin on the basis of specimens sent to New York Botanical Garden in 1918. The plants, obnoxious on one of the University of Wisconsin fields, were thought to have been introduced in alfalfa seed from Turkestan.

Like *R. sylvestris*, *R. austriaca* often fails to produce seed but propagates by creeping roots. These roots, much thicker and more fleshy than those of *R. sylvestris*, resemble those of the horseradish, *Armoracia rusticana*. Plants with such root systems are ideally adapted for spreading into areas, especially cultivated areas, where competition is minimal. Hansen (1922), Small (1923), Groh (1933), and Jensen (1955) expressed concern that this species would become well established and more widespread and thus difficult to eradicate. However, since its introduction 50 years ago, it has apparently neither spread nor become obnoxious. Map 22 shows field cress in scattered isolated localities in North America. Each locality probably represents a separate introduction, except possibly in North Dakota where there may have been some spread through agricultural practices. *Rorippa austriaca* may occur more frequently than the map indicates, but supporting records are lacking. Whether it is currently being introduced or whether it is spreading from already existing populations should be investigated.

25. RORIPPA AMPHIBIA (Linnaeus) Besser, Enum. Pl. Volh. 27. 1822.
Sisymbrium amphibium Linnaeus, Sp. Pl. 657. 1753.
Nasturtium amphibium R. Brown in Aiton, Hort. Kew. ed. 2. 4: 110. 1812.

DESCRIPTIONS: Butcher (1961, p. 337); Clapham, Tutin, & Warburg (1962, p. 174); Jonsell (1968, p. 161-162); Valentine (1964, p. 283); Wannenmacher (1960, p. 180).

ILLUSTRATIONS: Busch (1915, p. 216); Butcher (1961, p. 337); Clapham, Tutin, & Warburg (1962, p. 173, fig. 23, C), silique; Fassett (1940, p. 232, fig. 17, 18), silique; Gleason (1952, p. 239); Marie-Victorin (1947, p. 264); Wannenmacher (1960, p. 176, fig. 93, e-g; p. 180, fig. 95, c).

DISTRIBUTION: NORTH AMERICA: Map 22. EURASIA: Busch (1915, p. 218); NORTHWESTERN EUROPE: Hultén (1950, p. 237, fig. 924); Jonsell (1968, p. 104, fig. 14).

Rorippa amphibia, introduced from Eurasia, was first correctly reported in North America from the St. Lawrence River (Marie-Victorin, 1930). When the introduction was made is not known. According to Marie-Victorin the species had become very aggressive and had spread at the expense of other, native hydrophytes. The report by Norton (1933) from Maine is correct. Although I have not seen a specimen on which Bradley (1931) based his report of *R. amphibia* from Ridgefield, Connecticut, his plants may belong to *R. prostrata*, since Eames collected plants in that town very similar to *R. amphibia* but which I placed in *R. prostrata*. The report from Iowa by Wolden (1956) was based on a specimen of *R. austriaca*.

26. RORIPPA PROSTRATA (Bergeret) Schinz et Thellung, Viertelj. Naturf. Ges. Zürich 58: 62. 1913.
Myagrum prostratum Bergeret, Phyton 3: 149. 1784.

DESCRIPTIONS: Valentine (1964, p. 283); Wannenmacher (1960, p. 178).

ILLUSTRATION: Wannenmacher (1960, p. 179, fig. 94, a-d).

DISTRIBUTION: NORTH AMERICA: Map 22.

According to Valentine (1964), *R. prostrata*, a European species, comprises a series of variants ranging from those near *R. amphibia* at one end to those near *R. sylvestris* at the other. It is generally considered of hybrid origin, although it sometimes occurs in the absence of one of the parents. Jonsell (in litt., 5 Oct 1964) writes that *R. prostrata* "seems to be a name for various more or less stabilized hybrid complexes of different origin." Plants from Pennsylvania and New Jersey match well the illustration in Wannenmacher (1960) and are close to *R. sylvestris* in silique length and leaf dissection. In Connecticut and New York, the plants approach *R. amphibia* in leaf and silique morphology. Thus our few specimens, too, are a series of variants between *R. sylvestris* and *R. amphibia*.

27. RORIPPA MICROSPERMA (A. P. DeCandolle) L. H. Bailey, Gent. Herb. 1: 25. 1920.
Nasturtium microsperma A. P. DeCandolle, Syst. Nat. 2: 199. 1825.

DESCRIPTION: Busch (1915, p. 211).

ILLUSTRATION: Busch (1915, p. 212).

DISTRIBUTION: ASIA: Busch (1915, p. 213).

Rorippa microsperma has the pedicels subtended by entire to pinnatifid leafy bracts and thus readily can be separated from all other *Rorippa* in North America. Our collection matches material from Asia (GH) annotated by A. N. Steward as *R. microsperma.* In North America *R. microsperma* is known from only one locality (Vancouver Island) where it undoubtedly was brought from Asia: BRITISH COLUMBIA: Ballast, vicinity of Nanaimo, 12 Jul 1893, *Macoun s.n.* (GH, ND-G, NY).

28. RORIPPA HETEROPHYLLA (Blume) Williams, Fl. Trinidad and Tobago 1: 24. 1929.

Nasturtium heterophyllum Blume, Bijdr. Fl. Nederl. Ind. II St. 50. 1825.

DESCRIPTIONS: Gleason (1952, p. 240); Schulz (1903, p. 517).

ILLUSTRATION: Gleason (1952, p. 241).

DISTRIBUTION: NORTH AMERICA: Map 22.

Rorippa heterophylla appears to be introduced from South America. North American plants have sometimes been referred to *R. indica.* Small (1913, p. 1336) reported plants of this species under the name of *R. montana.* Later (1933) he used the name *R. heterophylla.* Following Schulz (1903), I have included as *R. heterophylla* all of these apetalous plants having straight siliques with flattened, somewhat elastic valves and seeds in a single row in each locule. In the silique character, this species suggests *Cardamine,* but the leaves are much like those of *Rorippa.* Plants similar to *R. heterophylla,* but with curved siliques and petals longer than the sepals, are referred by me to *R. indica.* Some descriptions of *R. indica (e.g.,* DeCandolle, 2: 199. Syst. Nat. 1821) state that petals are absent. These taxa need clarification. Rollins (1969) considered these apetalous plants to be *R. indica* (Linnaeus) Hiern var. *apetala* (A. P. DeCandolle) Hochreutiner.

29. RORIPPA INDICA (Linnaeus) L. H. Bailey, Rhodora 18: 155. 1916.

Sisymbrium indicum Linnaeus, Mant. 93. 1767.

Nasturtium indicum (Linnaeus) A. P. DeCandolle, Syst. Nat. 2: 199. 1821.

Rorippa indica has been brought to North America from Asia where it has either been cultivated or has escaped from cultivation. ILLINOIS: [Cook Co.]: Cult[ivated], Lincoln Park, Chicago, 17 Jun 1898, *Umbach sn.* (WIS 8683); NEW YORK: Bronx Co. Weed under rhododendrons, New York Botanical Garden, Bronx Park, 2 Jun 1947, *18653*, weed in roadways and waste ground under rhododendrons, same locality, 28 May 1948, *19437*, both *H. N. Moldenke* (NY). Reported from the same locality by Monachino (1957). See the note under *R. heterophylla.*

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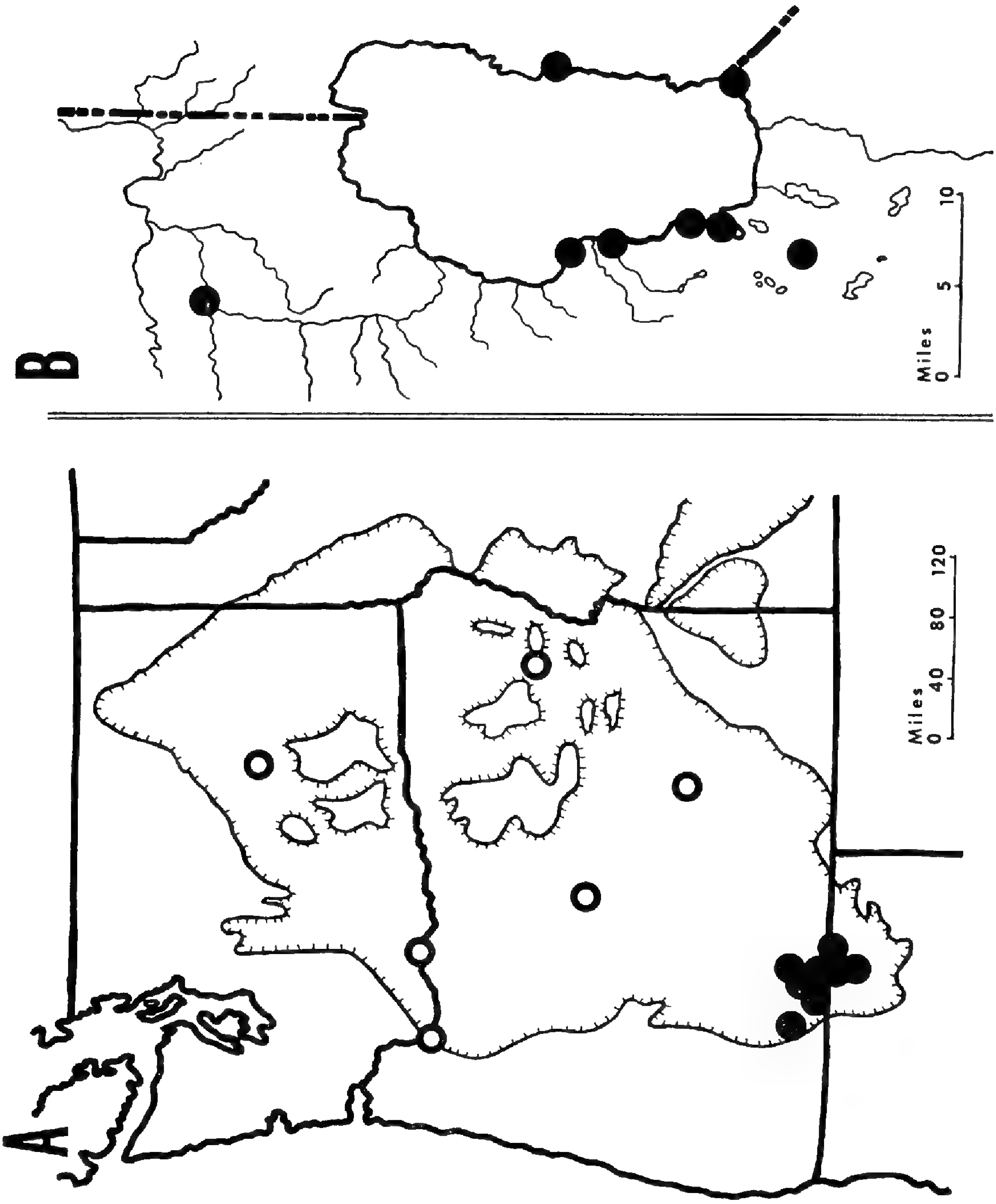
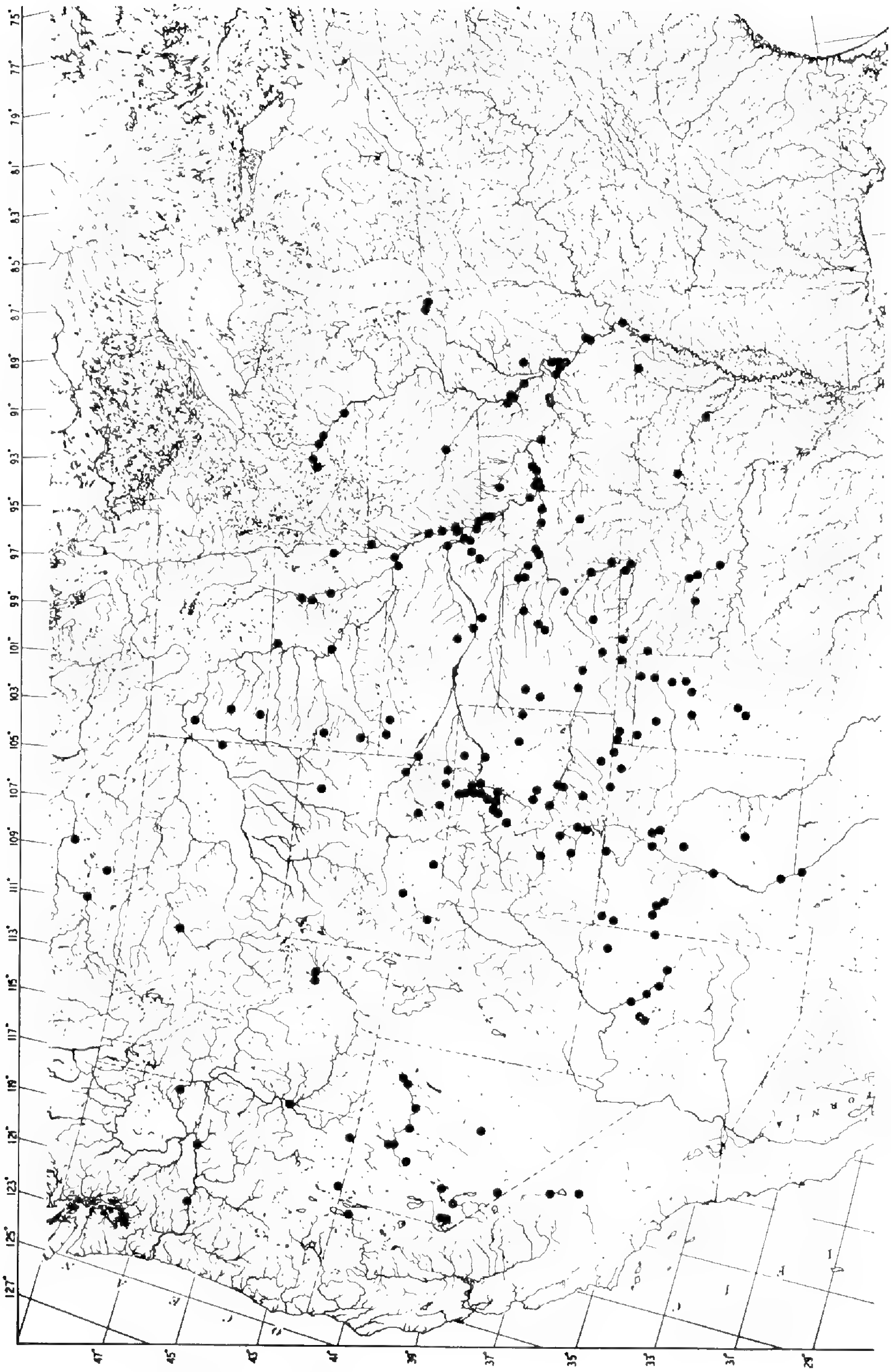
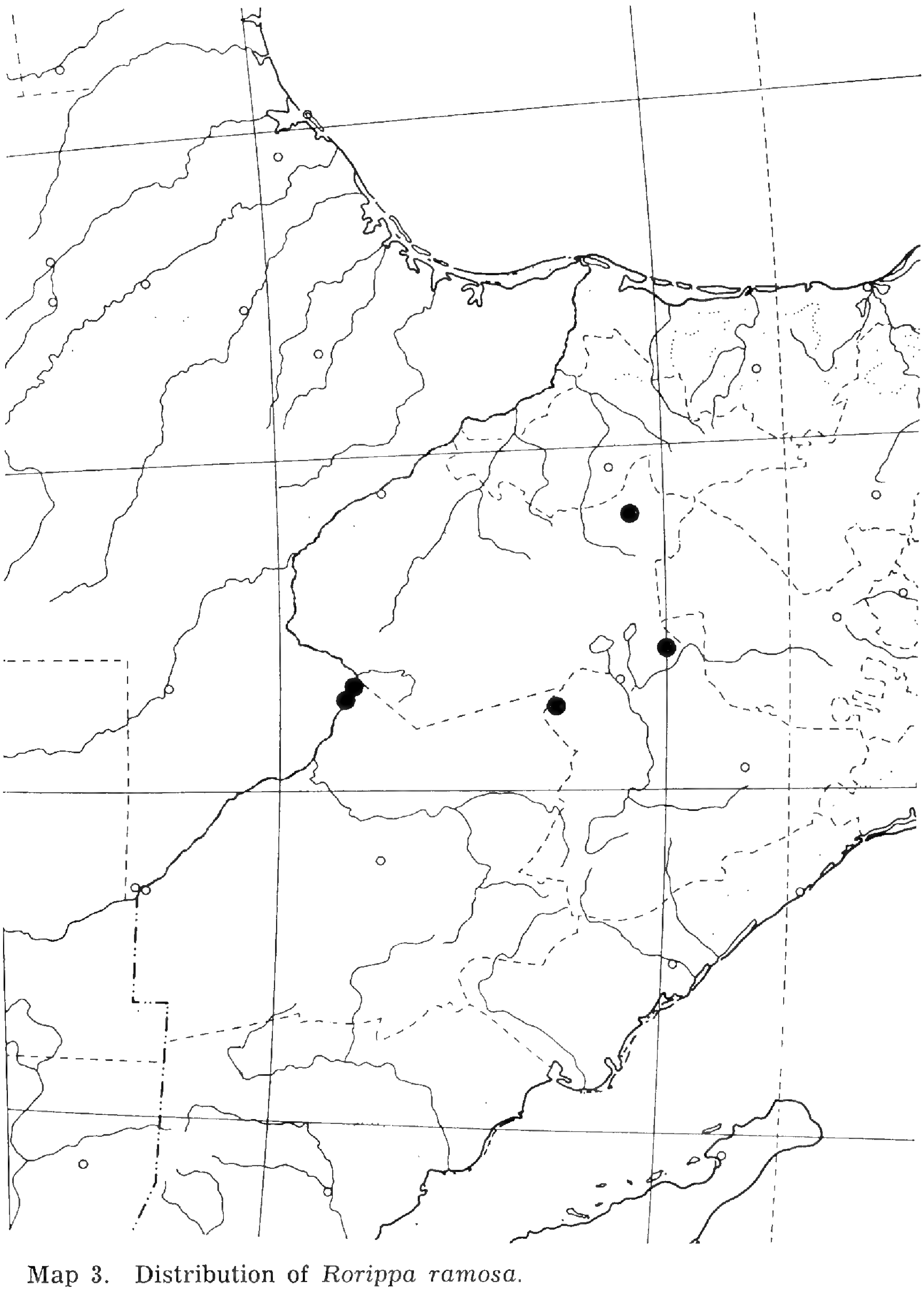


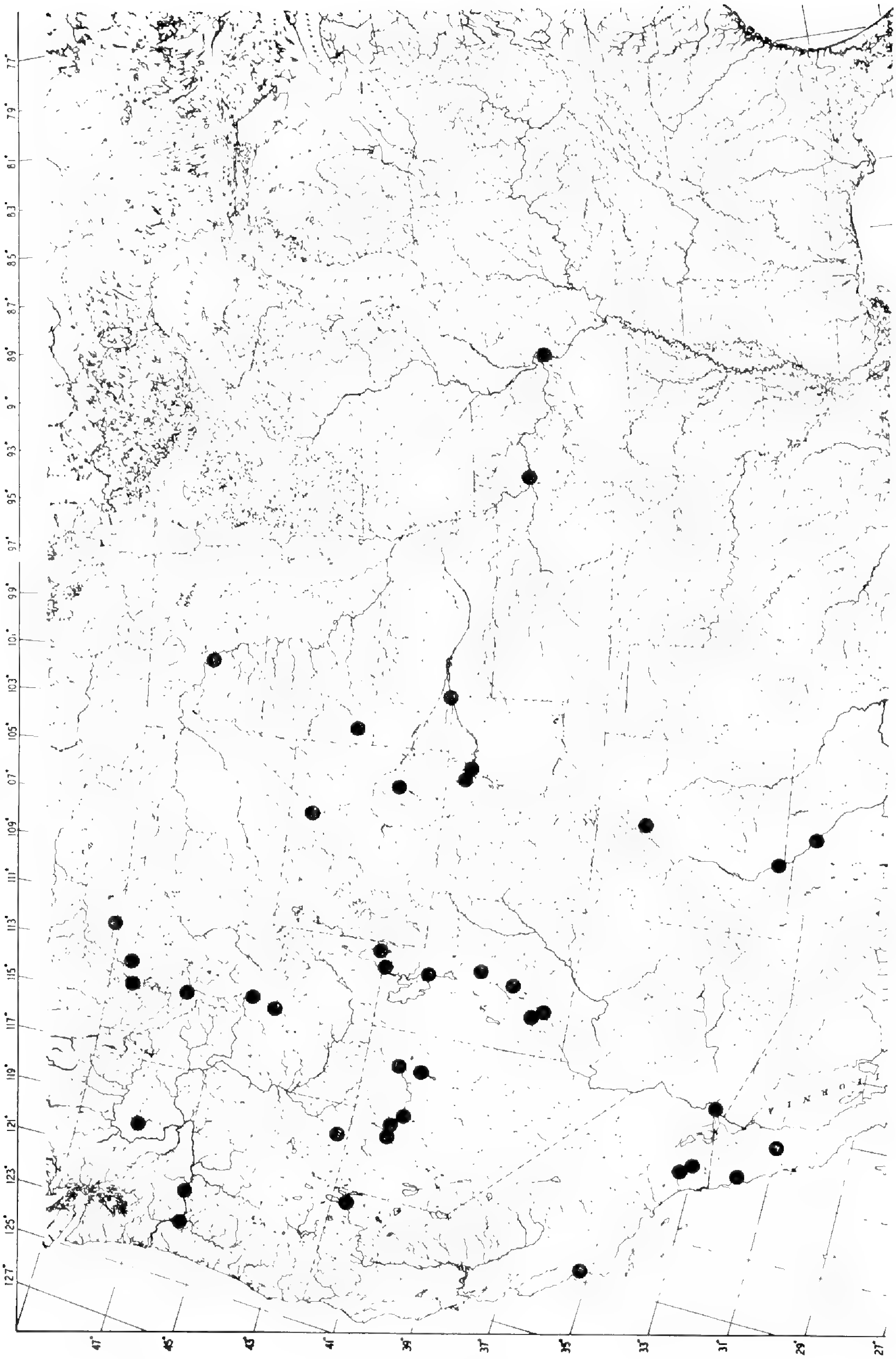
Map 1. Distribution of two endemic species of section *Sinuatae*. A. *Rorippa columbiae* in northwestern United States: The area enclosed by the half-barred line marks the limits of the Columbia River basaltic lava plateau of Tertiary age (after Hussey, 1947, p. 356). Circles represent collections made before 1905. Dots represent collections made since 1905. B. *Rorippa subumbellata* about Lake Tahoe and vicinity: The dot to the northwest is an old collection "collected at Truckee"; the dot to the southwest is an old collection "collected at Tallac Lake (near Tahoe)." (From a map of "Lake Tahoe Region, California State Automobile Association.")



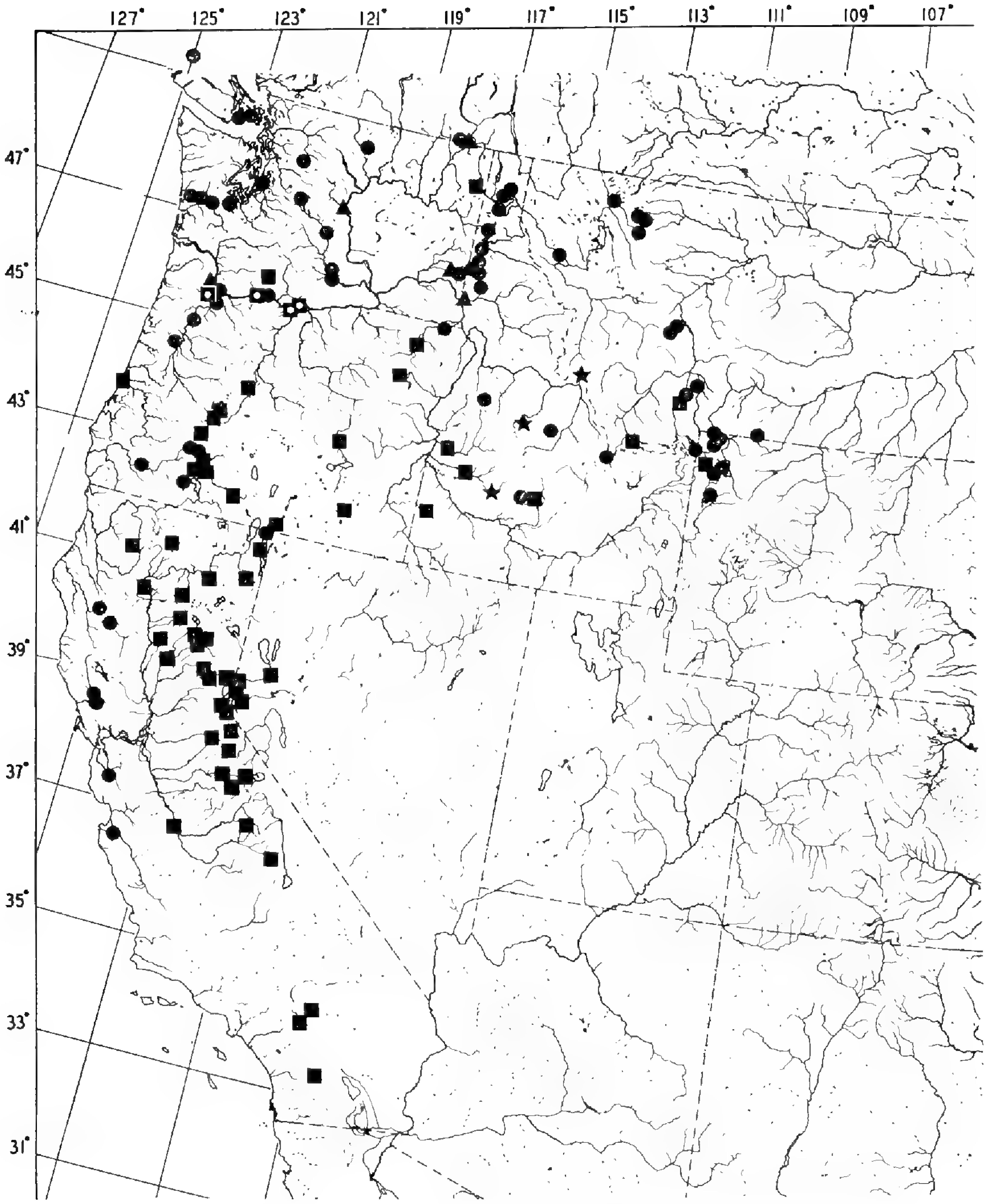
Map 2. Distribution of *Rorippa sinuata*.



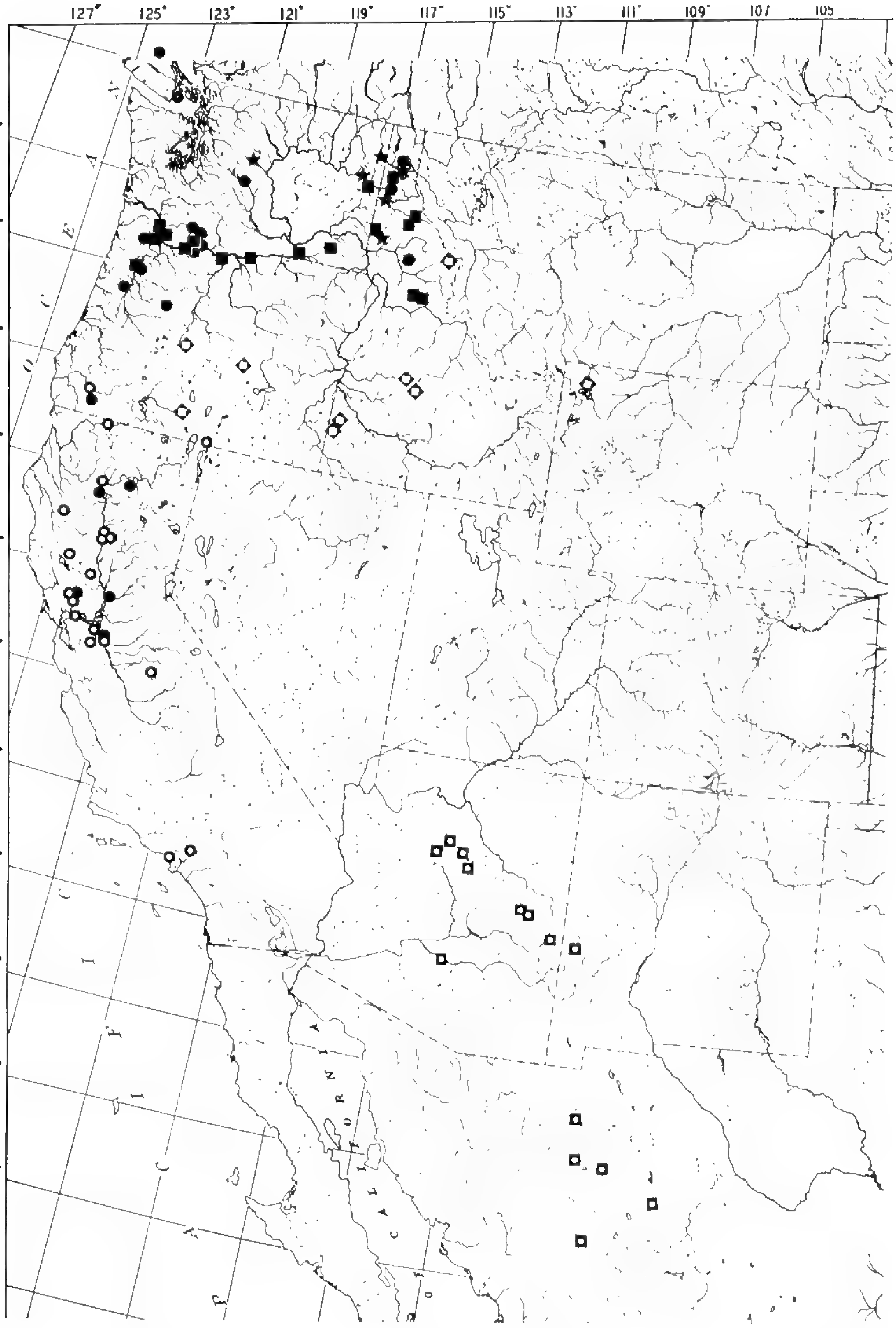
Map 3. Distribution of *Rorippa ramosa.*



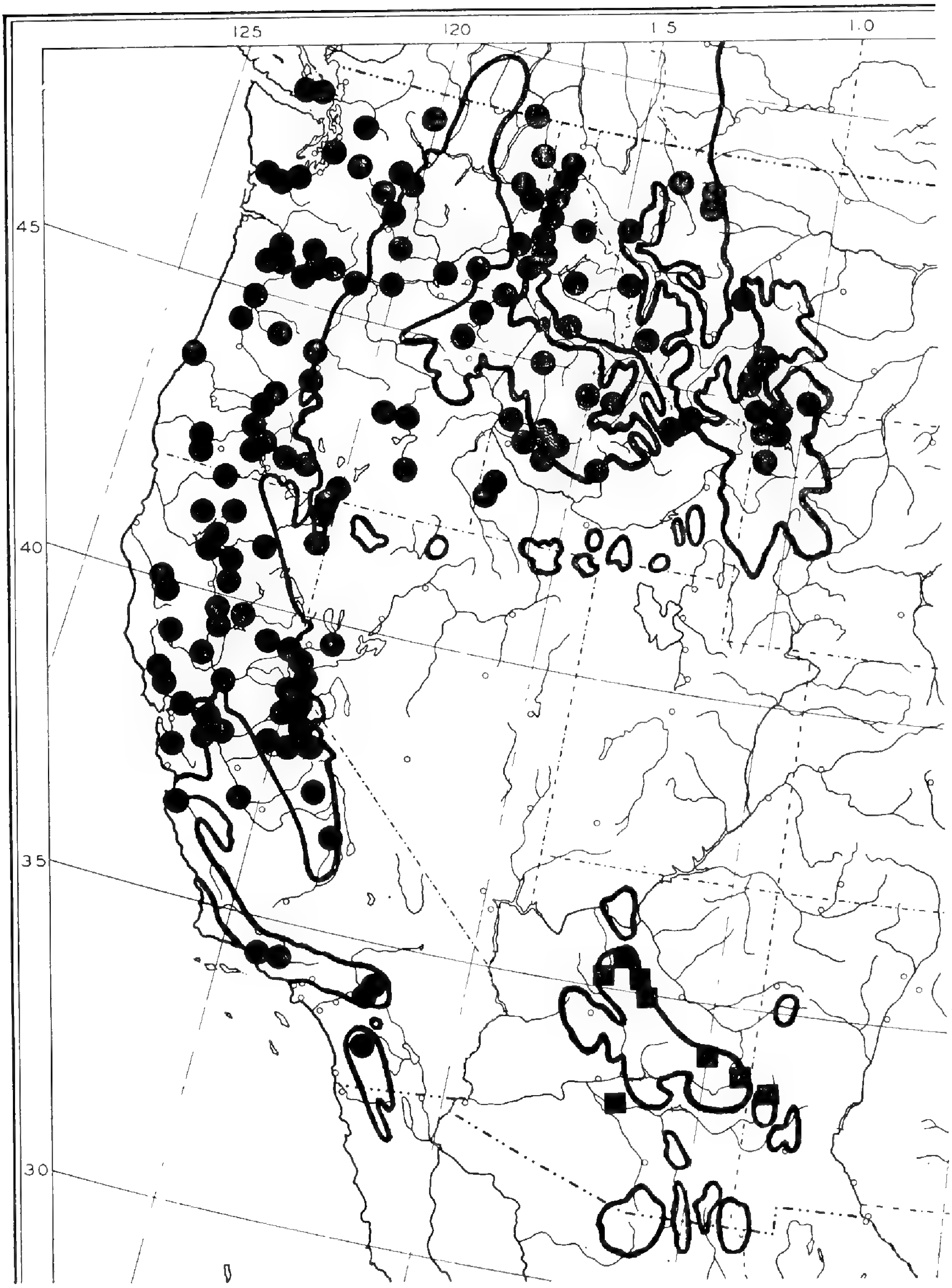
Map 4. Distribution of *Rorippa tenerrima*.



Map. 5. Distribution of the "pectinate-pinnatifid leaved" members of *Rorippa curvisiliqua* in western United States: ● *R. curvisiliqua* var. *curvisiliqua*, ☐ *R. curvisiliqua* var. *nuttallii*, ■ *R. curvisiliqua* var. *orientalis*, ▲ intermediates between var. *curvisiliqua* and var. *nuttallii*, ★ intermediates between var. *curvisiliqua* and var. *orientalis*.



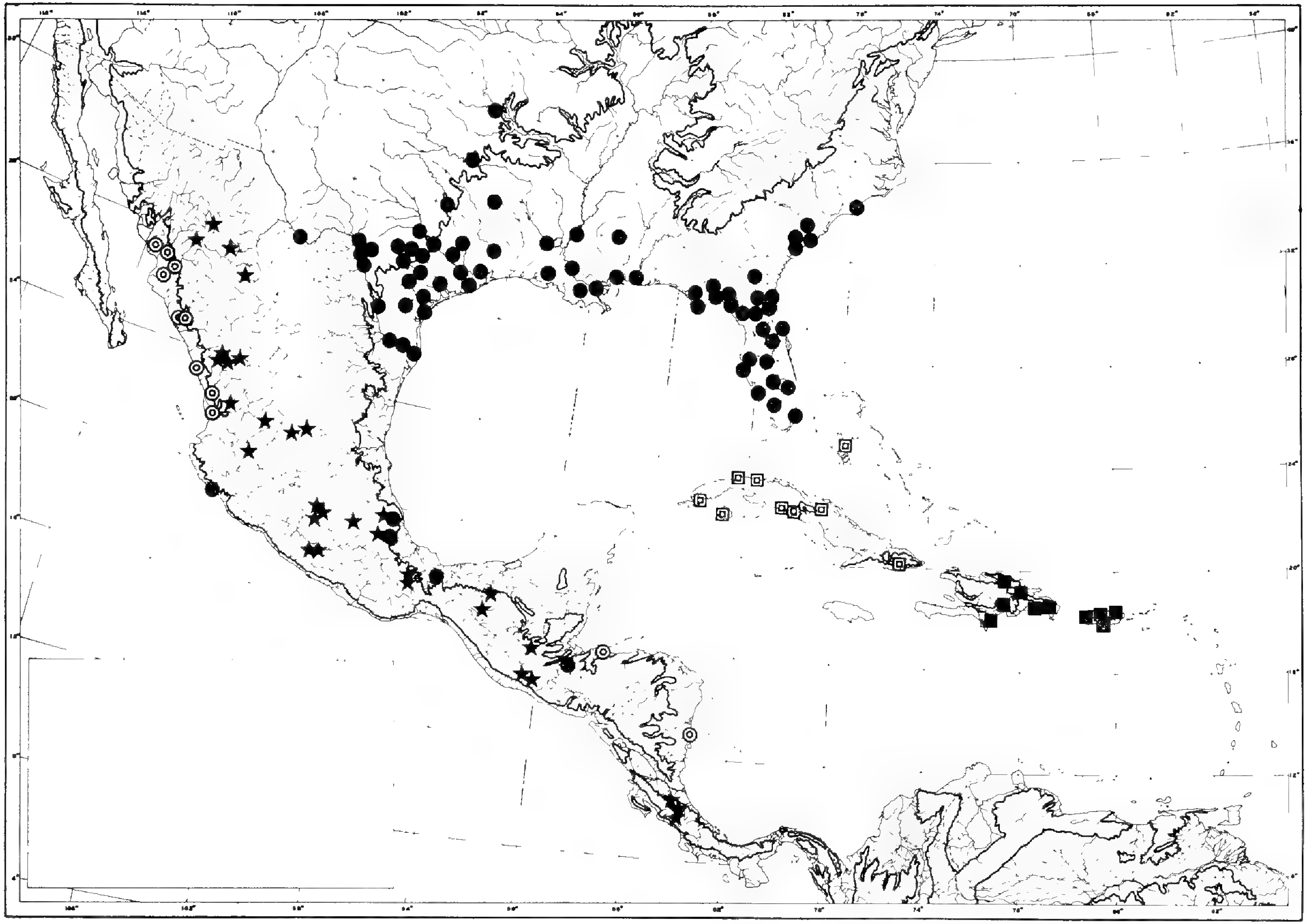
Map 6. Distribution of the "pinnatifid-spatulate leaved" members of *Rorippa curvisiliqua* and *R. microtitis*: ● *R. curvisiliqua* var. *procumbens*, ■ *R. curvisiliqua* var. *lyrata*, ◇ *R. curvisiliqua* var. *spatulata*, ○ *R. curvisiliqua* var. *occidentalis*, ★ intermediates between var. *procumbens* and var. *lyrata*, □ *R. microtitis*.

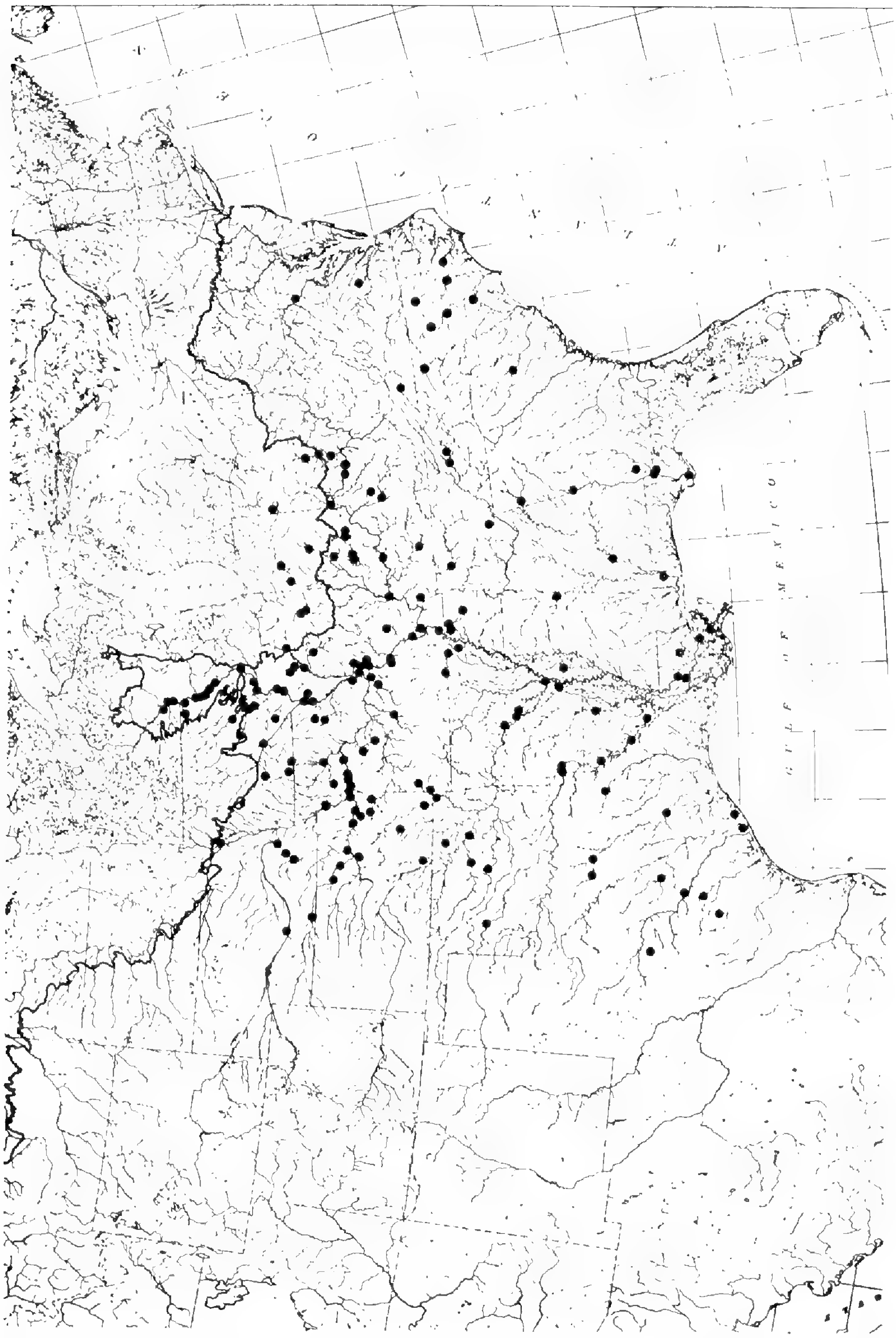


Map 7. Total distribution of *Rorippa curvisiliqua* (dots) and the Arizona and New Mexico distribution of *Rorippa microtitis* (squares) shown in relation to the 16-inch annual rainfall isohyet for western United States. Both species are largely confined to an area that receives more than 16 inches of rainfall a year. (Rainfall data are taken from a 1963 ed. of a map showing normal annual total precipitation (inches), based on data from 1931-60, prepared by the Office of Climatology, U. S. Dep. of Commerce Weather Bureau, U. S. Govt. Printing Office.)

Map 8. Distribution of certain related species of *Rorippa* in southern United States, Mexico, Central America, and the West Indies: ★ *R. mexicana*. This species is in the uplands; ● *R. teres* var. *teres*; ◎ *R. teres* var. *rollinsii*. This species is limited to the Coastal Plain of the continent, except in two places, western Texas of the United States and Veracruz of Mexico. The line marks the 200 meter contour; ■ *R. portoricensis* var. *portoricensis*; ▣ *R. portoricensis* var. *pumilum*. This species is absent from the western part of the island of Hispaniola in Haiti.

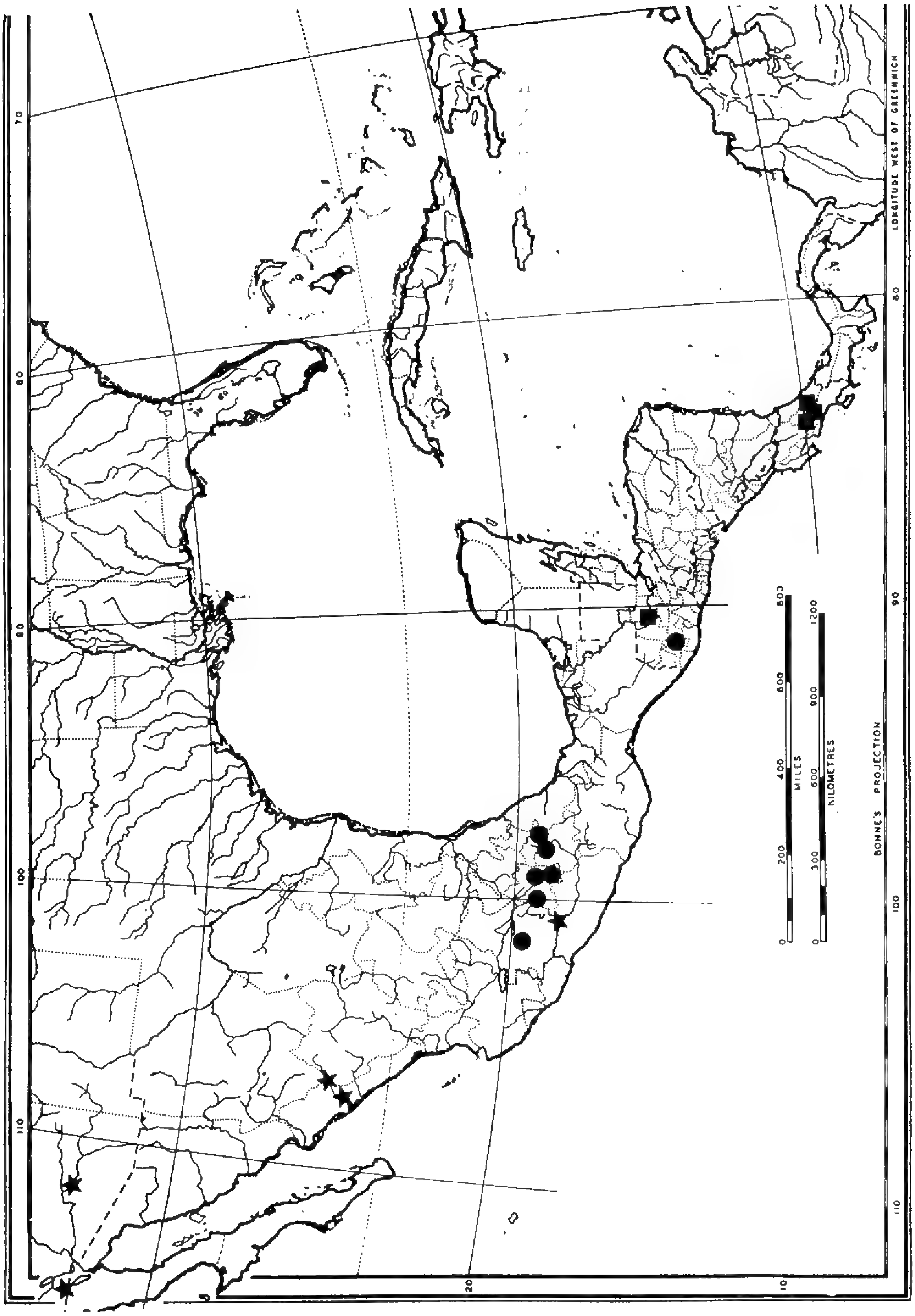
The solid line marks the 200 meter line of elevation throughout the map. The data are taken from two American Geographical Society maps, edition 1-AMS reprinted by Army Map Service (1949), and edition 2-AGS reprinted by Army Map Service (1952).



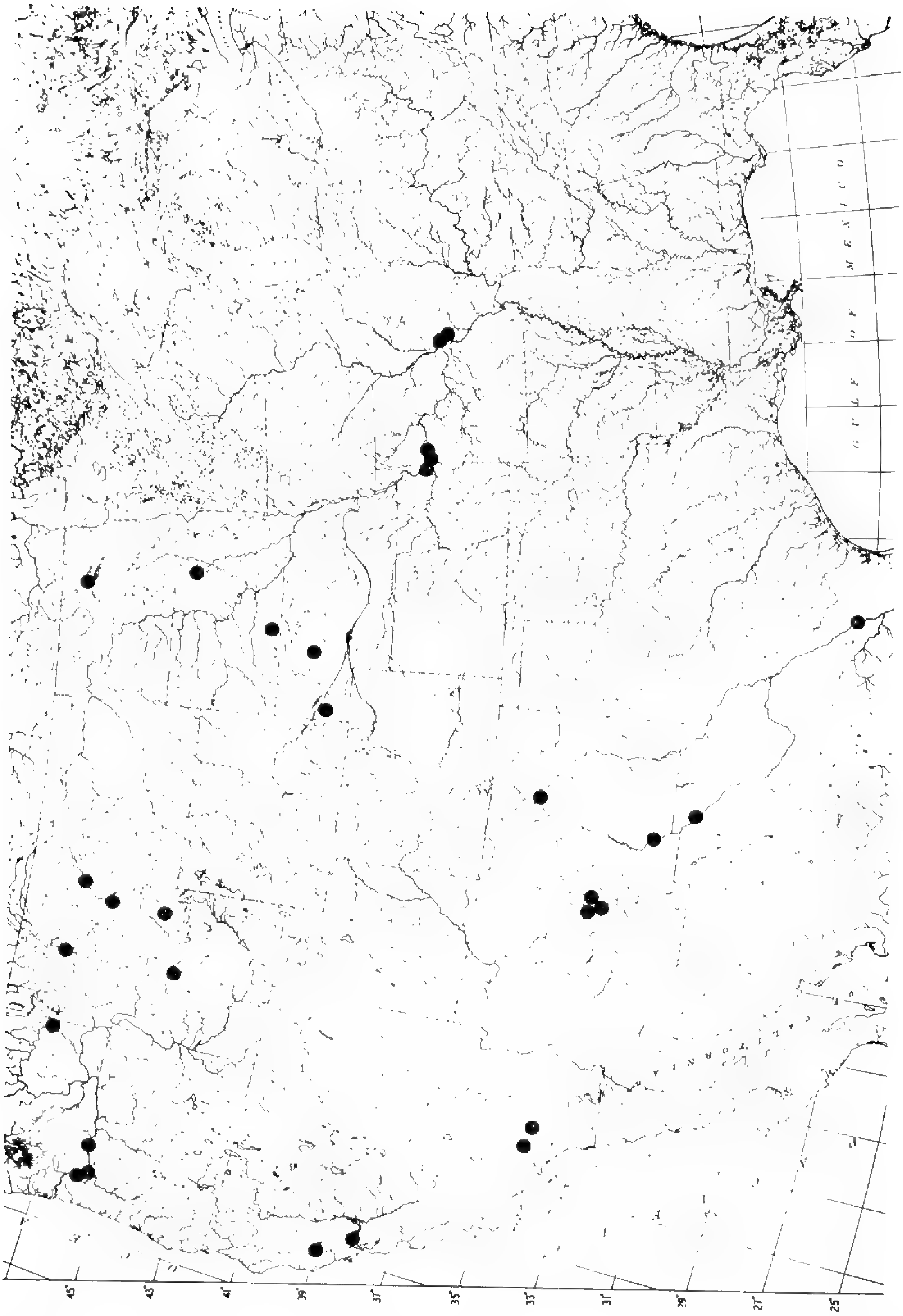


Map 9. Distribution of *Rorippa sessiliflora* in the Mississippi embayment and southeastern United States.

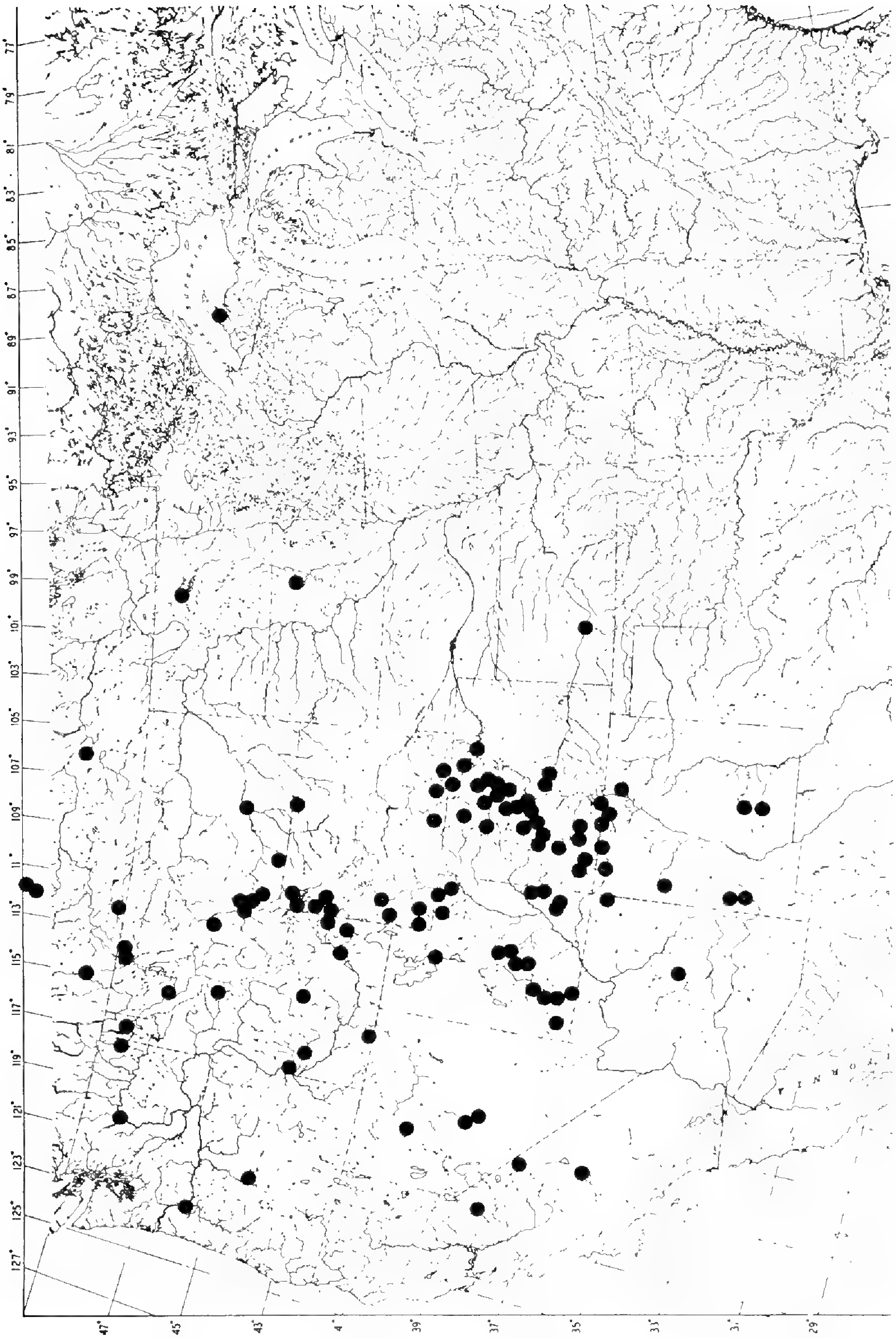
There is a good correlation of the localities with rivers and streams. The solid line represents the southern limit of Wisconsin Glaciation (after Flint *et al.*, 1959).



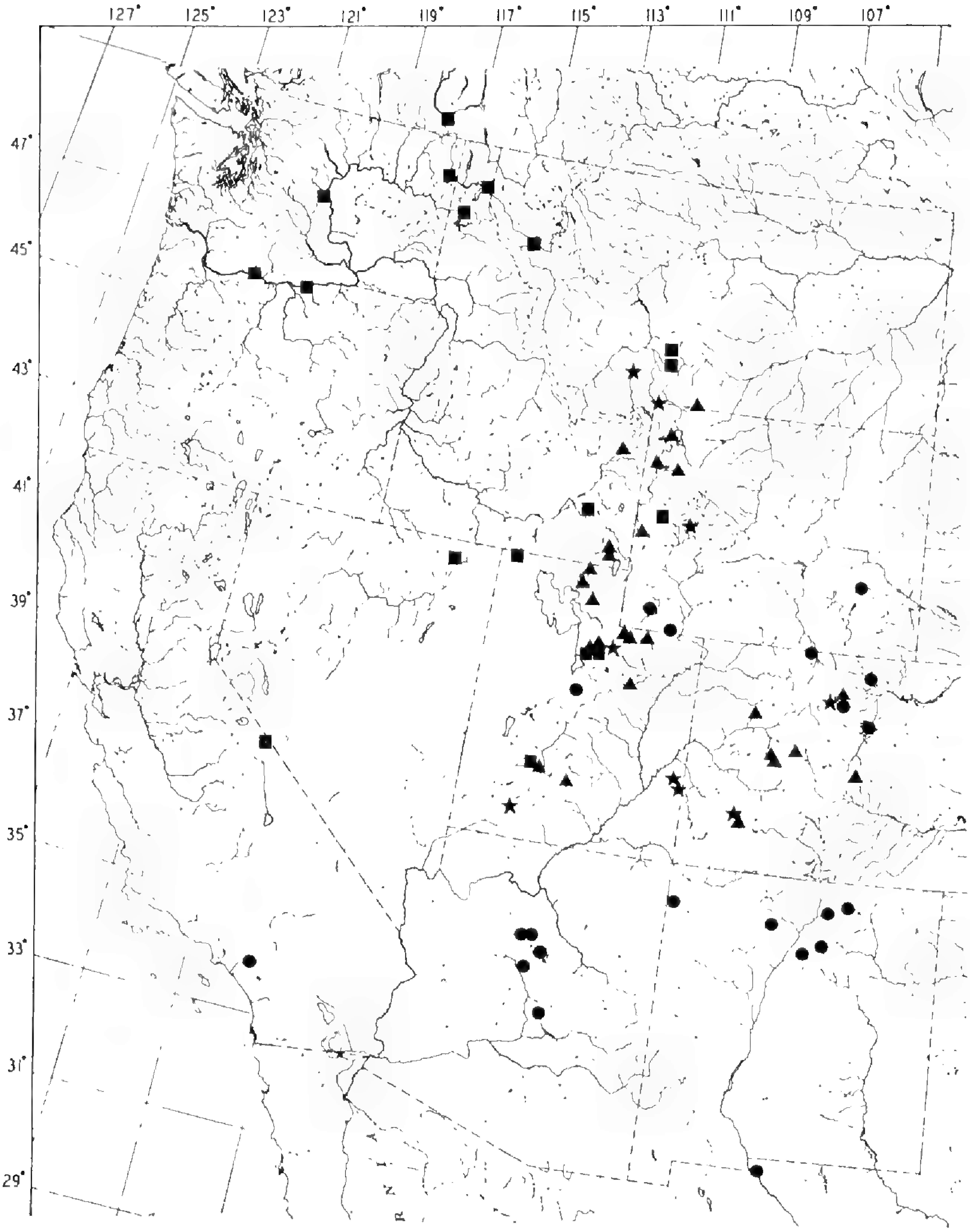
Map 10. Distribution of the pinnate-leaved species of *Rorippa* in southwestern United States, Mexico, and Central America: ■ *R. megasperma*, ● *R. pinnata*, ★ *R. intermedia*.



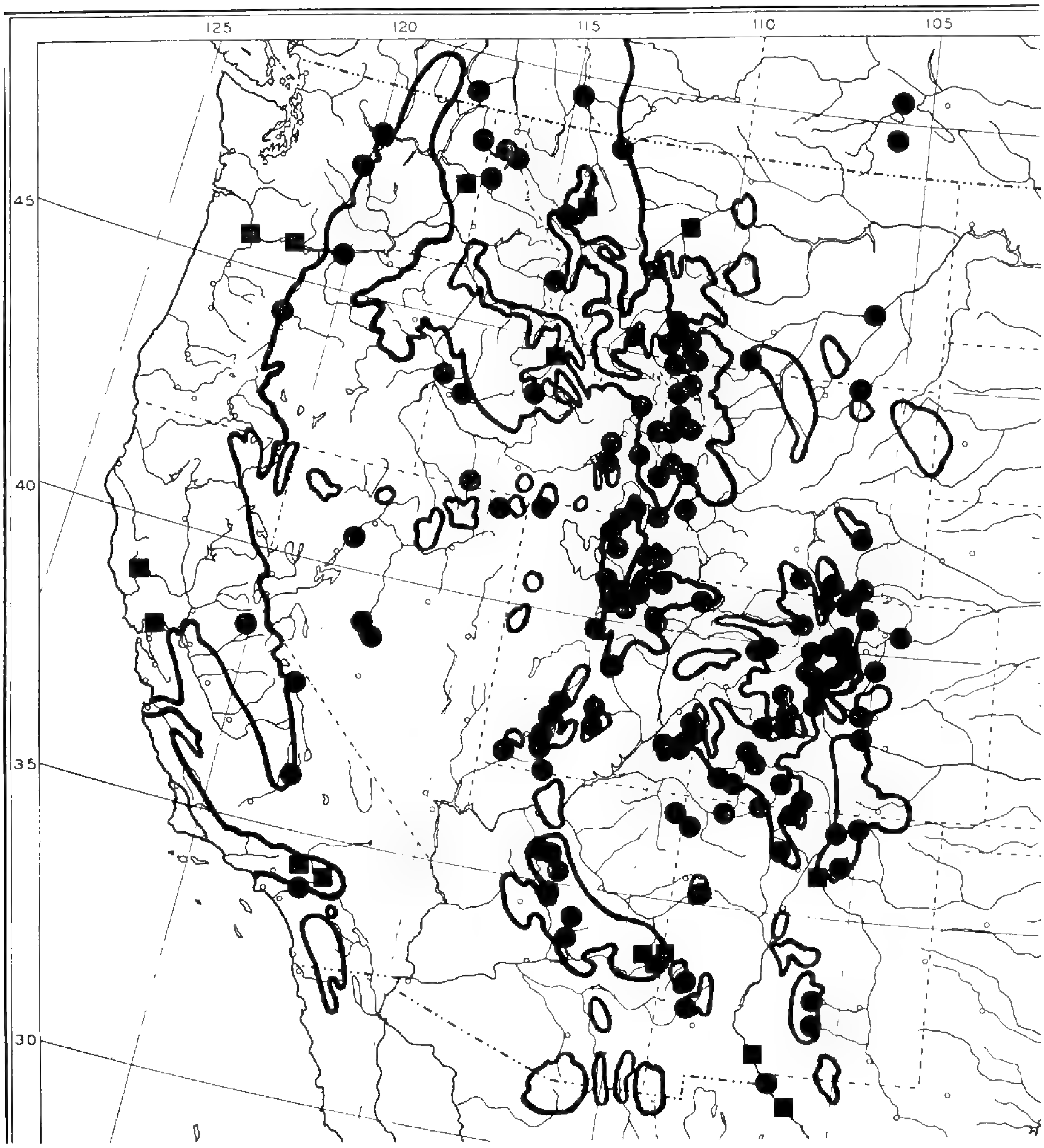
Map 11. Distribution of *Rorippa truncata* in central and western United States. This species is absent in the central Rocky Mountains. Its occurrence is outward from this region in the Rio Grande, Columbia, Platte, and Missouri River valleys.



Map 12. Distribution of *Rorippa curvipes* var. *curvipes* in western United States. The species is most abundant in the Rocky Mountains, occurring less frequently to the west and sparingly east on the plains. The record from Michigan doubtless represents an introduction.



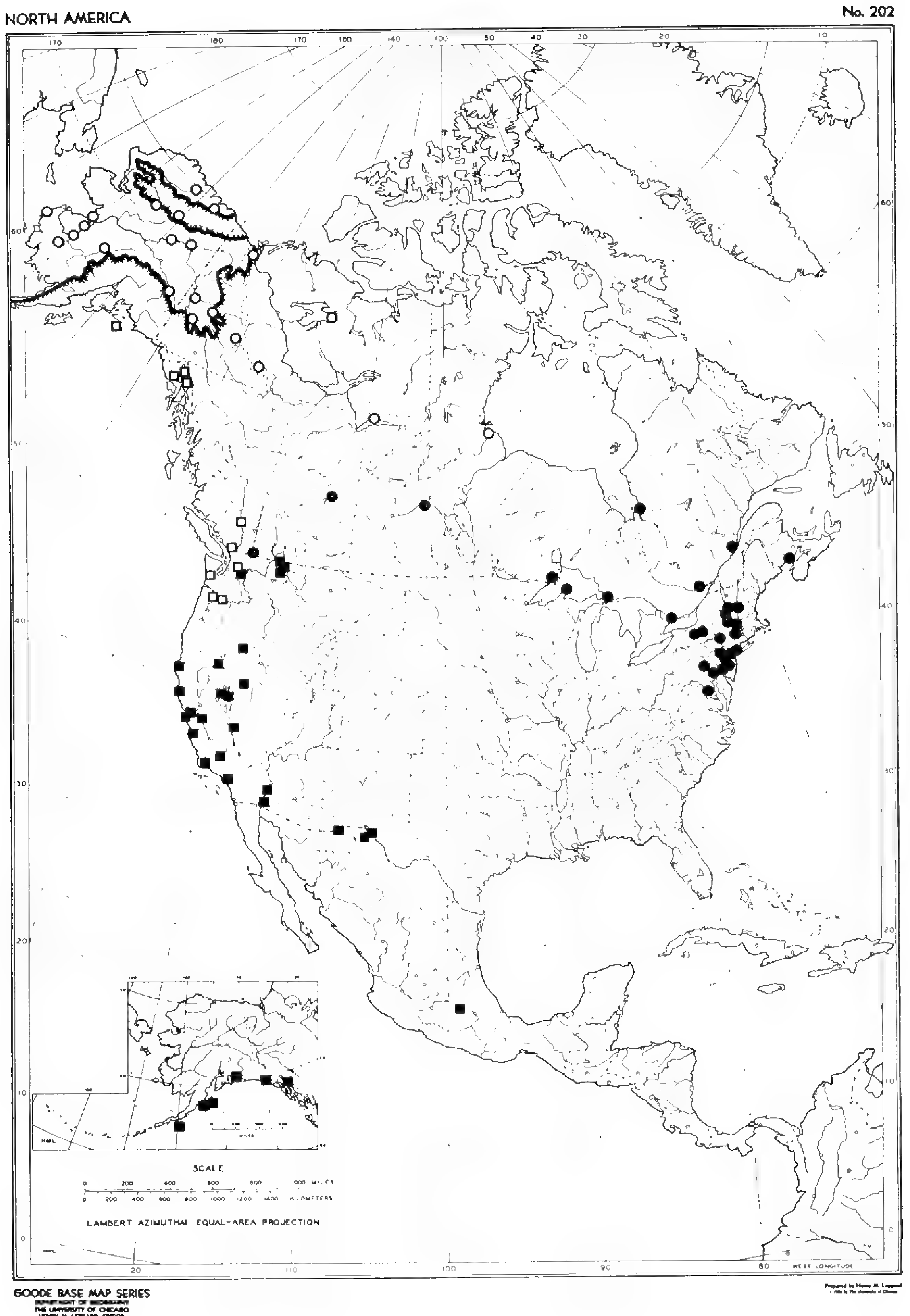
Map 13. Distribution of certain members of the *Rorippa curvipes* complex in western United States: ▲ *R. curvipes* var. *alpina* in the central Rocky Mountains. The triangles are located near the sources of the rivers, indicating that the plants come from high elevations in the mountains, mostly above 9000 feet; ★ *R. curvipes*, intermediates between var. *curvipes* and var. *alpina*. The intermediates have been found mostly along the outer limits of the range of var. *alpina*, mostly between elevations of 8,000 and 10,000 feet; ■ *R. curvipes* var. *integra* in northwestern United States. There has apparently been migration down the Columbia River; ● *R. sphaerocarpa* in southwestern United States.



Map 14. Total distribution of the *Rorippa curvipes* complex shown in relation to the 16-inch annual rainfall isohyet for western United States. (*R. curvipes* and *R. sphaerocarpa* are indicated by dots; *R. truncata* is designated by squares.)

This group of species is largely confined to an area that receives more than 16 inches of rainfall a year. (Rainfall data are taken from a 1963 ed. of a map showing normal annual total precipitation (inches), based on data from 1931-60, prepared by the Office of Climatology, U. S. Dep. of Commerce Weather Bureau, U. S. Govt. Printing Office.)

Map 15. Distribution of *Rorippa palustris* subsp. *palustris* and subsp. *occidentalis* in North America: ● *R. palustris* subsp. *palustris* var. *palustris*; ○ *R. palustris* subsp. *palustris* var. *williamsii*. The half-barred line marks the extent of Pleistocene Glaciation in northwestern North America (after Capps, 1939). The var. *williamsii* is absent from the glaciated territory of southeastern Alaska. The var. *palustris* is considered native to North America, except along the Atlantic coast south of the state of New York where the plants are believed to be introduced from western Europe. ■ *R. palustris* subsp. *occidentalis* var. *occidentalis*; □ *R. palustris* subsp. *occidentalis* var. *clavata*. The subsp. *occidentalis* is mostly west of the Continental Divide in the United States. In Alaska it is confined to the coast.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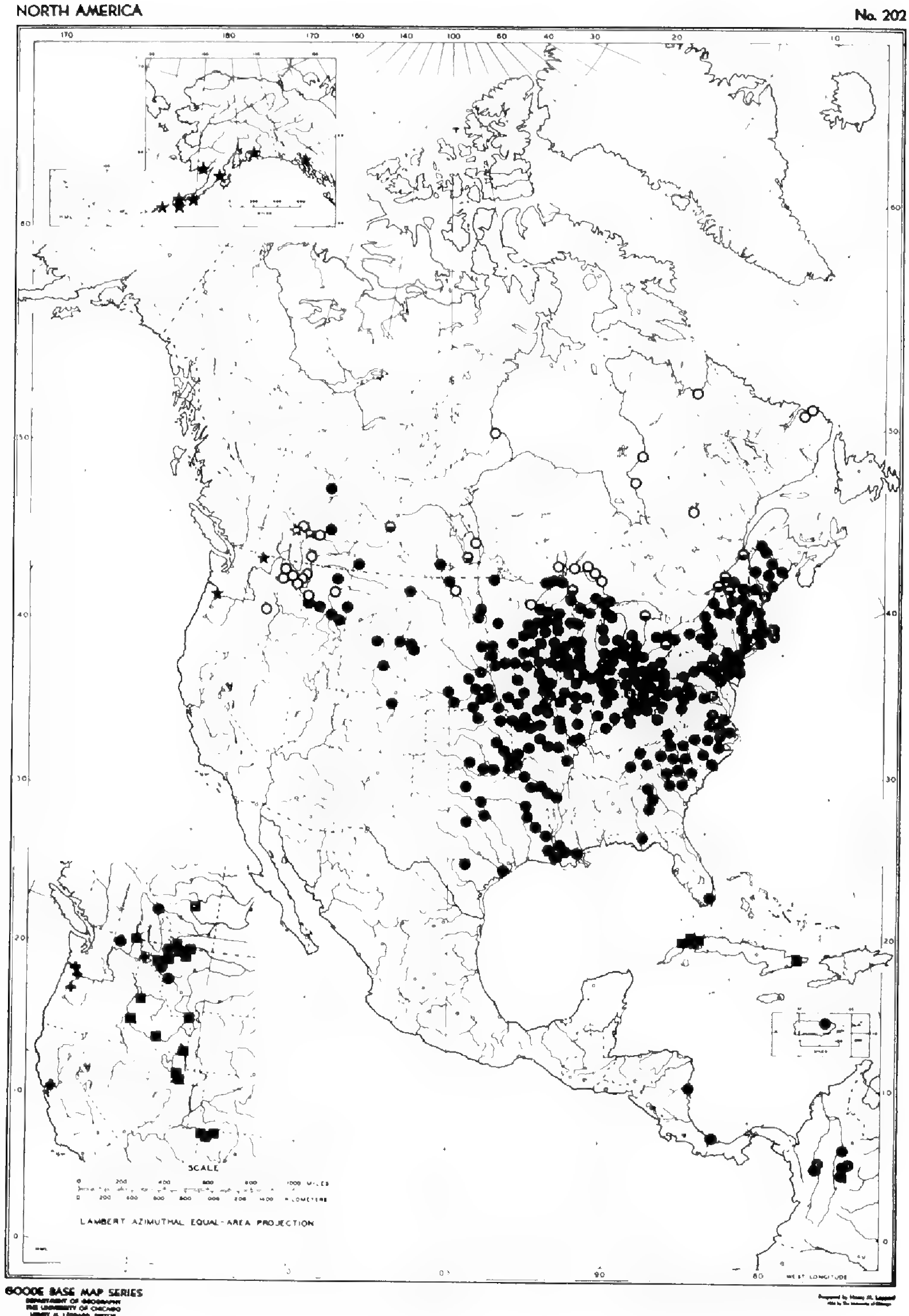
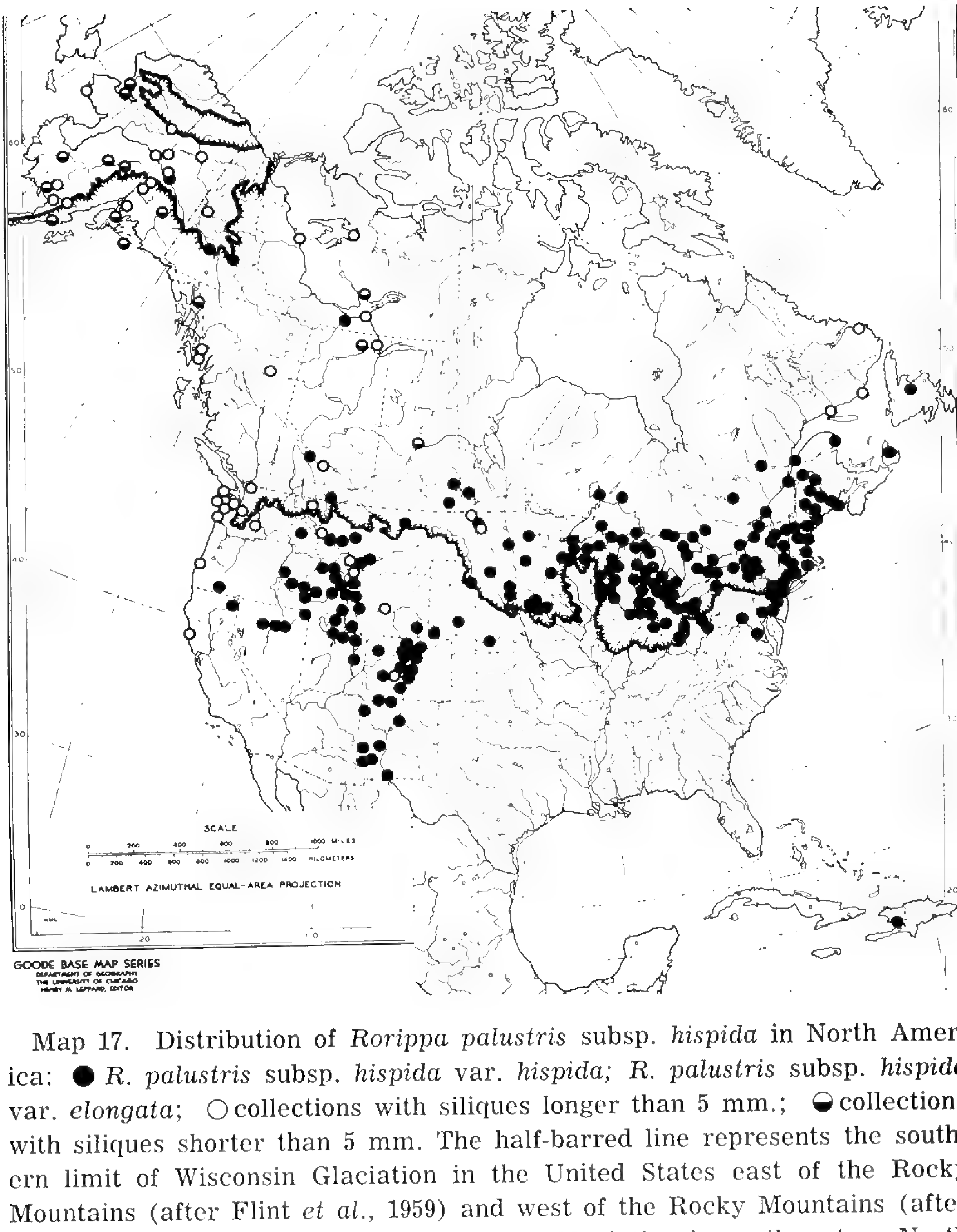
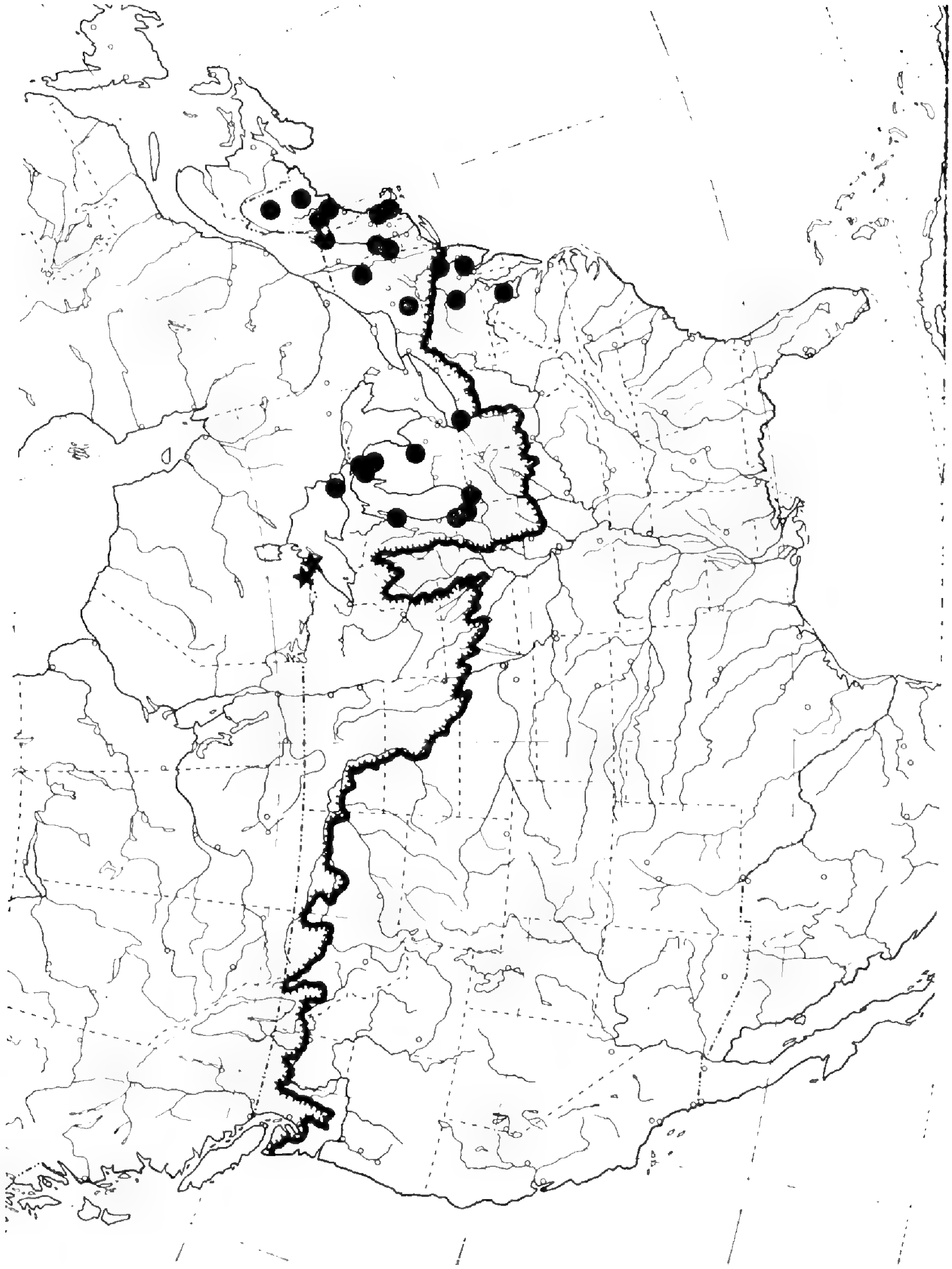


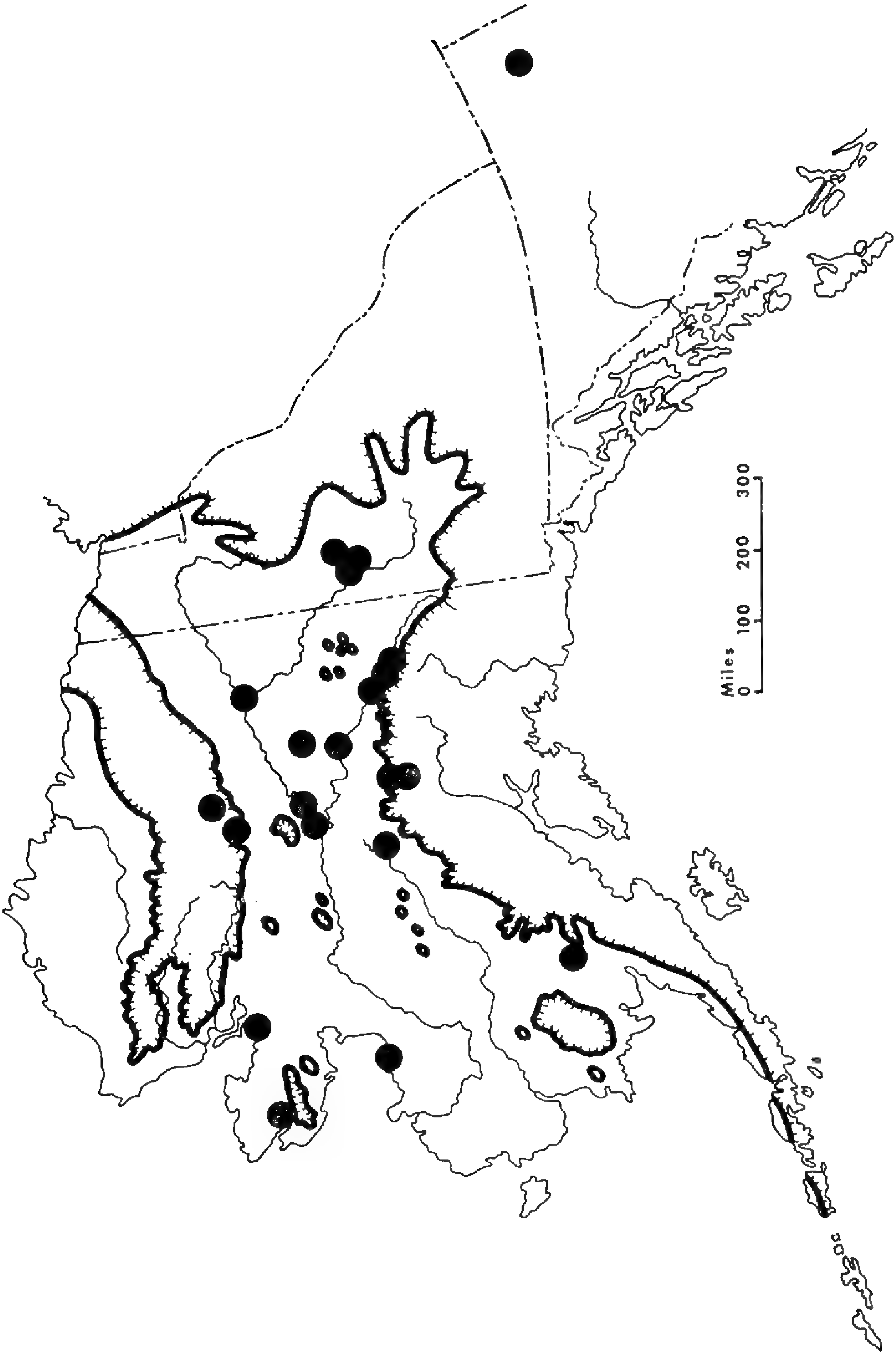
Map 16. Distribution of *Rorippa palustris* subsp. *glabra* in North America: ■ *R. palustris* subsp. *glabra* var. *glabra*; ✚ *R. palustris* subsp. *glabra* var. *dictyota*; ● *R. palustris* subsp. *glabra* var. *fernaldiana*; ○ *R. palustris* subsp. *glabra* var. *glabrata*; ★ *R. palustris* subsp. *glabra* var. *cernua*; ◒ intermediates between var. *glabrata* and var. *fernaldiana*; ☆ intermediates between var. *glabrata* and var. *cernua*.



Map 17. Distribution of *Rorippa palustris* subsp. *hispida* in North America: ● *R. palustris* subsp. *hispida* var. *hispida; R. palustris* subsp. *hispida* var. *elongata*; ○ collections with siliques longer than 5 mm.; ◒ collections with siliques shorter than 5 mm. The half-barred line represents the southern limit of Wisconsin Glaciation in the United States east of the Rocky Mountains (after Flint *et al.*, 1959) and west of the Rocky Mountains (after Flint, 1957), and the extent of Pleistocene Glaciation in northwestern North America (after Capps, 1939). The var. *hispida* is mostly in the Rocky Mountain region of western United States and on glaciated territory in eastern United States. The var. *elongata* occurs along the north shore of the Gulf of the St. Lawrence. In northwestern North America it is absent from the glaciated territory of northern Alaska.

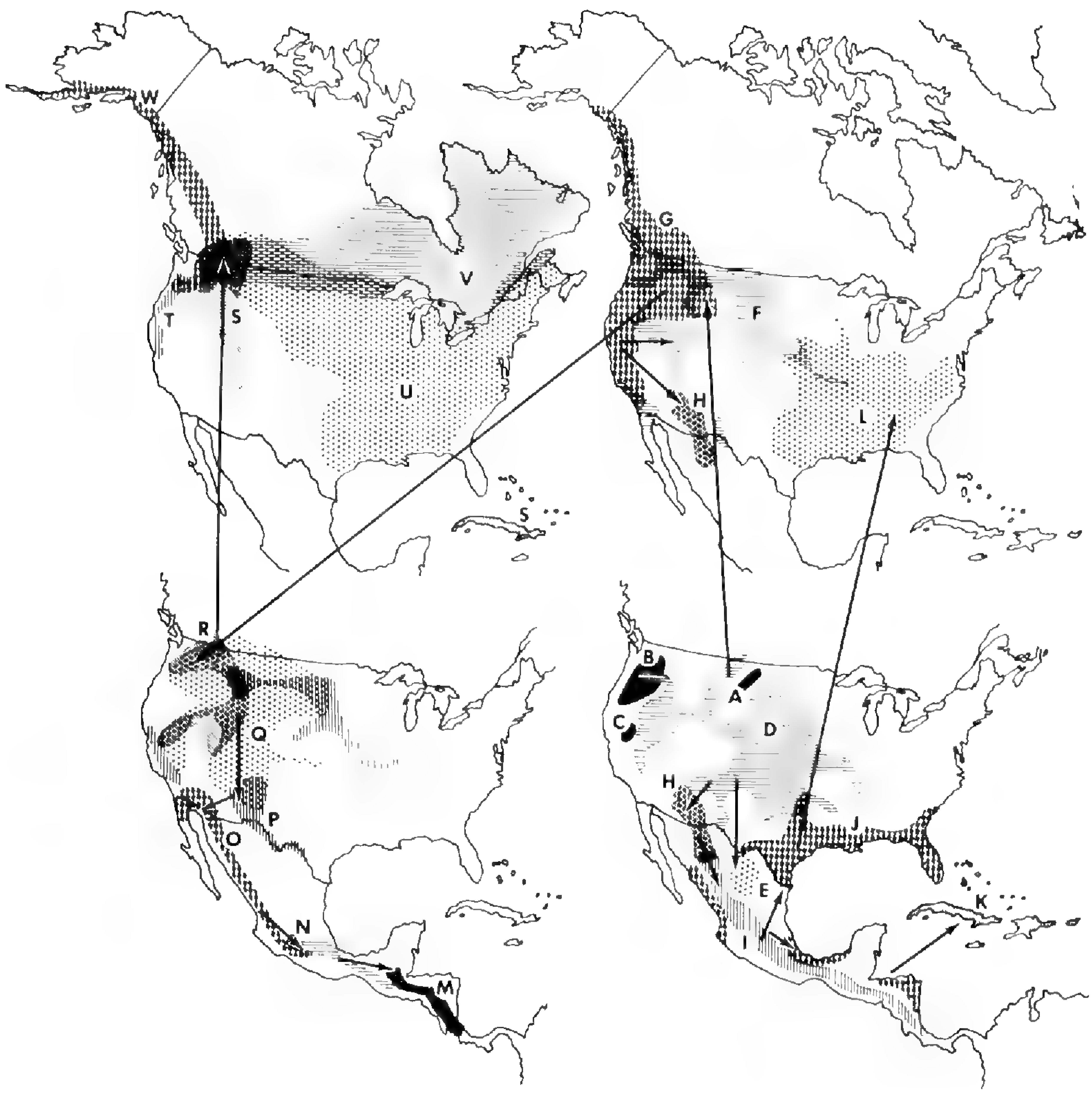


Map 18. Distribution of two hybrids within *Rorippa palustris* in glaciated eastern United States: ● *R. palustris* subsp. *hispida* var. *hispida* × subsp. *glabra* var. *fernaldiana*; ★ *R. palustris* subsp. *palustris* var. *palustris* × subsp. *hispida* var. *hispida*. The half-barred line represents the southern limit of Wisconsin Glaciation east of the Rocky Mountains (after Flint *et al.*, 1959) and west of the Rocky Mountains (after Flint, 1957).



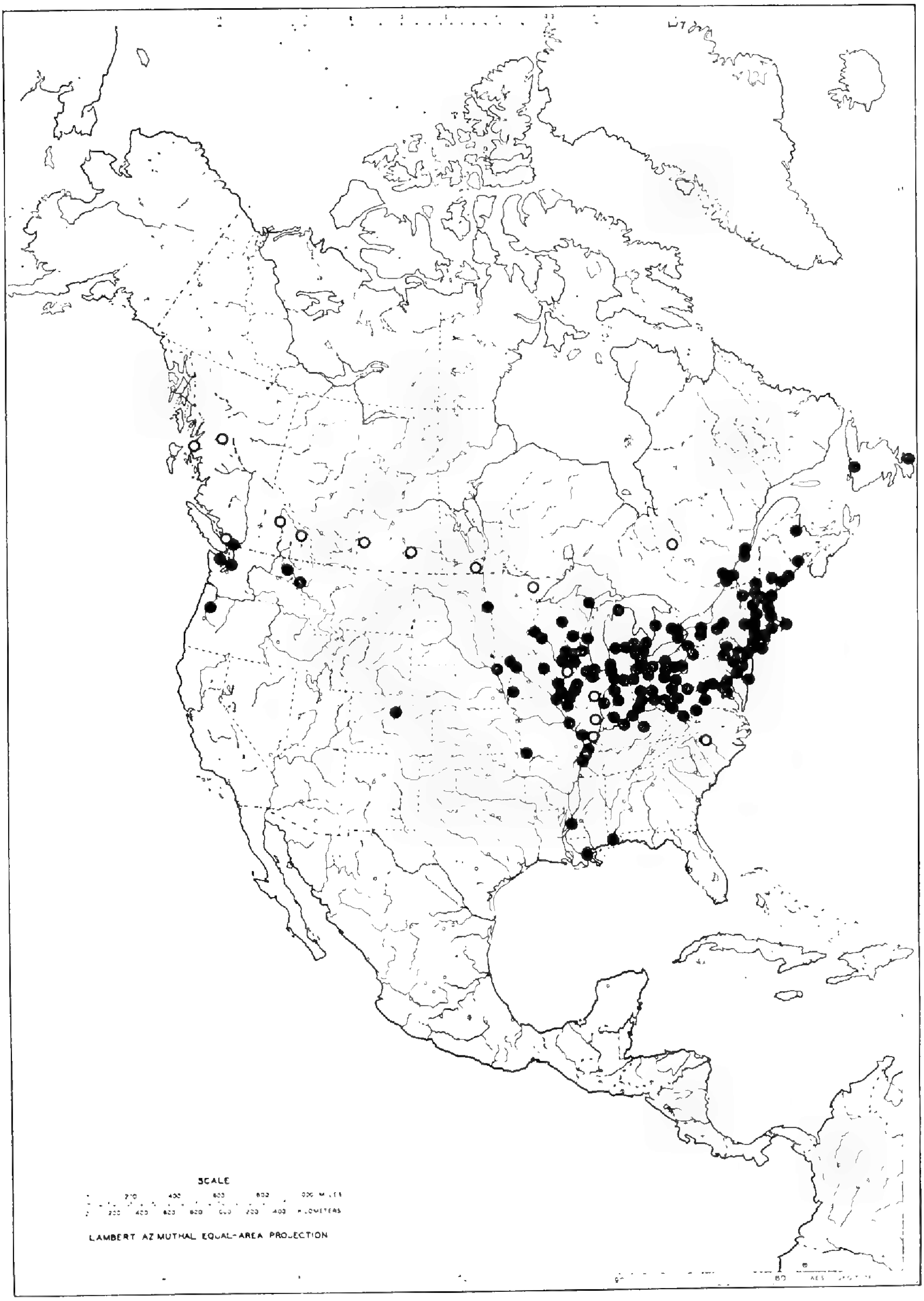
Map 19. Distribution of *Rorippa barbareifolia* in northwestern North America. The half-barred line marks the extent of Pleistocene Glaciation (after Capps, 1939). The localities are mostly from the region of unglaciated central Alaska.

GEOGRAPHICAL AND EVOLUTIONARY RELATIONSHIPS IN RORIPPA



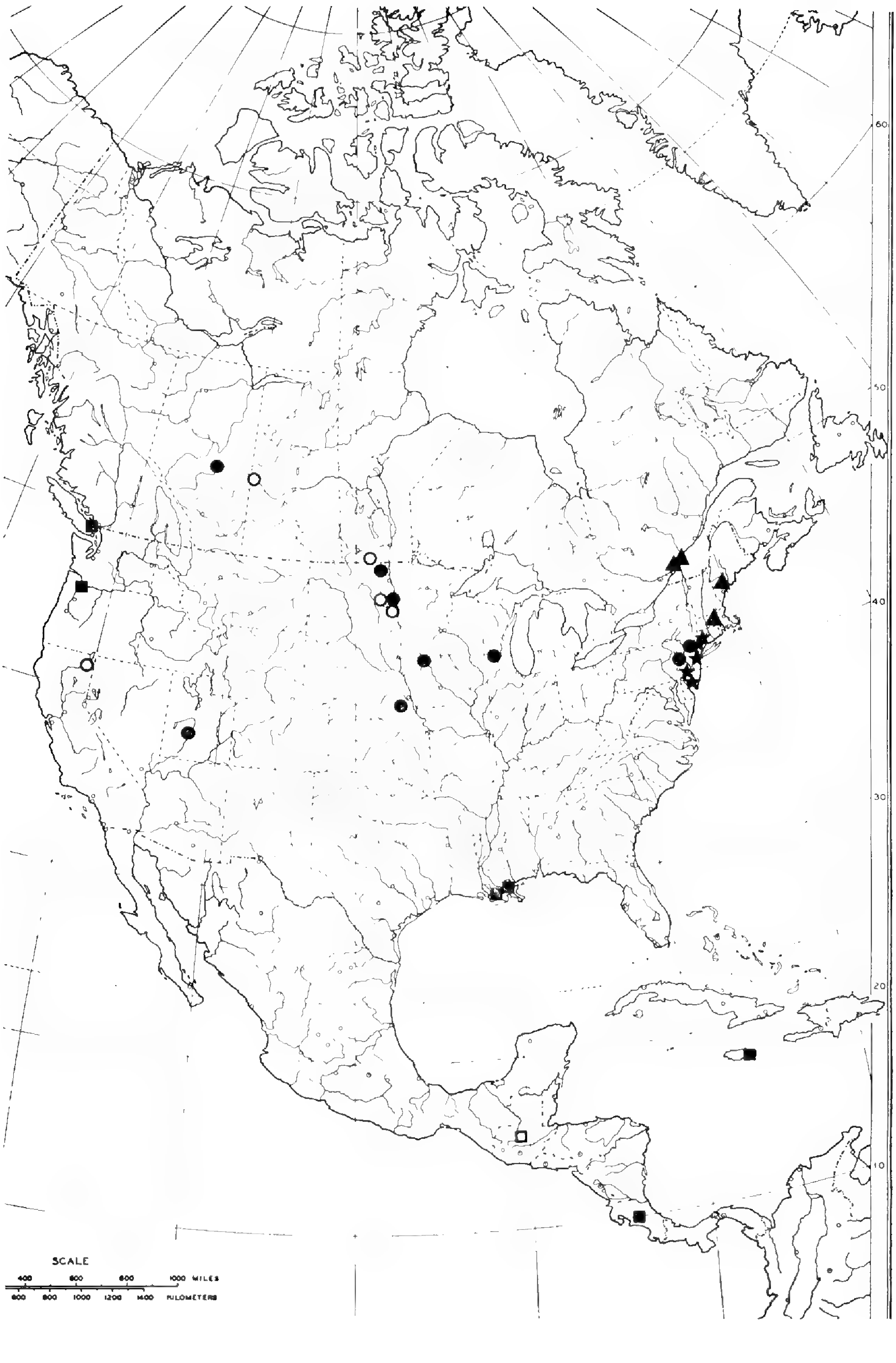
Map 20. Summary of the Geographical and Evolutionary Relationships in North American *Rorippa*.

To read the plate in its entirety, begin with taxon D, *R. sinuata*, a species with primitive characters. Additional information in the text. A. *Rorippa calycina*; B. *R. columbiae* (Map 1-A); C. *R. subumbellata* (Map 1-B); D. *R. sinuata* (Map 2); E. *R. ramosa* (Map 3); F. *R. tenerrima* (Map 4); G. *R. curvisiliqua* (Maps 5 and 6); H. *R. microtitis* (Map 6); I. *R. mexicana* (Map 8); J. *R. teres* (Map 8); K. *R. portoricensis* (Map 8); L. *R. sessiliflora* (Map 9); M. *R. megasperma* (Map 10); N. *R. pinnata* (Map 10); O. *R. intermedia* (Map 10); P. *R. truncata* (Map 11); Q. *R. curvipes* var. *curvipes* (Map 12); R. *R. curvipes* var. *integra* (Map 12); S. *R. palustris* subsp. *glabra* var. *glabra* (Map 16); T. *R. palustris* subsp. *glabra* var. *dictyota* (Map 16); U. *R. palustris* subsp. *glabra* var. *fernaldiana* (Map 16); V. *R. palustris* subsp. *glabra* var. *glabrata* (Map 16); W. *R. palustris* subsp. *glabra* var. *cernua* (Map 16).



Map 21. Distribution of *Rorippa sylvestris* in North America: ● *R. sylvestris*, based on specimens examined; ○ *R. sylvestris*, based on literature records.

Map 22. Distributions of four introduced species of *Rorippa* in North America: ● *R. austriaca*, based on specimens examined; ○ *R. austriaca*, based on literature records; ■ *R. heterophylla*, based on specimens examined; □ *R. heterophylla*, based on literature records; ▲ *R. amphibia*, based on specimens examined; ★ *R. prostrata*, based on specimens examined. These distributions do not correlate with natural physiographic or glacial features, as do those of the native species and varieties.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INDEX

NAMES: synonyms—italics; new taxa—boldface; other names—roman. PAGE NUMBERS: main entry for *Rorippa* names and synonyms—boldface; illustrations—italics; other names—roman.

SIDA

INDEX TO VOLUME 4

Names of contributing authors are in capital letters. New scientific names are in boldface. Synonyms are in italics. Page numbers in boldface are the main entry for the taxon involved. Page numbers in italics are of those on which an illustration appears. Generic names in article titles are indexed to the first page of the article only.