Rhodora

JOURNAL OF THE NEW ENGLAND BOTANICAL CLUB

Vol. 86 January 1984 No. 845

The New England Botanical Club, Inc.

Botanical Museum, Oxford Street, Cambridge, Massachusetts 02138

Conducted and published for the Club, by
NORTON H. NICKERSON, Editor-in-Chief

RHODORA.—Published four times a year, in January, April, July, and October. A quarterly journal of botany, devoted primarily to the flora of North America. Price $20.00 per year, net, postpaid, in funds payable at par in the United States currency at Boston. Some back volumes and single copies are available. Information and prices will be furnished upon request. Subscriptions and orders for back issues (making all remittances payable to RHODORA) should be sent to RHODORA, Botanical Museum, Oxford Street, Cambridge, Mass. 02138. In order to receive the next number of RHODORA, changes of address must be received prior to the first day of January, April, July or October.

Scientific papers and notes relating to the plants of North America and floristically related aras will be considered by the editorial committee for publication. Articles concerned with systematic botany and cytotaxonomy in their broader implications are equally acceptable. Brevity is urged whenever possible in all papers. Short items will be published on otherwise blank end pages as soon as possible, even if they appear ahead of longer articles already accepted. All manuscripts should be submitted in TRIPLICATE AND MUST BE DOUBLE (AT LEAST 3/8 OF AN INCH) OR TRIPLE-SPACED THROUGHOUT. Please conform to the style of recent issues of the journal. See "Instructions to Contributors to RHODORA" at the end of each issue. Extracted reprints, if ordered in advance, will be furnished at cost. RHODORA assesses modest page charges.

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Second Class Postage Paid at Boston, Mass.

PRINTED BY
THE LEXINGTON PRESS, INC.
LEXINGTON, MASSACHUSETTS

Cover illustration

Ledum groenlandicum Oeder, Labrador tea, reaches its southeastern distributional limit in Concord, Mass. It was first collected by Thoreau in 1858, subsequently regarded as extirpated by Richard Eaton in 1974, and rediscovered by Ray Angelo in 1978. Angelo has since found it in two more Concord locations.

Original artwork by Josephine Ewing.

Rhodora
(ISSN 0035-4902)
JOURNAL OF THE
NEW ENGLAND BOTANICAL CLUB

Vol. 86 | January 1984 | No. 845

THE TYPE LOCALITIES OF THE FLORA BOREALI-AMERICANA OF ANDRÉ MICHAUX

LEONARD J. UTTAL

ABSTRACT

Many habitats of the text of the *Flora boreali-americana* of A. Michaux (1803), which is presumed to have been anonymously authored by L. C. M. Richard, have been observed to vary, sometimes drastically, from the field stations on the labels of the type specimens collected by Michaux. Since the field stations are the actual type localities rather then those given in the text, it is important to record them to promote precision in the use of the Michaux flora. A key to the IDC 6211 microfiche set of the Michaux American specimens, which are in the Paris Museum of Natural History, has been devised because the microfiches were found awkward to use. Each non-superfluous name proposed by Michaux is listed and its microfiche key designation is equivalent to an annotation of the specimen as the type.

Key Words: Michaux flora, type localities, field/text variances

INTRODUCTION

In the course of work I pursued in *Senecio* L. it was observed that Barkley (1978) had not seen the type of *S. tomentosus* and its type locality was given as "in Carolinae loco dicto Flat-Roc.", after the text of Michaux (1803). The gazetteer prepared by Ewan (1974) for the introduction to a facsimile edition of *Flora boreali-americana* gives Flat Rock as near Hendersonville, Henderson County, North Carolina, and cites it as the type locality of *Sedum pusillum* Michx. and *Senecio tomentosus*. Knowing the montane location of Flat Rock, North Carolina well, and the fact that these lowland species do not occur there, this struck me as incongruous. Neither species was dotted in distribution maps in Radford et al. (1968) for

Henderson County, North Carolina. I then looked up the two types in the IDC microfiche set of Michaux's American specimens and found they both indeed had Flat Rock on the labels. I then read Michaux's journal, as published by Sargent (1889), and found that Michaux had never passed through Flat Rock, North Carolina, but on 23 April 1795 and 6 April 1796 he passed Flat Rock, South Carolina, en route northwest from Charleston, South Carolina. I subsequently learned that this Flat Rock is a granite boss in northern Kershaw County, South Carolina, now a quarry, on state highway 58, the old Catawba Road, well within the range of both species, which I found growing in the vicinity, but not at the type locality due to habitat destruction. Flat Rock, South Carolina is the correct type locality of these species, and the Flat Rock of North Carolina was listed in error. The state of anthesis of the specimens indicates that the 6 April 1796 visit was the date of collection.

In addition to the above incongruity, many examples of variation between habitat data given on Michaux's labels and that given in the text of *Flora boreali-americana* became evident. For example, the habitat of *Vaccinium brachycerum* Michx. (= *Gaylussacia brachycera* (Michx.) A. Gray) is given in the text as Virginia, circa *Winchester,* but the habitat on the label reads "Warm Spring". There are numerous "Warm Springs" in the Winchester area, but Warm Spring is used in the singular on old maps only for Warm Spring Road, present-day US 252, which passes east and west through Winchester. Michaux passed through Winchester several times and could well have collected at this station. Repeated searches for the species in this region have been fruitless. It is obvious from Michaux's journal that he neither passed through present Warm Springs, Bath County, Virginia, where the species does now grow, nor old Warm Springs of Berkeley County, now Berkeley Springs, West Virginia. The Winchester type locality of the species remains enigmatic.

Francois-André Michaux, an eminent botanist in his own right, who wrote the introduction to the *Flora* credited to his father[1] states that each specimen was accompanied by a sheet of information "too prolix" for publication. These sheets, presumably in the Paris Museum, are not presently available to me, but a study of them

[1]The *Flora* is believed to have been anonymously authored by L. C. M. Richard - *see* Stafleu and Cowan (1982).

might further add to the precision of the type localities of Michaux's North American collections. This study is based on a study of photographs of the specimens and their labels of IDC microfiche set 6211.

To use this present delineation of type localities it is necessary to slightly augment the gazetteer prepared by Ewan (1974) of Michaux's collecting stations. Additional place names which appear on Michaux's labels which are absent from the *Flora* are as follows:

Florida

Northwest River; Midwest River; those portions of the St. John's River geographically relative to St. Augustine, the Spanish capital of Florida, in St. John's and Clay Counties.

Tomoka River; in northeast Volusia county, north of Ormond Beach.

Georgia

Sunbury; in Long County, on south bank of mouth of Canoochee River, circa 10 miles south of Savannah.

Illinois

Fort Massac; Massac County, on Ohio River between Metropolis and Brockport, now a state park.

"Kaokia"; = Cahokia, St. Clair County.

Prairie du Rochier; Randolph County, a bluff on the Mississippi River, 21 miles northwest of Chester.

Kentucky

Big Barren River; Barren Oaks; Barren County.

"Piercetown"; apparently transliterated from Beardstown in Michaux's journal, presumably now Bardstown, Nelson County.

New York

Lasinburgh; = Lansingburg, Renssalaer County, now incorporated in Troy.

"Mountains near Lasinburg"; presumably a range of hills 10 miles east of Troy dominated by Rock Candy Mountain.

North Carolina

Davenport; an old rest stop at foot of Yellow Mountain, near Minneapolis, Avery County.

Fayetteville; Cumberland County.

Hill's Iron Works; actually in South Carolina on east bank of

Catawba River in York County, 32 miles north of Cane Creek (Lancaster County), according to Michaux's journal. Collecting done in North Carolina, across the river from this reference point, presumably was in Union County, near Waxhaw.

South Carolina

Fields of Caffet; not identified, believed to be in vicinity of Charleston.

Gaillard Road; present State Road 357, in Berkeley County, 7 miles southeast of Moncks Corner.

Garet Place; not identified, but believed to be in vicinity of Charleston.

Flat Rock; not in Henderson County, North Carolina, but in north Kershaw County, South Carolina, presently a quarry on State Road 58, 0.4 mile south of Lancaster County boundary.

Goose Creek; Berkeley County.

Nine Mile Brook (Ruisseau de Neuf Milles); unidentified but believed to be in vicinity of Charleston.[2]

Two Sisters: a ferry on the Savannah River north of the city of Savannah, with the Carolina dock in Beaufort County.

Virginia

Warm Spring; believed to refer to the Warm Spring Road (present US 252) running west out of Winchester in Frederick County.

Current taxonomic names used in this study for Michauxian equivalents represent, in the author's judgment, prevailing names in current manuals; not necessarily the most recently published combinations, but names which will be familiar to most botanists. Rarely a name recently published, not yet in manuals but widely accepted, is used. If an asterisk (*) follows the name it means an alternate name is present in the National List of Scientific Plant Names (1982). In any case, botanists can derive names they may prefer from names I use. Manuals particularly useful in this study are Cronquist (1980), Gleason and Cronquist (1963), Godfrey and Wooten (1979, 1981), and Radford, Ahles, and Bell (1968). Reference to several botanically historical works was frequent, and reference to geography and history was indispensable. *Index Kewensis* was virtually constantly used.

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[2]Michaux's plantation was at Ten Mile Station (10 miles north of old Charleston).

In the course of this study, the microfiche set of Michaux's North American collections (IDC 6211) was found awkward to use. It frequently deviated from the sequence of species in the *Flora* and lacked an index so that the user often had to resort to trial and error in locating a particular photograph of a specimen. To correct this situation a key to the type specimens photographed for the microfiche was devised which is very simple to use. There are twenty-one photographs on each microfiche film card, reading from left to right, and each film is numbered. Thus the microfiche photograph of *Senecio lyratus* Michx. is 99:13, 99 being the microfiche card number, 13 the particular specimen. This key appears in the upper right of each entry which follows and each such designation is equivalent to the selection of the specimen photographed as the holotype, if single, or lectotype, if one of a series.

Michaux's names and handwritten data are presented *sic*. Superfluous names are omitted. In general, the order of species follows the *Flora* text, but it is occasionally desirable to deviate from this sequence to keep the sequence of the microfiches in approximate order. In any case, the genus can be located in the *Flora* index. The few non-vascular types in the Michaux *Flora* were not considered practical to treat in this paper. There are 747 entries of types which follow.

EXAMPLES OF FORMAT OF VARIOUS ENTRIES

(Volume and page number in *Flora*) (Microfiche key number)

2: 120 *Senecio lyratus* Michx. 99: 13

T: in nemoribus Carolinae (Habitat in *Flora* text).

M: pastures arides pres Charlest. Printems. (Habitat on Michaux's specimen label, the actual type locality). *Senecio glabellus* Poir. (Prevailing present name. If asterisk follows, = alternative name in *National List of Scientific Plant Names.)*

In case the Michaux name is the presently accepted name and there are no locality data on the label, or the label data are exactly the same as the text data, the taxon will be listed (1) to give its microfiche key number and (2) to indicate that the specimen photographed is annotated as the type. The text habitat is accepted for the present. Format:

2: 117 *Solidago glomerata* Michx. 99: 12

Where the locality data situation is the same as above, but the present name is different than the one proposed by Michaux, the format will be the same except to show the prevailing current name, i.e.:

2: 121 *Doronicum nudicaule* Michx. 99: 21
Arnica acaulis (Walt) BSP

In a few cases the microfiche picture of a type was not located. In such an entry, the microfiche key space is left blank and the *Flora* text data are accepted as diagnostic.

ACKNOWLEDGMENTS

The gracious abundant counsel throughout the course of this study by Duncan Porter is gratefully acknowledged.

This study could not have been completed without the facilities and assistances of the Newman Library of Virginia Polytechnic Institute and State University, generously proffered and administered.

Financial assistance toward publication was provided by the Virginia Flora Committee.

ENTRIES OF TYPES

MICHAUX VOL. I

1:2 *Salicornia ambigua* Michx.
Salicornia virginica L.

1:6 *Gratiola quadridentata* Michx. 1:4
Gratiola ramosa Walt.

1:7 *Gratiola anagallidea* Michx. 1:3
T: in humidus Carolinae.
M: in umbrosus humidis Carolinae. Basse Carolina.
Lindernia anagallidea (Michx.) Pennell

1:7 *Gratiola pilosa* Michx. 2:2

1:8 *Justicia humilis* Michx. 2:9
Justicia ovata var. *lanceolata* (Chapm.) R. W. Long

1:7 *Justicia pedunculosa* Michx. 2:7
T: in littoribus hieme inundatis fluminum Ohio, S. Laurentii, Mississippi.
M: Ohio, Fl. S. Laurent.
Justicia americana (L.) Vahl

1:9 *Elytraria virgata* Michx. 2:14
T: in humidis Carolinae inferioris.
M: Carolina
Elytraria caroliniensis (J. F. Gmel.) Pers. var. *caroliniensis*

1:10 *Micranthemum orbiculatum* Michx. 2:15
Micranthemum umbrosum Walt. in J. F. Gmel.

1:11 *Pinguicula elatior* Michx. 3:3
Pinguicula caerulea Walt.

1:11 *Pinguicula acutifolia* Michx. 3:1
Pinguicula villosa L.

1:11 *Pinguicula pumila* Michx. 2:21

1:12 *Utricularia ceratophylla* Michx. 2:17
Utricularia inflata Walt.

1:13 *Utriculata cornuta* Michx. 2:18

1:14 *Utriculata setacea* Michx. 2:19
Utriculata gibba L.

1:13 *Cunila glabella* Michx. 3:11
Satureja glabella (Michx.) Briquet var. *glabella*

1:14 *Lycopus uniflorus* Michx. 3:17
T: ad Lacus S-Joannis et Mistassins.
M: Lac St. Jean au Lac Mistassins.

1:15 *Salvia angustifolia* Michx. 4:7
Salvia azurea Lam.

1:16 *Monarda allophylla* Michx. 4:14
Monarda fistulosa L. var. *fistulosa*

1:17 *Collinsonia tuberosa* Michx. 5:9

1:18 *Valeriana pauciflora* Michx. 5:18

1:20 *Elodea canadensis* Michx. 5:18
T: in rivulis Canadae.
M: env. de Montreal.

1:20 *Hertieria Gmelini* Michx. 5:21
Lachnanthes caroliniana (Lam.) Dandy

1:23 *Xyris brevifolia* Michx. 6:5
T: in pratensibus udis Georgiae inferioris.
M: Georgia.

1:24 *Commelina longifolia* Michx. 6:11
Commelina virginica L.

1:27 *Cyperus hydra* Michx. 7:3
T: in cultis Virginiae, Carolinae, Floridae.
M: in Virginia maritima Carolina Georgia.

1:27 *Cyperus flavicornus* Michx. 7:1
Cyperus strigosus L.

1:28 *Cyperus virens* Michx. 7:12

1:28 *Kyllingia pumila* Michx. 7:8
Cyperus tenuifolius (Steud.) Dandy

1:29 *Kyllingia maculata* Michx. 7:11
Lipocarpha maculata (Michx.) Torr.

1:29 *Kyllingia ovularis* Michx. 7:11
T: in Georgia et Carolina.
M: jardin Basse Carol. (Charleston? - auth.)
Cyperus ovularis (Michx.) Torr. var. *ovularis*

1:30 *Scirpus quadrangulatus* Michx. 8:2
T: in Carolina
M: in Marais de la Caroline. Fleurit in May et Juin, 1794.
Eleocharis quadrangulata (Michx.) R. & S. var. *quadrangulata*

1:30 *Scirpus tuberculosus* Michx. 7:20
T: in Carolina inferiore.
M: in herbosis humidis Carolina inferioris.
Eleocharis tuberculosa (Michx.) R. & S.

1:30 *Scirpus capillaceus* Michx. 8:3
T: in nova Anglia.
M: Connecticut.
Eleocharis acicularis (L.) R. & S.

1:31 *Scirpus puberulus* Michx.
T: in Carolina et Georgia.
M: in Georgia.
Fimbristylis dichotoma (L.) Vahl

1:31 *Scirpus castaneus* Michx. 8:5
T: in Florida.
M: in Carolina, juxta Tomoka creek (= Tomoka River, Volusia County, Florida—auth.)
Fimbristylis castanea (Michx.) Vahl

1:31 *Scirpus mucronulatus* Michx. 8:21
T: in montibus Carolinae.
M: haute et basse Caroline.
Fimbristylis autumnalis (L.) R. & S.

1:32 *Scirpus maritimus* var. *macrostachyus* Michx.
Scirpus robustus Pursh

1:35 *Scirpus lineatus* Michx. 8:8

1:34 *Eriophorum hudsonianum* Michx. 9:4
T: a sinu Hudsonis ad lacus Mistassins.
M: Lacs Mistassinis.
Eriophorum alpinum L.

1:36 *Schoenus sparsus* Michx. 9:18
T: in umbrosis syslvanum Carolinae, Georgiae.
M: Basse Carolina fôrets ombrages.
Rhynchospora miliacea (Lam.) A. Gray

1:36 *Schoenus longirostirs* Michx. 9:18
T: in Virginia et Carolina.
M: haute et basse Carolina.
Rhynchospora corniculata (Lam.) A. Gray

1:35 *Schoenus inexpansus* Michx. 9:21
Rhynchospora inexpansa (Michx.) Vahl

1:35 *Schoenus rariflorus* Michx. 9:5
Rhynchospora rariflora (Michx.) Ell.

1:36 *Schoenus capitellatus* Michx. 9:11
Rhynchospora capitellata (Michx.) Vahl.

1:36 *Schoenus ciliaris* Michx. 9:10
T: in Florida
M: in Florida, juxta Tomoka Creek (= Tomoka River, Volusia County - auth.)
Rhynchospora ciliaris (Michx.) Mohr

1:36 *Schoenus distans* Michx. 9:7
T: in Carolina.
M: in Carolina, Georgia.
Rhynchospora glomerata (L.) Vahl var. *glomerata*

1:37 *Schoenus fascicularis* Michx. 9:9
Rhynchospora fascicularis (Michx.) Vahl

1:37 *Dichromena leucocephala* Michx. 10:3
T: in Carolina et Georgia.
M: Carolina, 1794
Dichromena latifolia Baldw. ex. Ell.

1:37 *Fuirena squarrosa* Michx. 10:6
T: in paludosis Georgiae et Carolinae
M: Basse Carol et Jardin (Charleston - auth.)

1:38 *Fuirena scirpoidea* Michx. 10:9
T: in paludosis aestate exsiccabilibus Floridae.
M: Le 11 Avril (1787 - auth.) vers le haut de Tomoko riv.

1:39 *Leersia lenticularis* Michx. 10:12
T: in paludosis Illinoensibus.
M: in paludosis regionis Illinoensium.

1:40 *Dilepyrum aristosum* Michx. 10:15
T: in umbrosissylvis Georgiae et Carolinae.
M: in umbrosis Carolinae sylvis
Brachyelytrum erectum (Shreb.) Beauv. var. *erectum*

1:40 *Dilepyrum minutiflorum* Michx. 10:14
T: in apricis, pratensibus regionum Kentucky et Illinoensium.
M: in habitum praestantissinoens ad in Kentucky, Illinoensium.
Muhlengergia schreberi J. F. Gmel.

1:41 *Aristida oligantha* Michx. 10:19
T: in vastissimus pratensibus Illinoensibus.
M: Route des Illinois au fort Massac lieux alternativment submerger parles Pluy.

1:41 *Aristida dichotoma* Michx. 10:21
T: in Carolina superiore, juxta Lincoln in glareosis.
M: in Carolina septentrionali juxta Lincoln.

1:41 *Aristida stricta* Michx. 11:2
T: in Carolina inferiore.
M: in Carolina.

1:42 *Trichodium laxiflorum* Michx. 11:4
T: in humidis et pratensibus a sinu Hudsonis ad Floridam.
M: Pensylvanie.
Agrostis hyemalis (Walt.) BSP

1:42 *Trichodium decumbens* Michx. 11:14
T: a Virginia maritima ad Floridam.
M: in Carolina, praesertim in umbrosis ripariis Amnium.
Agrostis perennans (Walt.) Tuckerm. var. *perennans*

1:44 *Digitaria paspalodes* Michx. 11:15
T: in pascuis aridis, juxta Charlston.
M: in pascuis aridis Carolinae.
Paspalum distichum L. var. *distichum*

1:45 *Digitaria pilosa* Michx. 11:16
T: in sabulosis sylvarum Carolinae, Georgiae et alibe.
M: in sabulosis Carolina, Georgia.
Digitaria filiformis var. *villosa* (Walt.) Fern.

1:50 *Panicum melicarium* Michx. 11:19
T: in Carolina, Georgia.
M: in Carolina ad ripas rivorum affluviente mari inundatum. (incongruous; the species occurs in North Carolina in the piedmont and in montane areas - auth.)
Glyceria melicaria (Michx.) F. T. Hubb.

1:48 *Panicum anceps* Michx. 12:7
T: in Carolinae herbosis humidis sylvaticus.
M: in herbosis humidis Carolinae, Virginiae, Georgiae.
Panicum anceps Michx. var. *anceps*

1:48 *Panicum dichotomiflorum* Michx. 12:8
T: in occidentalibus montium Alleghanis.
M: in regione Illinoensium.
Panicum dichotomiflorum Michx. var. *dichotomiflorum*

1:47 *Panicum molle* Michx. 12:11
T: in cespitosis Floridae
M: Lieux tres humides a 15 miles de St. Augustin (believed to be to the south - auth.)
Erichloa michauxii (Poir.) Hitchc. var. *michauxii*

1:50 *Panicum ramulosum* Michx. 12:13
T: in sylvis Carolinae.
M: in pratis, cespitosus Carolina.
Panicum angustifolium Ell.* (The basionym is questioned by Hitchcock and Chase (1950)).

1:51 *Oryzopsis asperifolia* Michx. 12:20
T: a sinu Hudsonis ad Quebec, per tractus montium.
M: in praeriptus et saxosus per tractus montium a sinu hudsonis ad Canadam.

1:44 *Paspalum ciliatifolium* Michx.* 12:21
T: in Carolina.
M: in Carolina, Georgia.

1:44 *Paspalum debile* Michx.* 13:1
T: in maritimis Carolinae et Georgiae.
M: in Carolina.

1:43 *Paspalum setaceum* Michx. 13:2
T: in aridis Carolina inferioris.
M: in aridis apricis Carolina, Georgia. Champ a Caffet, Juiliet.
Paspalum setaceum Michx. var. *setaceum*

1:45 *Paspalum plicatulum* Michx. 13:3

1:44 *Paspalum laeve* Michx.* 13:4

1:44 *Paspalum floridanum* Michx.* 13:6
T: in Florida et Georgia.
M: Georgie et Floride.

1:53 *Agrostis lateriflora* Michx. 13:8
T: praesertim in praecipitus saxosus fluminis Mississippi et ripariis Illinoensibus.
M: (same except the "et" is omitted, meaning the Mississippi shores of Illinois - auth.)

1:53 *Agrostis racemosa* Michx. 13:9
Muhlenbergia racemosa (Michx.) BSP

1:52 *Agrostis dispar* Michx. 13:11
T: in Carolina inferiore.
M: in Carolina maritima.
Agrostis stolonifera L.

1:52 *Agrostis aspera* Michx. 13:13
T: in collibus rupibusque regione Illinoensis
M: in Illinois
Sporobolus asper (Michx.) Kunth var. *asper*

1:43 *Alopecurus aristulatus* Michx. 13:17
T: in paludosis Canadae.
M: in Canada ad ripas Lacus Champlain.
Alopecurus aequalis Sobol. var. *aequalis*

1:55 *Erianthus saccaroides* Michx. 13:19
Erianthus giganteus (Walt.) Muhl.

1:55 *Erianthus brevibarbis* Michx. 13:21
T: in collibus Tennassée et Carolinae.
M: in collibus desertis ab Amnio Wabash ad Ostium Missouri.

1:56 *Andropogon macrourum* Michx. 14:1
T: a Carolina ad Floridam
M: a Virginia ad Carolinam.
Andropogon glomeratus (Walt.) BSP

1:57 *Andropogon dissitiflorum* Michx. 14.5
T: a Carolina ad Floridam.
M: in Carolina, Georgia, Florida.
Andropogon virginicus L.

1:58 *Andropogon avenaceum* Michx. 14:6
T: in vastissimus pratis Illinoensibus.
M: in regionae Illinoensium.
Sorghastrum nutans (L.) Nash

1:57 *Andropogon scoparium* Michx. 14:7
Andropogon scoparius Michx.*

1:57 *Andropogon ternarium* Michx. 14:8
T: in montosis Carolinae.
M: in regiona Wabash, Georgia montosa.
Andropogon ternarius Michx. var. *ternarius*

1:59 *Chloris curtipendula* Michx. 14:10
T: in aridis regionis Illinoensis ad Wabast et in rupibus ad prairie du rocher.
M: in hauteurs du Missouri et Poste Vincenne.
Bouteloua curtipendula (Michx.) Torr. var. *curtipendula*

1:59 *Chloris mucronata* Michx. 14:13
Dactryloctenium aegyptium (L.) Willd.

1:59 *Chloris monostachya* Michx. 14:15
Ctenium aromaticum (Walt.) Wood

1:60 *Tripsacum cylandricum* Michx. 14:17
T: in sabulosis Floridae.
M: in Florida.
Manisuris cylindrica (Michx.) Kuntze*

1:61 *Aira ambigua* Michx. 15:2
T: circa lacus Mistassins et juxta anines in lacun s. Joannis defluent es.
M: Riv que lombent au Lac St. Jean.
Deschampsia cespitosa (L.) Beauv.

1:62 *Aira melicoides* Michx. 15:3
Trisetum melicoides (Michx.) Scribn.

1:62 *Aira obtusata* Michx. 15:4
T: in aridis, a Carolinae ad Floridam.
M: in sabulosis Carolinae, Georgiae, Floridae; in Florida juxta dominus Wiggin.
Sphenopholis obtusata (Michx.) Scribn. var. *obtusata*

1:62 *Melica glabra* Michx. 15:5
T: a Virginia ad Floridam.
M: a Carolina ad Floridam. Florida f. Matança.
Melica mutica Walt.

1:64 *Trachynotia polystachia* Michx. 15:6
T: in inundatis maritimis, a Nova Anglia ad Floridam.
M: Basse Caroline.
Spartina cynosuroides (L.) Roth

1:64 *Trachynotia juncea* Michx. 15:8
T: in sicca maritimis Carolinae, Georgiae.
M: Bord des creeks sales Basse Caroline.
Spartina patens (Ait.) Muhl. var. *patens*

1:65 *Eleusine mucronata* Michx. 15:9
T: in cultis Illinoensibus.
M: Illinois.
Leptochloa filiformis (Lam.) Beauv. var. *filiformis*

1:65 *Bromus canadensis* Michx. 15:14
T: in Canada.
M: Canada: Lac St. Jean.
Bromus ciliatus L. var. *ciliatus*

1:67 *Festuca distichiphylla* Michx. 15:18
T: in maritimis Carolinae.

M: Bord de la Mer en Carol.
Distichlis spicata (L.) Greene var. *spicata*

1:68 *Festuca polystachya* Michx. 15:19
Leptochloa fascicularis (Lam.) A. Gray

1:67 *Festuca poaeoides* Michx. 16:7
T: ad ripas maritimas fluminis S. Laurentii.
M: Fleuve St. Laurent
Festuca elatior L.*

1:65 *Poa hirsuta* Michx. 16:12
T: in Carolina inferiore.
M: Carol
Eragrostis hirsuta (Michx.) Nees

1:69 *Poa reptans* Michx. 16:14
T: in limosis ripariis amnium regionis Illinoensis.
M: Rivierre Kaskasia.
Eragrostis reptans (Michx.) Nees

1:71 *Uniola gracilis* 17:20
T: in umbrosis sylvarum, a Carolina ad Georgiam.
M: Larinburg (not to be confused with "Lasinburg", New York; presumably Laurinburg, Scotland County, North Carolina - auth.)
Chasmanthium laxum (L.) Yates.

1:70 *Uniola latifolia* Michx. 16:20
T: in occidentalibus montium Alleghanis.
M: Illinois.
Chasmanthium latifolium (Michx.) Yates.

1:72 *Avena flumosa* Michx. 17:2
T: in Pensylvania, Carolina.
M: Parmi les aristida Illinois. A Canada ad Carolinam.
Danthonia spicata (L.) Beauv. ex R. & S.

1:71 *Briza canadensis* Michx. 17:6
Glyceria canadensis (Michx.) Trin. var. *canadensis*

1:73 *Avena striata* Michx. 17:7
T: a sinu Hudsonis per tractus montium ad Canadam.
M: Lac des Cygnes Montagn. ent. la Baye d'Hudson et le Canada Mistassins.
Schizachne purpurascens (Torr.) Swallen

1:72 *Avena mollis* Michx. 17:8
T: in Canada.
M: Montreal.
Trisetum spicatum (L.) Richt. var. *spicatum*

1:72 *Avena palustris* Michx. 17:9
T: in Georgiae et Carolinae paludosis graminosis. Floret Maio.
M: Georgia et Carolina. Lieux humides.
Trisetum pensylvanicum (L.) Beauv.

1:73 *Arundo canadensis* Michx. 17:10
T: in Canada Lacunum.
M: a sinu Hudsonis ad Canadam praesertim ad ripas Lacunum.
Calamagrostis canadensis (Michx.) Beauv. var. *canadensis*

1:73 *Arundinaria macrosperma* Michx. 17:12
T: ad ripas flum. Mississipi: in Carolina, Florida, etc. Martio florens.
M: a Virginia ad Floridam et in occidentibus ab Illinoensibus ad ostium Misissipi.
Arundinaria gigantea (Walt.) Muhl.

1:74 *Zizania miliacea* Michx. 17:14
T: in aquosis Americae septentrionalis.
M: Lac Champlain, New Jersey, Carolines, Illinois et Lacs d'Am
Zizania aquatica L. var. *aquatica*

1:75 *Zizania fluitans* Michx. 17:15
T: ad lacum Champlain.
M: juxta Charleston, Carolines, Fleuret in Juillet.
Zizania aquatica L. var. *aquatica*

1:75 *Zizania clavulosa* Michx.
Zizania aquatica L. var. *aquatica*

1:54 *Stipa sericea* Michx. 18:4
T: in sabulosis Carolinae inferioris.
M: inferiore in Carolina
Muhlenbergia capillaris (Lam.) Trin.

1:77 *Lechea thymifolia* Michx. 20:1
Lechea minor L.

1:77 *Lechea racemulosa* Michx. 20:2

1:77 *Lechea tenuifolia* Michx. 20:3
Lechea tenuifolia Michx. var. *tenuifolia*

1:80 *Galium circaezans* Michx
Galium circaezans Michx. var. *circaezans*

1:78 *Galium asprellum* Michx. 20:7
T: in septentrionalibus Canadae.
M: Quebec, Lac St. Jean.

1:78 *Galium claytoni* Michx. 20:8

T: in Canada et Nova Caesarea.
M: Lac St. Jean, New Jersey.
Galium tinctorium L. subsp. *tinctorium*

1:79 *Galium latifolium* Michx. 20:9
T: in altis montibus utrisisque Carolinae.
M: Caroline hautes montag.

1:79 *Galium uniflorum* Michx. 20:10
T: in Carolina
M: Caroline

1:80 *Galium triflorum* Michx. 20:11
T: in umbrosis Canadae sylvis.
M: in Canada.

1:79 *Galium hispidulum* Michx. 20:12
T: in Carolina inferiore.
M: in Carolina.

1:80 *Galium puncticulosum* Michx. 20:13
T: in Carolina inferiore.
M: Basse Carolina.
Galium pilosum Ait. var. *pilosum*

1:81 *Rubia Brownei* Michx. 20:14
T: in umbrosis, a Carolina ad Floridam.
M: in umbrosis Sylvarum Carolinae.
Galium hispidulum Michx.

1:82 *Spermococe diodina* Michx. 20:17
T: in aridis sabulosis sylvarum Carolinae. Augusto et Septembri floret.
M: Lieux arides, basse Caroline.
Diodea teres Walt. var. *teres*

1:83 *Polypremum Linnei* Michx. 21:3
Polypremum procumbens L.

1:83 *Oldenlandia glomerata* Michx. 21:5
T: in humidis Carolinae inferioris.
M: Basse Caroline.
Oldenlandia uniflora L.

1:84 *Houstonia Linnaei* var. α *elatior* Michx. 21:11
Houstonia caerulea L.

1:85 *Houstonia Linnaei* var. β *minor* Michx. 21:10
Houstonia pusilla Schoepf.

1:85 *Houstonia serpyllifolia* Michx. 21:9
T: ad fonticulos rivosque excelsorum montium Carolinae.

Maio florens.
M: in sommet des plus hautes montagnes.

1:85 *Houstonia rotundifolia* Michx. 13:14
T: in apricis submaritimis Floridae et Carolinae. Martio floret.
M: in Voyes la descript. au supplem. des Pl. de la Floride. No. lem.
Houstonia procumbens (Walt. ex J. F. Gmel.) Standl.

1:86 *Houstonia varians* Michx. 21:16
T: in diversis locis ubrusque Carolinae et alibi. Floret Julio.
M: haute et basse Caroline.
Houstonia purpurea L. var. *purpurea*

1:85 *Houstonia angustifolia* Michx. 21:19
Houstonia longifolia Gaertn. var. *longifolia*

1:87 *Ludwigia nitida* Michx. 22:7
T: in humidis Carolinae inferioris. Floret Maio.
M: in Carolina, maio floret.
Ludwigia palustris (L.) Ell.

1:88 *Ludwigia pedunculosa* Michx. 22:8
T: in paludosis submaritimis Carolinae inferioris. Maio floren.
M: in Carolina maritima ad ripas uliginosis. Maio floret. flos lutens.
Ludwigia arcuata Walt.

1:88 *Ludwigia microcarpa* Michx. 22:10
T: in humidis Carolina inferioris. Julio floret.
M: in udis graminosis Carolina. Goose Creek.

1:88 *Ludwigia angustifolia* Michx. 22:12
T: juxta fossas aquosas Carolinae inferioris. Augusto et Septembri floret.
M: Carol.
Ludwigia linearis Walt.

1:89 *Ludwigia jussiaeoides* Michx. 22:14
T: in aquosis praesertim umbrosis Carolinae inferioris. Floret Julio.
M: Caroline.
Ludwigia decurrens Walt.

1:90 *Ludwigia macrocarpa* Michx. 22:16
Ludwigia alternifolia L.

1:89 *Ludwigia virgata* Michx. 22:17

1:90 *Ludwigia mollis* Michx. 22:18
T: in paludosis Carolinae inferioris. Julio floret.
M: Basse Carol
Ludwigia pilosa Walt.

1:90 *Ludwigia capitata* Michx. 22:20
Ludwigia suffruticosa Walt.

1:91 *Cornus tomentosula* Michx. 23:7
T: in collibus amnium ripariis Canadae, New Yorck, Connecticut. Junio et Julio floret.
M: Lac Champlain Canada et Rivierre Sagney.
Cornus rugosa Lam.

1:92 *Cornus lanuginosa* Michx. 23:8
T: in humidis Canadae et Carolinae.
M: Montreal. Riviere de l'Assompt.
Cornus amomum Mill.

1:92 *Cornus stolonifera* Michx. 23:18
T: ad ripas amnium rivorumque Canadae, Novae Angliae.
M: des rivages Lac St. John et rivierres qui coulant aux Lacs Mistassins.
Tres Rivierres.
Cornus stolonifera Michx. var. *stolonifera*

1:92 *Cornus fastigiata* Michx. 23:20
T: in dumosis, ad ripas rivolorum Virginiae, Carolinae, Aprili floret.
M: Pres le ruisseau de Neuf Miles...en Caroline. Fleurit a la fin d'Avril.
Cornus foemina Mill. subsp. *foemina*

1:93 *Cornus asperifolia* Michx.

1:94 *Plantago sparsiflora* Michx. 24:17
T: in sylvis Carolinae et Georgiae.
M: Basse Caroline et Georgia in aridis sylvanum.

1:95 *Plantago aristata* Michx. 24:19

1:97 *Fraseri walteri* Michx. 25:1
Swertia caroliniensis (Walt.) Kuntze

1:98 *Centaurella verna* Michx. 25:4
Bartonia verna (Michx.) Muhl.

1:98 *Centaurella paniculata* Michx. 25:5
Bartonia paniculata (Michx.) Muhl.

1:99 *Ammannia humilis* Michx. 25:8
T: in paludosis Carolinae septentrionalis. Septembri florens.
M: Fayetteville et Carolina.
Rotala ramosior (L.) Koehne

1:100 *Allionia nyctaginea* Michx. 25:10
T: ad ripas fluminis Tennassée.
M: au dessus de la maison du Docteur White des Rochers Cumberland River.
Mirabilis nyctaginea (Michx.) MacM.

1:105 *Pinckneya pubens* Michx. 26:5

1:105 *Caprifolium bracteosum* Michx. 26:12
T: in montibus Carolinae.
M: Lac Champlain et Maryland.
Lonicera dioica L. var. *dioica*

1:106 *Xylosteum villosum* Michx. 26:15
T: in praeruptis saxosis, per tractus montium, a sinu Hudsonis ad Canadam.
M: Lac des Cygnes, Mistassin et Riv des Goelands. *Lonicera villosa* (Michx.) R. & S.*

1:106 *Symphoricarpus vulgaris* Michx. 26:16
T: in Virginia et Carolina.
M: Etat de Cumberland et Lieux arides de Kentucky.
Symphoricarpus orbiculatus Moench.

1:107 *Symphoricarpus racemosus* Michx. 26:17
T: in montanis, ad lacus Mistassins.
M: hauteur des terres pres Mistassin.
Symphoricarpus albus (L.) Blake var. *albus*

1:108 *Diervilla tourneforti* Michx. 26:18
T: in Canada, Nova Anglia et in cacumne montium excelsorum Carolinae.
M: sur Black Mountain, Albany, Lasinburg, jusqu'aux Lacs de la Baye d'Hudson.
Diervilla lonicera Mill.

1:107 *Triosteum minus* Michx. 26:19
T: in Virginia.
M: in Carolina septentrionali juxta Hill's Iron Works.
Triosteum angustifolium L. var. *angustifolium*

1:108 *Campanula acuminata* Michx. 26:21
T: in remotis occidentalibus Pensylvania et Virginia.
M: hautes Montagn de Carol. et Kentucky et Illinois. Fleurit en Juillet, Aoust.
Campanula americana L.

1:109 *Campanula flexuosa* Michx. 27:1
T: in montibus altis Carolinae.
M: hautes Montag.
Campanula divaricata Michx.

1:108 *Campanula amplexicaulis* Michx. 27:2
T: in cultis hortensibus Pensylvaniae, Carolinae.
·M: in Carolina.
Specularia perfoliata (L.) A. DC.*

1:109 *Campanula divaricata* Michx. 27:3
T: in altis montibus Carolinae.
M: Montagn de la Carol.

1:110 *Ribes albinervium* Michx. 27:7
T: in Canada, ad amnen Mistassin.
M: Rivierre Mistassin Canada.
Ribes triste Pall.

1:110 *Ribes rigens* Michx. 27:11
T: in Canada, ad amnen Mistassin.
M: Rivierre Mistassin.
Ribes glandulosum Grauer

1:111 *Ribes hirtellum* Michx. 27:12
T: in saxosis, ad amnem Sagney.
M: Rochers de la Rivierre Sagney.
Ribes oxycanthoides L.

1:111 *Ribes gracile* Michx. 27:13
T: in montibus Tennassée.
M: in montibus Tennassée in itinera Nashville.
Ribes missouriense Nutt. var. *missouriense*

1:110 *Ribes rotundifolium* Michx. 27:14
T: in montibus excelsis Carolinae.
M: Tres hautes Montg Carolines.

1:110 *Ribes trifidum* Michx. 27:12
T: juxta Quebec et sinum Hudsonis.
M: Quebec.
Ribes glandulosum Grauer

1:112 *Thesium corymbulosum* Michx. 27:18
T: in aridis America Septentrionalis.
M: Lac Champlain, Pensylv, haute Caroline.
Comandra umbellata (L.) Nutt. var. *umbellata*

1:113 *Anychia herniarioides* Michx. 27:19
T: in arenosis Carolinae septentrionalis.
M: Pinieres arides, in sabulosis Carolinae.
Paronychia herniarioides (Michx.) Nutt.
Note: not listed in North Carolina today; very rare in South Carolina-auth.

1:113 *Anychia argyrocoma* Michx. 27:20
T: in rupibus montium superioris Carolinae.
M: Rochers des hautes Montagn des Carolines.
Paronychia argyrocoma (Michx.) Nutt. var. *argyrocoma*

1:113 *Anychia dichotoma* Michx. 27:21
T: in collibus calcariis Pensylvania superioris et Kentucky.

M: in excelsis montib. Carolinae Montag. de Pensyl
Paronychia canadensis (L.) Wood.

1:115 *Asclepias hybrida* Michx. 28:11
Asclepias variegata L.

1:116 *Asclepias longifolia* Michx. 28:18
T: in sylvis Georgiae occidentalibus.
M: Carolines et Illinois.

1:116 *Asclepias debilis* Michx. 28:19
T: in aquosis umbrosis Carolinae.
M: in umbrosis Carolinae.
Asclepias perennis Walt.

1:117 *Asclepias paupercula* Michx. 28:20
T: in herbidis humidis Carolina inferioris.
M: in herbidis humidis Carolina.
Asclepias lanceolatis Walt.

1:117 *Asclepias laurifolia* Michx. 28:21
T: secus amnem Althamaha, in Georgia.
M: secus amnem Altamaha, in Georgia.
Asclepias rubra L.

1:119 *Gonolobus laevis* Michx. 29:3
T: in dumetosis Fluminis Mississipi.
M: Illinoense.
Cynanchum laeve (Michx.) Pers.

1:119 *Gonolobus macrophyllus* Michx. 29:4
Cynanchum laeve (Michx.) Pers.

1:119 *Gonolobus hirsutis* Michx. 29:5
Matalea carolinensis (Jacq.) Woodson

1:120 *Gelsemium mitidum* Michx. 29:12
Gelsemium sempervirens (L.) Ait. f.

1:120 *Echites puberula* Michx. 29:15
T: in sylvis Carolinae inferioris.
M: Ohio, Fort Massac, Carol. et Georgia. Partie meridionale de la Virginie.
Trachelospermum difforme (Walt.)

1:121 *Amsonia latifolia* Michx. 29:17
Amsonia Tabernaemontana Walt.

1:121 *Amsonia angustifolia* Michx. 29:18
T: in sabulosis apricis Georgia.
M: Carol.
Amsonia ciliata Walt.

1:123 *Sideroxylon chrysophylloides* Michx. 30:1
T: in dumetis littoralibus Carolinae.
M: juxta Charleston; Carol. et Georgie.
Bumelia tenax (L.) Willd.

1:122 *Sideroxylon lanuginosum* Michx. 30:3
T: in dumosis humidis Georgiae.
M: in Georgia.
Bumelia lanuginosa (Michx.) Pers.

1:122 *Sideroxylon reclinatum* Michx. 30:6
T: in dumetosis ripariis Georgiae.
M: sur la rivierre Ste Marie. Fleurit le 10 May. (1787 - auth.)
Bumelia tenax (L.) Willd.

1:123 *Dodecatheon integrifolium* Michx. 30:7
T: in montibus Alleghanis, juxta rivulos sylvaticos.
M: in montibus occidentalibus Caroline juxta rivulos sylvaticos.
Dodecatheon meadia L. var. *meadia*

1:124 *Primula mistassinica* Michx. 30:16
T: ad lacus Mistassins Canadam inter et fretum Hudsonis.
M: Rivierre des Goelands.

1:126 *Menyanthes trachysperma* Michx. 30:18
Nymphoides aquatica (Walt. ex J. F. Gmel.) Kuntze

1:130 *Batschia canescens* Michx. 31:9
Lithospermum canescens (Michx.) Lehm.

1:130 *Batschia gmelini* Michx. 31:11
Lithospermum carolinense (Walt. ex J. F. Gmel.) MacM.

1:130 *Lithospermum angustifolium* Michx. 31:12
T: ad flumen Ohio.
M: Pres les Rapides de l'Ohio.
Lithospermum incisum Lehm.

1:131 *Lithospermum latifolium* Michx. 31:13
T: in umbrosis sylvis Kentucky.
M: Bois umbrages de Kentucky.

1:131 *Pulmonaria parviflora* Michx. 31:14
T: ad littoria mari ascendente inundata imi fluminis S. Laurentii.
M: Malbaye.
Mertensia maritima (L.) S. F. Gray var. *maritima*

1:132 *Cynoglossum amplexicaule* Michx. 31:17
T: in montibus Alleghanis.
M: Haute Caroline, Kentucky, etc.
Cynoglossum virginianum L.

1:133	*Onosmodium molle* Michx.	31:18
T:	in Tennassée, circa Nashville.	
M:	Nashville, lieux arides et pierreaux.	
	Onosmodium molle Michx. var. *molle*.	
1:133	*Onosmodium hispidum* Michx.	31:19
	Onosmodium virginianum (L.) A. DC. var. *virginianum*	
1:134	*Hydrophyllum appendiculatum* Michx.	32:3
T:	in sylvis montanis Tennassée.	
M:	Forets de Cumberland et de Kentucky.	
1:134	*Phacelia bipinnatifida* Michx.	32:4xy[3]
1:135	*Phacelia fimbriata* Michx.	32:4x[4]
T:	in excelsis montibus Carolinae.	
M:	Lieux bas tres humides et riches au pied des montagnes apres avoir tourné a main droite pour aller de Th. Yong chez Davenport.	
1:160	*Ampelopsis bipinnata* Michx.	32:5
	Ampelopsis arborea (L.) Koene	
1:159	*Ampelopsis cordata* Michx.	32:6
1:139	*Convolvulus obtusilobus* Michx.	32:18
T:	in littoribus arenosis Georgiae et Floridae.	
M:	in littoribus arenosis Georgiae.	
	Ipomoea stolonifera (Cyrill.) J. F. Gmel.	
1:136	*Convolvulus stans* Michx.	32:21
T:	juxta lacum Champlain, Canada.	
M:	Lac Champlain.	
	Calystegia spithamaea spp. *stans* (Michx.) Brummitt	
1:137	*Convolvulus ciliolatus* Michx.	33:5
T:	circa urbem Knoxville, in Tennassée	
M:	environs de Knoxville.	
	Ipomoea pandurata (L.) G. F. W. Mey.	
1:141[3]	*Ipomoea macrorhiza* Michx.	33:14
1:141[4]	*Ipomopsis elegans* Michx.	33:18
	Ipomopsis rubra (L.) Wherry	
1:143	*Phlox triflora* Michx.	34:1
	Phlox glaberrima ssp. *triflora* (Michx.) Wherry	

[3,4] On same sheet. "x" is on left side of sheet, "xy" is on right.

1:144 *Phlox aristata* Michx.
var. *α virens* Michx. 34:3
T: in Carolina, ad ripas amnis Santee.
M: Riv. Santee, locis sabulosis
Phlox pilosa L. var. *pilosa*
var. *β canescens* Michx. 34:2
T: in Tennassée, circa Knoxville.
M: Knoxville
Phlox pilosa L. var. *pilosa*

1:145 *Phlox reptans* Michx. 34:7
T: in excelsis montibus Carolinae occidentalis.
M: Lieux umbrages des hautes Montagnes Carolina septentrionalis.
Phlox stolonifera Sims

1:143 *Phlox latifolia* Michx. 34:12
T: in umbrosis humidis et solito sphagnosis sylvanum Carolinae.
M: in umbrosis Carolinae.
Phlox ovata L.

1:147 *Chironia chloroides* Michx. 35:11
T: in Noveboraco et Nova Caesarea.
M: New York, prairies.
Sabatia dodecandra (L.) BSP

1:146 *Chironia paniculata* Michx. 35:7
T: in Georgia et Carolina.
M: Georgia.
Sabatia quadrangula Wilbur

1:146 *Chironia gracilis* Michx. 35:9
T: in Carolina inferiore.
M: Carol.
Sabatia campanulata (L.) Torr.

1:148 *Verbascum claytoni* Michx. 35:18
T: in Carolina.
M: rare in Caroline.
Verbascum blattaria L.

1:149 *Physalis lanceolata* Michx. 35:21
T: in Carolina.
M: Carolina
Physalis heterophylla var. *villosa* Waterfall

1:149 *Physalis obscura* Michx.
var. *α glabra* Michx. 35:1 (a)
Physalis pubescens var. *glabra* (Michx.) Waterfall
var. *β viscido-pubescens* Michx. 35:1 (b)
Physalis pubescens var. *grisea* Waterfall

1:150 *Azalea canescens* Michx. 36:4
T: juxto rivolos Carolinae inferioris.
M: Basse Caroline.
Rhododendron canescens (Michx.) Sweet.

1:151 *Azalea periclymenoides* Michx. 36:9
T: in New Jersey.
M: New York.
Rhododendron nudiflorum L.

1:151 *Azalea calendulacea* Michx.
var. *α flammea* Michx. 36:13
T: ad ripas fluvii Savannah loco dicto Two Sisters.
M: Two Sisters.
Rhododendron flammeum (Michx.) Sargent
var. *β crocea* Michx. 36:15
Rhododendron calendulaceum (Michx.) Torr.

1:152 *Pyxidanthera barbulata* Michx. 36:18
T: in Carolina superiore.
M: in sabulosis Carolina septentrionalis juxta Wilmington.
Pyxidanthera barbulata Michx. var. *barbulata*

1:153 *Rhamnus franguloides* Michx. 36:19
T: ad lacum Champlain.
M: de Cumberland; Kentucky Lieux arides.
Rhamnus alnifolius L'Her.

1:154 *Rhamnus minutiflorus* Michx. 36:20
Sargeretia minutiflora (Michx.) Mohr
(reported in text from North Carolina; it is apparently not in that state now. - auth.)

1:154 *Ceanothus microphyllus* Michx. 37:5
T: in herbosis sabulosis sylvarum Georgiae et Floridae.
M: le 16 Mars (1787 - auth.) Lieux arides vers Nord West river.

1:160 *Claytonia caroliniana* Michx. 37:17

1:162 *Hydrocotyle lineata* Michx. 38:21
T: in inundatis Carolinae inferioris. Aprili et Maio floret.
M: in salsis a mare inundatis Carolinae.
Lilaeopsis chinensis (L.) Kuntze

1:163 *Eryngium ovalifolium* Michx. 38:5
Eryngium integrifolium Walt.

1:164 *Eryngium yuccifolium* Michx. 38:7
T: in paludosis Virginiae.
M: in apricis sylvarum inter gramineas a Virginia ad Floridam.

1:164 *Daucus pusillus* Michx. 38:8

T: in campestribus Carolinae.
M: in salbulosis Carolina.

1:164 *Ammi capillaceum* Michx. 38:9
T: in campestribus Carolinae.
M: in cultis Carolinae.
Ptilimnium capillaceum (Michx.) Raf.

1:165 *Selinium canadense* Michx. 38:10
T: ad ostium fluminis S. Laurentii.
M: in Canada juxta Tadoussack.
Conioselinum chinense (L.) BSP

1:166 *Heracleum lanatum* Michx. 38:11
T: in Canada.
M: Chicoutoume, Tadoussack.

1:166 *Ligusticum actaeifolium* Michx. 38:13
T: ad ripas fluminis S. Laurentii, juxta Tadoussack.
M: Tadoussack in Canada.
Ligusticum canadense (L.) Britt.
(Type locality out of range; specimen annotated by L. Constance, 1963 - auth.)

1:167 *Ligusticum barbinode* Michx. 38:14
Thaspium barbinode (Michx.) Nutt.

1:167 *Sium lineare* Michx. 38:15
Sium suave Walt.

1:167 *Angelica triquinata* Michx. 38:16
(Type locality (Canada) out of range - auth.)

1:168 *Sison pusillum* Michx. 38:17
Spermolepis divaricata (Walt.) Raf. ex Seringe

1:168 *Sison trifoliatum* Michx. 38:20
T: in Carolina superiore.
M: haute Caroline in Montosis.
Zizia trifoliata (Michx.) Fern

1:168 *Sison marginatum* Michx. 38:21
T: in udis Carolinae.
M: Caroline.
Oxypolis rigidior (L.) Raf.

1:170 *Myrrhis claytoni* Michx. 39:1
T: in montibus Alleghanis.
M: in Canada, Nova Anglia et in monitbus Carolinae.
Osmorhiza claytoni (Michx.) Clarke

1:171 *Heuchera cortusa* Michx. 39:7
T: in in variis locis Pensylvaniae, Carolinae, etc.

frequentius in regione Illinoensis.
M: Illinoensi regiona Carolina etc.
Heuchera americana L. var. *americana*

1:172 *Heuchera villosa* Michx. 39:8
T: in altoribus montibus Carolinae borealis.
M: Tres hautes montagnes des Carol.
Heuchera villosa Michx. var. *villosa*

1:173 *Ulmus alata* Michx. 39:10
T: in Virginia et Carolina inferiore.
M: Kentucky endroits pierreux pres Beardstown (see amended gazetteer in introduction - auth.), Carolina Sept., Caroline Meridionale et environs de Richmond 1794 (the latter station underlined, suggesting it was collected there and is probably the actual type locality - auth.)

1:172 *Ulmus fulva* Michx. 39:14
T: in Canada, Vermont, Connecticut, montibus Alleganis, etc., frigid. Americae regionibus.
M: Baye d'Hudson Canada, haute Carolina, N. York, etc.
Ulmus rubra Muhl.

1:174 *Salsola platiphylla* Michx. 40:1
T: in regione Illinoensium, hue alluvientibus Mississippi aquis allata.
M: in regione Illinoensium.
Cycloma atriplicifolium (Spreng.) Coult.

1:177 *Gentiana acuta* Michx. 40:5
T: in altis montibus Carolinae et in Canada, prope Tadoussack.
M: Partie basse pres Tadoussack, Canada.
Gentiana amarella L.*

1:175 *Gentiana amerelloides* Michx. 40:6
T: in monticulis Kentucky.
M: Lieux arides sur Kentuckey river.
Gentiana quinquefolia L. var. *quinquefolia**

1:176 *Gentiana puberula* Michx.* 40:8
T: ad confluentum fluviorum Ohio et Mississipi, prope propringnaculum Cheroquis.
M: Fort Cheroquis ad ostium fluvii Ohio.

1:177 *Gentiana angustifolia* Michx. 40:9
T: in pratis Carolinae inferioris.
M: in herbosis Carolinae.
Gentiana autumnalis L.

1:177 *Hydrolea caroliniana* Michx. 40:10

T: in aquis et montibus Carolinae inferioris.
M: in aquis Carolina.
Hydrolea quadrivalvis Walt.

1:178 *Viburnum lantanoides* Michx. 40:12
T: in rupestribus opacarum sylvarum Canadae.
M: des Cataractes de la Caroline Septentrionale sur les hautes montagnes. Bois ombrages et bas vers ter Lac Champlain et en Canada.
Viburnum alnifolium Marsh.*

1:180 *Viburnum molle* Michx. 40:13
T: in Kentucky, circa Danville.
M: in Kentucky, juxta Danville.

1:180 *Viburnum opulus*
var. *α europeanum* Michx.
var. *β pimina* Michx.
var. *γ edule* Michx.
T: in Canada
M: var. *β* Depuis Lac Champlain jusquan Lac St. Jean hautes Montag. de Pensylv. hautes M de Caroline
(not found in Carolina - auth.)
Viburnum opulus var. *americanum* Ait.*

1:181 *Sambucus pubens* Michx.* 41:19
T: in altis montibus Pensylvaniae, Canadae, Carolinae.
M: in Canada et in altis Montib. Allegani.

1:183 *Rhus toxicodendron* var. *β quercifolium* Michx. 42:1
T: in Carolina inferiore et Georgia.
M: Virginie et Carolines.
Rhus toxicodendrom L.*

Rhus toxicodendron var. *α vulgare* Michx. 42:3
Rhus radicans var. *rydbergii* (Small) Rehder*

Rhus toxicodendron var. *γ microcarpon* Michx. 42:4
Rhus radicans L. var. *radicans**

1:182 *Rhus pumilum* Michx. 42:13
T: in Carolina superioris comitatu Mecklenbourg.
M: in montosis Carolina Burke comitatus Haute Carolina.
(this type locality is in error - auth.)
Rhus michauxii Sarg.

1:188 *Hypoxis caroliniensis* Michx. 43:21
Hypoxis hirsuta (L.) Coville

1:189 *Aletris alba* Michx. 44:2
Aletris farinosa L.

1:190 *Juncus melanocarpus* Michx. 44:4
T: in montibus sinum Hudsonis inter et Canadam juxta lacum Cycmorum.
M: hauteur des Terres Lac des Cygnes.
Luzula parviflora (Ehrh.) Desv. var. *parviflora*

1:191 *Juncus repens* Michx. 44:5
T: in Carolina et Georgia.
M: in inundatis Carolinae, Georgiae. Mayo floret; Junio-Julio matureait.

1:192 *Juncus acuminatus* Michx. 44:10
T: in Carolina inferiore.
M: in Carolina, Georgia.

1:192 *Juncus aristulatus* Michx. 44:11
Juncus marginatus Rostk. var. *marginatus*

1:191 *Juncus bicornis* Michx. 44:12
T: in Georgia et Carolina.
M: "Duplicata Georgia"
Juncus tenuis Willd. var. *tenuis*

1:192 *Juncus polycephalus* Michx. 44:13
Juncus scirpoides Lam.

1:195 *Allium mutabile* Michx. 45:4
T: in Georgiae meridionalibus. Inuente Maio floret.
M: in Carolina et in Georgia.
Allium canadense L. var. *canadense*

1:197 *Lilium carolinianum* Michx. 45:16
Lilium michauxii Poir.

1:199 *Uvularia puberula* Michx. 45:20
T: in altissimus montibus Carolinae.
M: Tres hautes Montagn.
Uvularia pudica (Walt.) Fern.*

1:201 *Streptopus roseus* Michx. 46:1
T: in excelsis montibus Carolinae septentrionalis et in Canada.
M: in sylvis a sinu Hudsonis ad Quebec et in excelsis montib Carolinae.
Streptopus roseus Michx. var. *roseus*

1:201 *Streptopus lanuginosus* Michx. 46:3
T: in altis montibus Carolinae meridionalis.
M: in excelsis montib Carolinae septentrionalis.
Disporum lanuginosum (Michx.) Nichols.

1:202 *Convallaria umbellulata* Michx. 46:16
T: in montibus Alleghanis.

M: Vue dans les Montagnes du Pays des Indiens Cheroquis et cellui de la Car. Sept.
Clintonia umbellulata (Michx.) Morong.

1:203 *Diphylleia cymosa* Michx. 47:2

1:206 *Cabomba aubleti* Michx. 47:7
T: in aquosis Carolinae et Georgiae.
M: in aquis Ogechee.
Cabomba caroliniana A. Gray var. *caroliniana*

1:206 *Chamaerops serrulata* Michx. 47:9
T: in maritimis Georgiae-Floridaeque.
M: environs de Sunbury en Georgiae at Savanah (entre Savanah et Sunbury).
Serenoa repens (Bartr.) Small

1:207 *Chamaerops acaulis* Michx. 47:13
T: in Carolina et Georgia.
M: Environs de Charleston Carolina.
Sabal minor (Jacq.) Pers.

1:208 *Triglochin triandrum* Michx. 47:15
T: in inundatis circa Charlston.
M: in salsis paludosis juxta Charleston.
Triglochin striatum R. & P.

1:209 *Narthecium pubens* Michx. 47:17
T: in Carolina inferiore circa Charlston.
M: Basse Caroline pres Charleston.
Tofieldia racemosa (Walt.) BSP.

1:210 *Narthecium glutinosum* Michx. 47:18
Tofieldia glutinosa (Michx.) Pers. var. *glutinosa*

1:209 *Narthecium pusillum* Michx. 47:19
T: ad lacus Mistassins.
M: in sphagnosis a sinu Hudsonis ad Lacus Misstassinos.
Tofieldia palustris Huds.*

1:211 *Xerophyllum setifolium* Michx. 47:20
T: none given
M: Zinneville Mountain, haute montagne de la Caroline septentrionale a 30 miles de Morganton.
Xerophyllum asphodeloides (L.) Nutt.

1:212 *Helonias erythrosperma* Michx. 47:21
T: in ubrosis rivulis Carolinae inferioris.
M: dans les lieux boubeaux et ombrages Basse Carol.
Amianthium muscaetoxicum (Walt.) A. Gray

1:213 *Helonias dubia* Michx. 48:1
T: in sabulosis Georgiae et Floridae.

M:	Floride.	
	Schoenocaulon dubium (Michx.) Small	
1:212	*Helonias angustifolia* Michx.	48:2
T:	in herbosis et fruticetis sylvarum humidis Carolinae inferioris.	
M:	Lieux plus eleves et moins humides Basse Caroline.	
	Zigadenus densus (Desr.) Fern.	
1:214	*Zigadenus glaberrimus* Michx.	48:3
T:	in herbosis, humidis, Carolinae inferioris.	
M:	in Carolina.	
1:215	*Trillium rhomboideum* Michx.	
	var. α *atropurpureum* Michx.	48:5
T:	in excelsis montibus Carolinae.	
M:	hautes Montagnes des Carolines.	
	Trillium erectum L.	
	Trillium rhomboideum var. β *album* Michx.	48:10
	Trillium erectum L.	
1:216	*Trillium rhomboideum* var. γ *grandiflorum* Michx.	48:9
	Trillium grandiflorum (Michx.) Salisb.	
1:215	*Trillium pusillum* Michx.	48:11
T:	in pinetis Carolinae inferioris.	
M:	Basse Caroline environ 35 m de Charleston, Gaillard Road.	
1:217	*Rumex crispatulus* Michx.	48:16
	Rumex obtusifolius L. var. *obtusifolius*	
1:219	*Aesculus lutea* Michx.	49:2
	Aesculus octandra Marsh.*	
1:220	*Aesculus macrostachya* Michx.	49:5
	Aesculus pavia L. var. *pavia*	
1:222	*Rhexia glabella* Michx.	49:7
	Rhexia alifanus Walt.	
1:221	*Rhexia ciliosa* Michx.	49:9
	Rhexia petiolata Walt.	
1:221	*Rhexia mariana*, var. γ *exalbida* Michx.	40:11
T:	none given	
M:	Carolines.	
	Rhexia mariana var. *exalbida* Michx.*	
1:221	*Rhexia mariana* var. β *rubella* Michx.	49:12
T:	none given	
M:	Carolines.	
	Rhexia mariana L. var. *mariana*	

1:221 *Rhexia mariana* var. *α purpurea* Michx. 49:14
Rhexia mariana var. *purpurea* Michx.*

1:223 *Epilobium oliganthum* Michx. 49:17
T: ad sinum Hudsonis et lacus Mistassins.
M: env. de Mistassin.
Epilobium palustre L.

1:224 *Oenothera chrysantha* Michx. 49:21
T: a Quebec usque ad sinum Hudsonis.
M: Quebec.
Oenothera parviflora L.

1:225 *Oenothera pusilla* Michx. 50:1
T: in rupibus, ad lacus Mistassins.
M: Lacs Mistassins.
Oenothera parviflora L.

1:225 *Oenothera linearis* Michx. 50:3
Oenothera fruticosa L. subsp. *fruticosa*

1:225 *Oenothera hybrida* Michx. 50:7
T: in Carolina superiore.
M: Caroline.
Oenothera fruticosa L. subsp. *fruticosa*

1:224 *Oenothera glauca* Michx. 50:8
T: in sylvis remotis et occidentalibus flumini Mississipi confinibus, versus regionem Illinoensium.
M: Ouest de l'Ohio Route aux Illinois.
Oenothera fruticosa subsp. *glauca* (Michx.) Straley

1:226 *Gaura angustifolia* Michx. 51:2
T: in Carolina inferiore.
M: Caroline.

1:232 *Vaccinium galezans* Michx. 51:4
T: in umbrosis Carolinae.
M: in Carolina.
Vaccinium tenellum Ait.

1:234 *Vaccinium myrtilloides* Michx. 51:12
T: a Canada ad sinum Hudsonis.
M: Lacs Mistassins heauteur des Terres.

1:231 *Vaccinium disomorphum* Michx. 51:19
T: none given
M: Environs de Philade (Philadelphia - auth.)
Vaccinium corymbosum L.

1:227 *Vaccinium erythrocarpum* Michx. 52:16
T: in altis montibus Carolinae Septentrionalis.
M: Hautes montagnes de la Carol. Sept.

1:234 *Vaccinium brachycerum* Michx. 52:10
T: in Virginia, circa Winchester.
M: in Virginia Warm Spring. (see introduction - auth.)
Gaylussacia brachycera (Michx.) A. Gray

1:229 *Vaccinium myrtifolium* Michx. 52:13
T: in Carolina.
M: avant d'arriver a Wilmington sables arides.
Vaccinium crassifolium Andr.

1:234 *Vaccinium caespitosum* Michx. 52:14
T: in borealibus Americae, praesertim circa sinum Hudsonis.
M: au Lacs Mistassins.

1:235 *Menziesia smithi* Michx. 53:7
Menziesia pilosa (Michx. ex Lam.) Juss. ex Pers.

1:237 *Jeffersonia bartonis* Michx. 53:10
Jeffersonia diphylla (L.) Pers.

1:237 *Polygonum ramosissimum* Michx. 53:12a
T: in regione Illinoensi.
M: Illinois, Kaskaskia.
Polygonum ramosissimum Michx. var. *ramossimum*

1:238 *Polygonum tenue* Michx. 53:14
T: in Canada.
M: in Canada et Nova Caesarea ad Snake Hill in pratensib Illinoensum.

1:241 *Polygonum clinode* Michx. 53:17
T: in Canada.
M: in Canada Malbaye, Tadoussack, Riv. Sagney, etc.

1:242 *Polygonum hydropiperoides* Michx. 53:18
T: in Pensylvania, Virginia, Carolina.
M: Kentucky. fleurit au commencement de Juill. 1794.

1:243 *Laurus diospyroides* Michx. 55:1
T: none given
M: en Fleurs le 25 Mars (I have not been able to relate this date to a locality in Michaux's journal - auth.).
Lindera melissaefolium (Walt.) Blume

1:243 *Laurus pseudo-benzoin* Michx. 55:4
T: juxta rivulos et in udis, a Canada ad Floridam.
M: Pres d'Alexandrie en Virginie.
Lindera benzoin (L.) Blume

1:246 *Eriogonum tomentosum* Michx.

1:248 *Pleea tenuifolia* Michx.

1:256 *Andromeda speciosa*
var. *α nitida* Michx. 57:18
var. *β pulverulenta* Michx. 57:18
Leucothoe racemosa (L.) A. Gray

1:257 *Kalmia cuneata* Michx. 58:20
T: in Carolina.
M: pres Cambden.

1:258 *Rhododendron minus* Michx. 59:5
T: in montibus Carolinae superioris et versus originem amnis Savannah.
M: Hautes Montagnes de la Carol. Septentrionale. Aux sources de la Rivierre Savanah.

1:258 *Rhododendron catawbiense* Michx. 59:6
T: in montibus excelsis Carolinae septentrionalis juxta originem amnis Catawba.
M: Au sommet des hautes montagnes de la Caroline Septentrionale.

1:260 *Clethra acuminata* Michx. 59:18
T: in excelsis montibus Carolinae.
M: Hautes montagnes de Carol.

1:262 *Cassia fasciculata* Michx.
T: in Pensylvania et Virginia
M: in Pensylvania et Virginia et Carolina.
Cassia fasciculata Michx. var. *fasciculata*

1:263 *Podalyria uniflora* Michx. 60:9
T: in Carolina et Georgia.
M: Route de Sunbury a Alatamah le 7 May (1787 - auth.)
Baptisia lanceolata (Walt.) Ell.

1:264 *Podalyria mollis* Michx. 61:2
T: in comitatu Mecklenburg Caroline Superiore.
M: Entre Burke et Lincoln.
Thermopsis mollis (Michx.) M. A. Curtis ex A. Gray var. *mollis*

1:264 *Podalyria coerulea* Michx. 60:22
T: in sabulosis inundatis fluminis Ohio.
M: Isles Bahama.
Baptisia australis (L.) R. Br. var. *australis*
(This taxon does not occur in the Bahama Islands but it does in the Ohio Valley. Michaux's localization is inexplicit to me at present - auth.)

1:266 *Monotropa lanuginosa* Michx. 61:4
Monotropa hypopitys L.*

1:266 *Monotropa morrisoniana* Michx. 61:7
Monotropa uniflora L.

1:269 *Saxifraga virginiensis* Michx. 61:8
T: in rupibus Pensylvaniae, Virginiae et in montibus Carolinae.
M: Haute Caroline et in rupib. Virginiae Pensylvaniae ad Schuykill.
Saxifraga virginiensis Michx. var. *virginiensis*

1:270 *Mitella prostrata* Michx. 61:19
T: ad fines meriodionales Canadae.
M: Lac Champlain.
Mitella nuda L.

1:267 *Jussiaea grandiflora* Michx. 61:9
Ludwigia peploides var. *glabrescens* (Kuntze) Shinners*

1:268 *Hydrangea nivea* Michx. 61:11
Hydrangea arborescens ssp. *radiata* (Walt.) McClintock

1:268 *Hydrangea vulgaris* Michx. 61:12
Hydrangea arborescens L. var. *arborescens*

1:272 *Silene pensylvanica* Michx. 62:6
T: in Pensylvania.
M: Plus rare dans la Basse Caroline.
Silene caroliniana Walt.*

1:273 *Stellaria pubera* Michx. 62:10
T: in montibus sylvaticus Carolinae septentrionalis.
M: Hautes montagnes des Carolines.

1:274 *Arenaria glabra* Michx. 62:11
T: in rupibus Carolinae septentrionalis.
M: Rochers des h. Montag. de la Am. Sept.
Arenaria groenlandica var. *glabra* (Michx.) Fern.*

1:273 *Arenaria squarrosa* Michx. 62:13
T: in sabulosis, pinetis Carolinae, juxta amnem Santee.
M: Sables arides high hills Santee.
Arenaria caroliniana Walt.*

1:274 *Arenaria stricta* Michx. 62:15
T: in rupibus Novae Angliae, Canada.
M: Lac Champlain et Canada sur les Rochers Etat de N. York pres Albany. Arenaria stricta Michx. var. *stricta**

1:276 *Spergulastrum gramineum* Michx. 62:17
Stellaria longifolia Muhl. ex Willd.

1:275 *Spergulastrum lanceolatum* Michx. 62:18
T: in borealibus Americae septentrionalis.
M: Riv. Sagney.
Stellaria calycantha (Ledeb.) Bong.

1:275 *Spergulastrum lanuginosum* Michx. 62:21

T: in meridionalibus Amercae septentrionalis.
M: Georgia 1790 #7 du Voyage en Georgia Insula Cumberland, Georgia americana.
Arenaria lanuginosa (Michx.) Rohrb. ssp. *lanuginosa*

1:277 *Sedum ternatum* Michx. 63:1
T: in rupibus altissimus Americae septentrionalis.
M: hautes montagnes des Carolines et de Virginie.

1:277 *Sedum telephioides* Michx. 63:2

1:277 *Sedum pulchellum* Michx. 63:3
T: in rupibus, circa Knoxville.
M: Western Territories on the Rocks.

1:276 *Sedum pusillum* Michx. 63:4
T: in Carolina septentrionali, loco dicto Flat-rock.
M: Flat Rock (Kershaw County, South Carolina, not Henderson County, North Carolina - auth.)

1:279 *Asarum arifolium* Michx. 63:10
T: in umbrosis sylvis Carolinae inferioris.
M: Caroline.
Hexastylis arifolia (Michx.) Small*

1:280 *Befaria paniculata* Michx. 63:11
T: in Florida arenosis.
M: Partie meriodionale de la Georgie et Floride.
Befaria racemosa Vent.

1:282 *Decumaria forsythia* Michx. 63:21
Decumaria barbara L.

1:283 *Chrysobalanus oblongifolius* Michx. * 64:3
T: in sabulosis sylvarum Georgiae et Floridae.
M: ad Fluvium Ste. Mary in Georgia.

1:286 *Cerasus borealis* Michx. 64:6
Prunus pensylvanica L.f.

1:284 *Prunus chickasa* Michx. 64:9
Prunus angustifolia Marsh.

1:284 *Prunus sphaerocarpa* Michx. 64:10
T: in maritimis Novae Angliae.
M: in maritimus Nova Caesarea.
Prunus maritima Marsh.

1:284 *Prunus hiemalis* Michx. 64:12
Prunus americana Marsh. var. *americana*

1:285 *Cerasus virginiana* Michx. 64:13
var. *α virginiana*

var. *β humilior* Michx.
Prunus serotina Ehrh. var. *serotina*

1:284 *Prunus acuminata* Michx.
T: in Virginia.
M: none given
Prunus maritima Marsh. (occasional reports of this species from Virginia have not been verified - auth.)

1:287 *Agrimonia striata* Michx. 64:20
T: in Canada
M: Chicoutoumé

1:287 *Crataegus apiifolia* Michx. 65:1
T: in humidis sylvarum Carolinae.
M: des swamps de la Basse Caroline.
Crataegus marshallii Eggl.

1:288 *Crataegus spathulata* Michx. 65:4
T: in Carolina utruque et Virginia.
M: haute Caroline.

1:292 *Mespilus arbutifolia* (L.) Michx. var. *melanocarpa* Michx. 65:20
T: in Canada, a sinu Hudsonis ad Virginiam et in Montis altis Carolinae.
M: Tres hautes Montagnes de la Caroline septentrionale et Canada; aussi Connecticut, Boston, etc.
Aronia melanocarpa (Michx.) Ell.

1:291 *Mespilus canadensis* var. *α obovalis* Michx. 65:21
T: Carolina inferiore.
M: Carolines.
Amelanchier obovalis (Michx.) Ashe

1:291 *Mespilus canadensis* var. *δ oligocarpa* Michx. 66:1
Amelanchier bartramiana (Tausch) Roemer

1:291 *Mespilus canadensis* var. *β cordata* Michx. 66:2
T: a Canada ad Virginiam et in montibus Carolinae.
M: a Canada ad Virginiam et in montibus Carolinae haute et basse Caroline. Rare dans la basse Caroline.
Amelanchier arborea (Michx. f.) Fern.

1:291 *Mespilus canadensis* var. *γ rotundifolia* Michx. 66:3
T: in Canada.
M: Lac Champlain, Lac Mistassin.
Amelanchier canadensis (L.) Medic.

1:295 *Rosa setigera* Michx. 67:5
T: in Carolina inferiore.
M: Illinois, Kentucky, Georgia.
Rosa setigera Michx. var. *setigera*

1:295 *Rosa laevigata* Michx. 67:6

1:296 *Rosa pensylvanica* Michx. 67:8
T: in paludosis Pensylvaniae et Novae Angliae.
M: a Nova Anglia ad Pensylvania.
Rosa virginiana Mill.

1:298 *Rubus obovalis* Michx. 67:12
Rubus hispidus L.*

1:298 *Rubus acaulis* Michx.* 67:14
T: in sphagnosis sinui Hudsonis adjacentibus.
M: in sphagnosis juxta sinum Hudsonis.

1:297 *Rubus strigosus* Michx. 67:15
T: in montibus Pensylvaniae et in Canada.
M: des Pensylvanie Etat de New York Canada.
Rubus strigosus Michx. var. *strigosus*

1:296 *Rubus trivialis* Michx. 67:20
T: in Carolina et Pensylvania.
M: Haute et basse Carolines.

1:300 *Dalibarda fragaroides* Michx. 67:21
T: none given
M: au nord au pres de l-Etang a un demiquart de mile de Knoxville (Tennessèe juxta Knoxville).
Waldsteinia fragaroides (Michx.) Tratt.

1:299 *Dalibarda violaeoides* Michx. 68:1
Dalibarda repens L.

1:300 *Geum geniculatum* Michx. 68:3
T: in Canada (M: also). Locality incorrect; restricted to high mountains of North Carolina and Tennessee - auth.)

1:300 *Geum radiatum* Michx. 68:5
T: in excelsis Carolinae montibus.
M: Sommet de Roun Mountain.
(A. Gray is sometimes incorrectly given as the author of this species. Topotypes are frequent in collections - auth.)

1:303 *Potentilla hirsuta* Michx. 68:13
T: in Canada, a Quebec ad ostium fluminis S. Laurentii.
M: Malbaye in Canada, Tadoussack in Canada a Quebec ad ostium fluminis St. Laurentii.
Potentilla norvegica L.

1:303 *Potentilla simplex* Michx. 68:17
T: in Canada, Pensylvania, et Carolina.
M: Montagnes de Pensylvanae, Virginiae, etc.

Potentilla simplex Michx. var. *simplex*

1:305 *Calycanthus ferax* Michx. 69:5
T: in altis montibus Carolinae et Virginiae.
M: Montagnes de Caroline.
Calycanthus floridus var. *laevigatus* (Willd.) T & G

1:306 *Tilia canadensis* Michx. 69:8
Tilia americana L.

1:306 *Tilia laxiflora* Michx. 69:12
T: in maritimis Carolinae, Virginiae.
M: Tilleul de Caroline.
Tilia caroliniana Mill.

1:307 *Helianthemum ramuliflorum* Michx. 69:19
T: in Georgia et Carolina.
M: "Yard in Cels." (Charleston ? - auth.)
Helianthemum canadense (L.) Michx.

1:307 *Helianthemum corymbosum* Michx. 69:20
T: in maritimis Carolinae et Georgiae.
M: Caroline.

1:309 *Chelidonium diphyllum* Michx. 70:5
Stylophorum diphyllum (Michx.) Nutt.

1:310 *Sarracenia variolis* Michx. 70:14
Sarracenia minor Walt.

1:311 *Sarracenia psyttacina* Michx. 70:16
Sarracenia psittacina Michx.

1:312 *Nymphaea longifolia* Michx. 70:20
T: in amnibus Carolinae Sept. et Merid.
M: Black River, Yadkin and Santee Rivers Carolines
Nuphar luteum ssp. *sagittifolium* (Walt.) Beal

1:314 *Delphinium tridactylum* Michx. 71:5
T: in montibus Virginiae et Carolinae.
M: Montagnes de Virginie et de Caroline.
Delphinium exaltatum Ait.

1:314 *Delphinium tricorne* Michx. 71:6
T: in altissimis montibus Carolinae.
M: Tres hautes Mont.

1:314 *Delphinium azureum Michx.*
Delphinium carolinianum Walt.

1:319 *Anemone parviflora* Michx. 71:17
.T: ad amnes in sinum Hudsonis defluentes.
M: Rivierre des Goelands.

1:320 *Anemone aconitifolia* Michx. 71:20
T: in Canada et Nova Anglia.
M: Fleuve St. Laurent, Connecticut.
Anemone canadensis L.

1:320 *Ranunculus filiformis* Michx. 72:3
T: ad ripas fluminis S. Laurentii et sinum Hunsonis.
M: ad ripas fluminis Hudson, St. Laurent, rives dur Lac Mistassin.
Ranunculus flammula var. *filiformis* (Michx.) DC.

1:321 *Ranunculus hispidus* Michx. 72:4
T: in umbrosis sylvis Carolinae inferioris.
M: in humides Virginiae Carolinae.
Ranunculus hispidus Michx. var. *hispidus*

1:322 *Thalictrum anemenoides* Michx. 72:5
T: a Canada ad Virginianum.
M: Depuis le Canada jusque en Caroline en suivant la chaine des Mos.
Thalictrum thalictroides (L.) Eames & Boiv.

1:322 *Thalictrum laevigatum* Michx. 72:7
Thalictrum dioicum L.

1:316 *Cimifuga americana* Michx. 70:3

1:316 *Cimifuga palmata* Michx. 70:4
Trautvettaria carolinensis (Walt.) Vail var. *carolinensis*

1:326 *Illicium parviflorum* Michx. 73:2

1:327 *Magnolia macrophylla* Michx. 73:11

1:330 *Orchidocarpum grandiflorum* Michx. 73:20
T: in Georgia et Florida.
M: Georgie.
Asimina speciosa Nash*

1:329 *Orchidocarpum parviflorum* Michx. 73:21
Asimina parviflora (Michx.) Dunal

1:329 *Orchidocarpum arientinum* Michx. 74:1
T: a Virginia ad Floridam, juxta inundatus amnium ripas.
M: Pensylvania Virginie Carolines Ohio et Misissipi (river - auth.)
Asimina triloba (L.) Dunal

MICHAUX VOL. II

2:2 *Mentha tenuis* Michx. 74:15
Mentha spicata L.

2:2 *Mentha borealis* Michx. 74:16
T: juxta manes ad sinum Hudsonis defluentes.

M: 48 deg de latitude. Hauteur des Terres lieux tres humides.
Mentha arvensis var. *glabrata* (Benth.) Fern.

2:4 *Isanthus coeruleus* Michx. 74:18
T: in cretaceis Virginiae, Carolinae, Kentucky.
M: Kentucky.
Isanthus brachiatus (L.) BSP var, *brachiatus**

2:4 *Lamium hispidulum* Michx. 74:19
T: in sylvis Tennassée apacis.
M: Kentucky et forêts humides de Tennassee.
Synandra hispidula (Michx.) Britt.

2:4 *Stachys hyssopifolia* Michx. 74:20
Stachys hyssopifolia Michx. var. *hyssopifolia*

2:5 *Stachys aspera* Michx. 75:4

2:6 *Brachystemum verticillatum* Michx. 75:6
T: in montibus Pensylvaniae, adusque Carolinam superiorem.
M: Carolines, Pittsburgh (Pa. - auth.)
Pycnanthemum verticillatum (Michx.) Pers.

2:6 *Brachystemum muticum* Michx. 75:9
Pycnanthemum muticum (Michx.) Pers.

2:8 *Pycnanthemum aristatum* Michx. 75:20
T: a Marylandia ad Carolinam superiorem.
M: Carolina.
Pycnanthemum setosum Nutt.

2:8 *Pycnanthemum montanum* Michx. 76:1
T: in altis montibus Carolinae.
M: hautes Montagnes.

2:8 *Pycnanthemum monardella* Michx. 76:2
T: in altis montibus Carolinae.
M: in excelsis montibus Carolina Septentrionalis.
Monarda clinopodia L.

2:9 *Thymus carolinanus* Michx. 76:8
Satureja georgiana (Harper) Ahles

2:11 *Scutellaria parvula* Michx. 76:17
T: in regione Illinoensis et Canada.
M: Montreal - Illinois.

2:11 *Scutellaria pilosa* Michx. 76:19
Scutellaria elliptica Muhl. var. *elliptica*

2:13 *Verbena bracteosa* Michx. 76:19
T: in regione Illinoensi et in urbe Nash-ville.
M: Nashville sur Tennassée, St. Vincent, Kaskaskia, etc.
Verbena bracteata Lag. & Rodr.

2:14	*Verbena rigens* Michx.	77:17
T:	in regione Illinoensi.	
M:	Kaskaski, Illinois.	
2:11	*Scutellaria pilosa* Michx.	76:19
	Scutellaria elliptica Muhl. var. *elliptica*	
2:13	*Verbena bracteosa* Michx.	77:17
T:	in regione Illinoensi et in urbe Nash-ville.	
M:	Nashville sur Tennassée, St. Vincent, Kaskaskia, etc.	
	Verbena bracteata Lag. & Rodr.	
2:14	*Verbena rigens* Michx.	77:17
T:	in regione Illinoensi.	
M:	Kaskaski, Illinois.	
	Verbena stricta Vent.	
2:14	*Verbena angustifolia* Michx.	77:13
T:	in Tennessee et in comitatu Carlisle Pensylvaniae.	
M:	Cumberland et haute Pensylvaniae & western Territories.	
	Verbena simplex Lehm.	
2:16	*Melampyrum americanum* Michx.	77:21
T:	a sinu Hudsonis ad montosum Carolinam.	
M:	Canada (Tadoussack-auth., from isotypes). Hautes montagnes de Caroline.	
	Melampyrum lineare var. *americanum* (Michx.) Beauv.	
2:18	*Pedicularis gladiata* Michx.	78:9
	Pedicularis canadensis L.	
2:19	*Pedicularis lanceolata* Michx.	78:10
2:20	*Gerardia auriculata* Michx.	78:10
2:20	*Gerardia auriculata* Michx.	78:16
T:	in pratis regionis Illinoensis.	
M:	Prairies des Illinois & du Misissipi.	
	Tomanthera auriculata (Michx.) Raf.	
2:20	*Gerardia afzelia* Michx.	78:17
T:	in sabuletis aridis Carolinae.	
M:	Basse Caroline.	
	Seymeria cassioides (Walt. ex J. F. Gmel.) Blake	
2:22	*Capraria multifida* Michx.	79:7
T:	in ripis arenosis fluminum amniculorumque in Tennassée et Illinoensi regione.	
M:	Illinois, Kentucky.	
	Leucospora multifida (Michx.) Nutt.	
2:22	*Monniera cuneifolia* Michx.	79:8
T:	in locis mari inundatis Carolinae inferiores.	

M: Lieux aquatiq inondés par la Mer pres Charleston.
Bacopa monnieri (L.) Wettst.

2:22 *Monniera rotundifolia* Michx. 79:9
Bacopa rotundifolia (Michx.) Wettst.

2:22 *Monniera amplexicaulis* Michx. 79:10
T: in fossis, stagnis Carolinae.
M: in stagnis Carolinae.
Bacopa carolina (Walt.) Robins.

2:23 *Ruellia humistrata* Michx. 79:17
T: ad fines Georgiae et Floridae.
M: sur la rivierrre Ste. Marie en Georgie.
Ruellia caroliniensis (Walt. ex J. F. Gmel.) Stued,
var. *caroliniensis*

2:23 *Ruellia oblongifolia* Michx. 79:16
T: in Georgia.
M: Georgie, le 27 Avril (1787 - auth.)
Dyschoriste oblongifolia (Michx.) Kuntze

2:27 *Cochlearis humifusa* Michx. 80:12
Coronopus didymus (L.) J. E. Sm.

2:28 *Draba arabisans* Michx. 80:15
T: in rupibus ripariis ad lacum Champlain et in Nova Anglia.
M: Rochers du Lac Champlain.

2:28 *Draba hispidula* Michx. 80:16
Draba reptans (Lam.) Fern. var. *reptans*

2:30 *Cardamine rotundifolia* Michx. 80:17
T: in rivulis altissimosum montium Carolinae.
M: Tres hautes montagnes - Ruisseaux.

2:29 *Cardamine uniflora* Michx. 80:18
T: in rupibus circa Knoxville.
M: Rochers environs Knoxville.
Leavenworthia uniflora (Michx.) Britt.

2:29 *Cardamine spathulata* Michx. 80:19
T: in excelsis montibus Carolinae.
M: Hautes Mont
Arabis lyrata L. var. *lyrata*

2:29 *Cardamine teres* Michx. 80:20
T: in Nova Anglia.
M: Etat de Vermont Lac Champlain.
Rorippa teres (Michx.) Stuckey var. *teres*
(A mistake in type locality; limited to southeastern
coastal plain of U.S.; another variety in southwestern
U.S. - auth.)

2:20 *Dentaria diphylla* Michx. 81:1
T: in sylvis vastis Tennassée et montibus altissimus Carolinae.
M: New York et Hautes Mont.
Cardamine diphylla (Michx.) Wood

2:30 *Dentaria concatenata* Michx. 81:2
Cardamine concatenata (Michx.) O. Schw.

2:31 *Hesperis pinnatifida* Michx. 81:4
T: in humidis sylvanum Tennassée.
M: Lieux tres humides fôrets de Tennessée.
Iodanthus pinnatifidus (Michx.) Steud.

2:31 *Arabis falcata* Michx. 81:9
T: in rupestibus Canadae et Novae Angliae ad Virginianum.
M: Connecticut, Etat de Vermont, Lac Champlain.
Arabis canadensis L.

2:33 *Sisyrinchium mucronatum* Michx. 81:13
T: Pensylvania.
M: Mistassin - in Penslvania.

2:40 *Halesia parviflora* Michx. 82:14
T: in Florida, circa Matança.
M: Floride.

2:41 *Styrax pulverulentum* Michx. 82:19
Styrax americana Lam.

2:43 *Malachodendron ovatum* Michx.
T: in montosis a mare remotis Caroline.
M: Haute Caroline Catawba river.
Stewartia malacodendron L.

2:44 *Sida alcaeoides* Michx. 84:9
T: in glareosis Kentucky & Tennessée.
M: Barren Oaks endica de Big Barren River Kentucky.
Callirhoe alcaeoides (Michx.) A. Gray

2:46 *Hibiscus grandiflorus* Michx. 84:6
T: in maritimis Georgiae et Floridae et in regione Natchez ad Mississipi.
M: Lieux maritimes.

2:45 *Hibiscus hastatus* Michx. 84:17
T: ad ripas fluviorum Ohio, Mississipi et amnium Carolinae.
M: Sur les Isles et les rives de la Rivierre Santee in Carolinae de Juillet 1790.
Hibiscus militaris Cav.*

2:50 *Petalostemum violaceum* Michx. 84:20
Petalostemum purpureum (Vent.) Rydb.*

2:49	*Petalostemum carneum* Michx. *	84:19
T:	in Georgia et Florida.	
M:	Lieux humides prest MidWest riv. en Floride.	
2:51	*Fumaria recta* Michx.	85:2
T:	ad fines Canadae et in montibus Pensylvaniae.	
M:	Montagnes pres Lasingburgh.	
	Adlumia fungosa (Ait.) Greene	
2:52	*Polygala setacea* Michx.	85:5
T:	in Carolina septentrionali.	
M:	Same as text. (The species is presently unknown in North Carolina; it is confined to the coastal plain from Georgia to Mississippi - auth.)	
2:54	*Polygala corymbosa* Michx.	85:6
	Polygala cymosa Walt.	
2:53	*Polygala uniflora* Michx.	85:16
	Polygala paucifolia Willd.	
2:57	*Dalea linnaei* Michx.	86:1
T:	none given	
M:	Kaskaskia.	
	Dalea alopecuroides Willd.*	
2:58	*Psoralea lupinellus* Michx.	86:3
T:	in Carolinae locis arides.	
M:	Carolines.	
2:57	*Psoralea canescens* Michx.	86:4
2:58	*Psoralea melilotoides* Michx.	86:5
	Psoralea psoralioides (Walt.) Cronq. var. *psoralioides*	
2:58	*Trifolium carolinianum* Michx.	86:10
2:60	*Phaseolus trilobus* Michx.	86:14
T:	in Carolina	
M:	(locality ms. faded; illegible - auth.)	
	Strophostyles helveola (L.) Ell.	
2:62	*Galactia glabella* Mich.	86:21
T:	in Carolina et Georgia.	
M:	Carolina.	
	Galactia volubilis (L.) Britt. var. *volubilis*	
2:64	*Amorpha pumila* Michx.	87:8
	Amorpha herbacea Walt.	
2:66	*Astragalus glaber* Michx.	88:12
T:	in sabulosis arides Georgiae.	
M:	Georgie lieux arides.	
	Astragalus michauxii (Luntze) Hermann	

2:67	*Astragalus villosus* Michx.	88:14
2:67	*Galega villosa* Michx.	88:19
T:	a Carolina ad Floridam.	
M:	Caroline et Floride.	
	Tephrosia spicata (Walt.) T. & G.	
2:68	*Galega hispidula* Michx.	89:1
	Tephrosia hispidula (Michx.) Pers.	
2:69	*Vicia parviflora* Michx.	89:10
T:	in montibus altis Carolinae et Virginiae.	
M:	Montagnes de l'Am. sept.	
	Vicia caroliniana Walt.	
2:70	*Lespedeza sessiliflora* Michx.	89:13
	Lespedeza virginica (L.) Britt.	
2:71	*Lespedeza polystachya* Michx.	89:14
	Lespedeza hirta (L.) Hornem. ssp. *hirta*	
2:71	*Lespedeza capitata* Michx.	89:1a
2:71	*Lespedeza procumbens* Michx.	89:20
2:74	*Hedysarum alpinum* var. *americanum* Michx.*	90:4
T:	in borealibus Canadae et in calaractis montium Alleghanis (not found in the Alleghany Mountains - auth.)	
M:	Lac St. Jean et Mistassins.	
2:73	*Hedysarum bracteosum* Michx.	90:6
	Desmodium cuspidatum (Muhl. ex Willd.) DC ex Loudon var. *cuspidatum*	
2:73	*Hedysarum glabellum* Michx.	90:7
T:	in Carolina inferiore	
M:	Dans herbois Basse Caroline	
	Desmodium glabellum (Michx.) DC.	
2:72	*Hedysarum acuminatum* Michx.	90:8
	Desmodium cuspidatum (Muhl. ex Willd.) DC ex Loudon var. *cuspidatum*	
2:74	*Aeschymomene viscidula* Michx.	90:21
2:75	*Stylosanthes hispida* Michx.	91:1
T:	in Virginia et Carolina.	
M:	Georgie.	
	Stylosanthes biflora (L.) BSP var. *biflora*	
2:76	*Zornia tetraphylla* Michx.	91:2
	Zornia bracteata Walt. ex J. F. Gmel.	
2:77	*Ascyrum amplexicaule* Michx.	91:8
	Hypericum crux-andreae (L.) Crantz*	

2:77 *Ascyrum stans* Michx. 91:9
Hypericum crux-andreae (L.) Crantz*

2:77 *Ascyrum multicaule* Michx. 91:10
Hypericum stragalum P. Adams & Robson*

2:77 *Ascyrum pumilum* Michx. 91:11
Hypericum suffruticosum P. Adams & Robson

2:78 *Hypericum nudiflorum* Michx. 91:13
T: in Carolina.
M: Goose Creek & Garet Place.
Hypericum cistifolium Lam.

2:78 *Hypericum sphaerocarpum* Michx. 91:15
T: in Kentucky.
M: Route de Louisville.
Hypericum sphaerocarpum Michx. var. *sphaerocarpum*

2:81 *Hypericum frondosum* Michx. 91:16

2:82 *Hypericum macrocarpon* Michx. 91:18
T: in Canada, circa Montreal.
M: Montreal.
Hypericum pyramidatum Ait.

2:78 *Hypericum glaucum* Michx. 91:21
Hypericum myrtifolium Lam.

2:79 *Hypericum sarothra* Michx. 92:2
Hypericum gentianoides (L.) BSP.

2:81 *Hypericum axillare* Michx. 92:3
Hypericum galioides Lam. var. *galioides*

2:78 *Hypericum angulosum* Michx. 92:6
T: in paludosis Carolinae.
M: in humides Carolina ad Floridam.
Hypericum denticulatum Walt. var. *denticulatum*

2:84 *Prenanthes racemosa* Michx. 92:11
T: in septentrionalibus Canada.
M: Lac St. Jean.
Prenanthes racemosa Michx. var. *racemosa*

2:83 *Prenanthes virgata* Michx. 92:13
T: in Virginia et Carolina.
M: Basse Caroline.
Prenanthes autumnalis Walt.

2:84 *Prenanthes crepidinea* Michx. 92:17
T: in regione Illinoensi et in excelsis montibus Carolinae.
(Not in mountains of the Carolinas - auth.)
M: none given

2:85 *Lactuca longifolia* Michx. 92:21
T: in Carolina superiore.
M: in Carolina environs de Burke.
Lactuca canadensis var. *longifolia* (Michx.) Farw.

2:85 *Lactuca graminifolia* Michx.* 93:1
T: in Carolina inferiore.
M: Floride et Basse Caroline.

2:86 *Hieracium canadense* Michx. 93:8
T: in Canada.
M: Lacs Mistassins.
Hieracium canadense Michx. var. *canadense*

2:86 *Hieracium scabrum* Michx. 93:9
T: in septentrionalibus Canadae et in excelsis montibus Carolinae.
M: Lacs Mistassins.
Hieracium canadense Michx. var. *scabrum*

2:87 *Hyoseris amplexicaulis* Michx. 93:10
T: in Pensylvania, Tennassee et Carolina.
M: Knoxville.
Krigia biflora (Walt.) Blake

2:87 *Hyoseris montana* Michx. 93:12
T: in altissimis montibus Carolinae septentrionalis.
M: Sommet des hautes mont. de la Carol. Sept.
Krigia montana (Michx.) Nutt.

2:89 *Scorzonera pinnatifida* Michx. 93:14
T: in ruderatis Carolinae.
M: in ruderatis Carolinae inferioris.
Pyrrhopappus carolinianus (Walt.) DC. var. *carolinianus*

2:89 *Cirsium repandum* Michx. 93:15

2:89 *Cirsium muticum* Michx. 93:17
T: in altissimis montibus Carolinae.
M: in excelsis montib. Carolinae.

2:91 *Liatris pychnostachya* Michx. 93:19
T: in pratis Illinoensibus.
M: Illinois prairies.
Liatris pychnostachya Michx. var. *pychnostachya*

2:93 *Liatris bellidifolia* Michx. 94:5
T: in sabulosis Carolina septentrionalis.
M: Sables arides de la Caroline Septentrionale.
Carphephorus bellidifolius (Michx.) T. & G.

2:93 *Liatris tomentosa* Michx. 94:6
T: in Carolina septentrionali.

M: Fayetteville dans les bois.
Carphephorus tomentosus (Michx.) T. & G.

2:92 *Liatris squarrulosa* Michx. 94:9
T: none given
M: Basse Caroline.

2:92 *Liatris aspera* Michx. 94:10
T: in regione Illinoense.
M: du pays des Illinois.
Liatris aspera Michx. var. *aspera*

2:92 *Liatris sphaeroides* Michx.
T: in pratis Illinoensibus et in excelsis montibus Caroline.
M: Prairies vers Misissipi.
Liatris scariosa (L.) Willd.

2:91 *Liatris macrostachya* Michx. 94:14
T: in Virginia et Carolina.
M: Basse Virginie et Carolina.
Liatris spicata (L.) Willd. var. *spicata*

2:93 *Liatris cylindracea* Michx. 93:21
T: in pratis sylvisque Illinoensibus.
M: Priaries et Bois du Misissipi.

2:94 *Vernonia oligophylla* Michx.
var. α *verna* Michx.
var. β *autumnalis* Michx.
Vernonia acaulis (Walt.) Gleason

2:95 *Vernonia angustifolia* Michx. 94:17
T: in aridis apricis sylvarum Carolinae.
M: Terrains arides et decouverts dans la Basse Caroline.
Vernonia angustifolia Michx. ssp. *angustifolia*

2:94 *Vernonia fasciculata* Michx. 94:18
Vernonia fasciculata Michx. ssp. *fasciculata*

2:95 *Vernonia praealta* Michx. 94:19
T: in Nova Anglia.
M: in Pensylvania.
Vernonia noveboracensis (L.) Michx.

2:95 *Sparganophorus verticillatus* Michx. 95:3
T: in inundatus, a Carolina ad Floridam.
M: paladosa Caroline.
Sclerolepis uniflora (Walt.) BSP.

2:99 *Eupatorium falcatum* Michx. 95:10
T: ad ripas fluviorum Ohio et Scioto.
M: Rives de l'Ohio.
Eupatorium purpureum L.*

2:100 *Eupatorium serotinum* Michx. 95:14
T: in scirpetis Carolina maritimis.
M: in scirpetis Carolina et in agris neglectis Illinoensib.
Eupatorium serotinum Michx. var. *serotinum*

2:98 *Eupatorium verbenaefolium* Michx. 95:20
T: in humides Carolinae.
M: in humides Carolinae, in aridis sylvarum Caroline.
Eupatorium pilosum Walt.

2:101 *Eupatorium connatum* Michx. 95:7
T: a Canada ad Floridam.
M: Carolines, Virginie, Illinois, Quebec, etc.
Eupatorium perfoliatum L. var. *perfoliatum*

2:101 *Critonia kuhnia* Michx. 96:3
T: none given
M: Haute Carol. rare dans la Basse.
Kuhnia eupatorioides L. var. eupatorioides*

2:101 *Chrysocoma capillacea* Michx. 96:5
T: in pascuis, juxta Charlstown et in Floride.
M: in pascuis juxta Savannah.
Eupatorium capillifolium (Lam.) Small

2:102 *Crysocoma coronopifolia* Michx. 96:6
Eupatorium compositifolium Walt.

2:101 *Chrysocoma nudata* Michx. 96:8
T: in humidis Carolinae.
M: Carolines.
Bigelowia nudata (Michx.) DC var. *nudata*

2:106 *Personia angustifolia* Michx. 96:12
Marshallia trinervia (Walt.) Trel.

2:105 *Personia latifolia* Michx.
Marshallia trinervia (Walt.) Trel.

2:105 *Personia lanceolata* Michx.
Marshallia obovata var. *scaposa* Channell

2:107 *Melanthera hastata* Michx. 95:15
T: in Carolina.
M: Caroline, Virginie.
Melanthera nivea (L.) Small

2:108 *Aster solidagineus* Michx. 96:16
T: in Virginia et Carolina.
M: A Charleston ad Montes Carolae. Junio floret.

2:114 *Aster biflorus* Michx. 96:17
Aster radula Ait.

2:109 *Aster acuminatus* Michx. 96:19
T: in Canada.
M: Canada et Montagnes (of North Carolina - auth.)

2:110 *Aster uniflorus* Michx. 97:2
T: in vastis sphagnosis, juxta lacus Mistassinos.
M: Lac des Cygnes et Rivierra des Goelands.
Aster nemoralis Ait.

2:109 *Aster infirmis* Michx. 97:3
T: a Canada ad Carolinam, per tractus montium.
M: in collibus Carolinae Septentrionalis et ad Lineville Mountaenae Canada.

2:108 *Aster tortifolius* Michx. 97:6
T: in Carolina inferiore.
M: in Carolina.

2:113 *Aster villosus* Michx. 97:7
T: in pratis Illinoensibus.
M: Illinois.
Aster ericoides L. var. *ericoides*

2:112 *Aster surculosus* Michx. 97:8

2:114 *Aster amplexicaulis* Michx. 97:9
T: in Carolinae inferioris dumosis.
M: Basse Caroline.
Aster patens var. *gracilis* Hook.

2:111 *Aster argenteus* Michx. 97:12
T: in rupibus ripariis fluminis Missouri.
M: in rupibus ad ripas fluminis Missouri.
Aster sericeus Vent.

2:113 *Aster diversifolius* Michx. 98:2
Aster undulatus L.

2:112 *Aster sparsiflorus* Michx. 98:3
T: in Carolina inferiore.
M: Basse Carol.
Aster dumosus L. var. *dumosus*

2:111 *Aster subulatus Michx.*
Aster subulatus Michx. var. *subulatus*

2:116 *Solidago pauciflosculosa* Michx.
Chrysoma pauciflosculosa (Michx.) Greene.

2:116	*Solidago lanceolata* L. var. *minor* Michx. *Euthamia minor* (Michx.) Greene	98:10
2:117 T: M:	*Solidago virgata* Michx. in humidis sylvarum Carolinae inferioris. Basse Caroline in humidis sylvariis. *Solidago stricta* Ait.	99:8
2:117 T: M:	*Solidago retrorsa* Michx. in Carolina inferiore. Basse Caroline. Bois pres l'habitat. (vic. Charleston - auth.)	99:10
2:117	*Solidago glomerata* Michx.	99:12
2:120 T: M:	*Senecio lyratus* Michx. in numoribus Carolinae. Pastures arides pres Charlest. *Senecio glabellus* Poir.	99:13
2:120 T: M:	*Senecio pauperculus* Michx. in Canada, juxta lacus. Lac St. Jean.	99:16
2:119 T: M:	*Senecio tomentosus* Michx. in Carolinae loco dicto Flat.-Roc. Sur un Rocher. Flat Roc or hanging Roc. (South Carolina, not North Carolina, see note under *Sedum pussillum,* 1:276. 6 April 1794 - auth.)	99:19
2:121	*Tussilago integrifolia* Michx. *Chaptalia tomentosa* Vent.	99:20
2:121	*Doronicum nudicaule* Michx. *Arnica acaulis* (Walt.) BSP.	99:21
2:122 T: M:	*Inula gossypina* Michx. in maritimis Carolinae et Floridae. Lieux arides en Basse Caroline. Fleurit en Septembre. *Chrysopsis gossypina* (Michx.) Ell.*	100:3
2:122 T: M:	*Inula graminifolia* Michx. a Carolina ad Floridam. Caroline. *Chrysopsis graminifolia* (Michx.) Ell. var. *graminifolia**	100:4
2:123 T: M:	*Erigeron divaricatum* Michx. in pratensibus Illinoensibus, prope Kaskaskia. Kaskaskia, Prairie du Rocher et Kaokia (aux Pays du Illinois). *Conyza ramosissima* Cronq.	100:5
2:124 T:	*Erigeron pulchellum* Michx. in Canada, Pensylvania et montibus Carolinae.	100:6

M: Canada et Montagn de la Caroline Septentri.
Erigeron pulchellus Michx. var. *pulchellus*

2:123 *Erigeron hyssopifolium* Michx. 100:8
T: ad sinum Hudsonis et juxta lacus Mistassins.
M: Lacs Mistassins.
Erigeron hyssopifolius Michx. var. *hyssopifolius*

2:124 *Erigeron nudicaule* Michx. 100:9
T: in udis herbosis Carolinae.
M: in humidis sylvarum Carolina inferioris.
Erigeron vernus (L.) T. & G.

2:125 *Baccharis sessiflora* Michx. 100:12
Baccharis halimifolia L.

2:125 *Baccharis angustifolia* Michx. 100:13

2:126 *Conyza marilandica* Michx. 100:21
T: a Pensylvania ad Carolinam.
M: Virgin et Carol.
Pluchea camphorata (L.) DC.

2:126 *Conyza amplexicaulis* Michx. 100:18
T: in humidis Carolinae.
M: Basse Caroline - Lieux tres humides.
Pluchea foetida (L.) DC.

2:126 *Conyza pycnostachya* Michx. 100:19
T: a Carolina ad Floridam.
M: Carolina.
Pterocaulon pycnostachyum (Michx.) Ell. (*P. virgatum* (L.) DC. listed for this species in NLSPN (1982) is a different species according to Cronquist (1980) - auth.)

2:127 *Gnaphalium polycephalum* Michx. 101:1
Gnaphalium purpureum L. var. *purpureum*

2:129 *Artemisia caudata* Michx. 101:8
T: ad ripas sabulosis fluminis Missouri
M: Bords Sablonneux du Misissipi.
Artemisia caudata Michx. var *caudata*

2:128 *Artemisia campestris* Michx. 101:9
T: in arena mobili secus lacus ad sinum Hudsonis.
M: in arena mobili lacum ad sinum hudsonis.
Artemisia campestris ssp. *borealis* (Pall.) Hall & Clements

2:130 *Eclipta brachypoda* Michx. 101:12
Eclipta alba (L.) Hassk.

2:131 *Bellis integrifolia* Michx. 102:1
T: ad ripas rivulorum et in collibus umbrosis Tennassee.

M:	Cumberland.	
	Astranthium integrifolium (Michx.) Nutt. var. *integrifolium*	
2:131	*Spilanthes repens* Michx.	102:2
	Spilanthes americana (Mutis) Hieron. var. *americana*	
2:134	*Verbesina sigesbeckia* Michx.	102:15
	Verbesina occidentalis (L.) Walt.	
2:134	*Verbesina coreopsis* Michx.	
	var. *α lutea* Michx.	102:16
T:	in Virginia et Carolina superiore.	
M:	in Virginia et Carolina superiore et in regione Illinoensium.	
	var. *β alba* Michx.	102:17
T:	in Carolina maritima.	
M:	in Carolina maritima, Georgia in umbrosis ripariis amnium.	
	Verbesina alternifolia (L.) Britt.	
2:135	*Verbesina helianthoides* Michx.	103:1
T:	in occidentalibus Alleghanis, territoria Tennassée, et regione Illinoens.	
M:	Illinois & Wilderness entre Cumberland & Kentucky.	
2:136	*Bidens chrysanthemoides* Michx.	103:6
T:	a Pensylvania ad Carolinam, in aquosis.	
M:	Carol.	
	Bidens laevis (L.) BSP.	
2:140	*Coreopsis mitis* Michx.	103:8
	Bidens coronata (L.) Britt. var. *coronata*	
2:138	*Coreopsis senifolia* Michx.	103:9
	Coreopsis major Walt.	
2:137	*Coreopsis latifolia* Michx.	103:17
T:	in excelsis montibus Carolinae.	
M:	Vers le sommet de Black Mountain.	
2:137	*Coreopsis dichotoma* Michx.	103:21
T:	in sphagnosis umbrosis Carolinae.	
M:	Basse Caroline, lieux tres humides.	
	Coreopsis gladiata Walt. var. *gladiata*	
2:140	*Coreopsis aristosa* Michx.	104:1
	Bidens aristosa (Michx.) Britt. var. *aristosa*	
2:139	*Coreopsis trichosperma* Michx.	104:2
T:	in humidis Carolinae superioris.	
M:	Montagnes de Carol.	
	Bidens coronata (L.) Britt. var. *coronata*	
2:140	*Helianthus canescens* Michx.	104:9
T:	in pratensibus irrigris regionis Illinoensis et Tennassee.	

M: Illinois.
Helianthus mollis Lam.

2:141 *Helianthus tomentosus* Michx. 104:10
T: in pratensibus Illinoensibus.
M: Illinois.
Helianthus strumosis L.

2:142 *Galardia fimbriata* Michx. 104:13
T: in paludosis aprocis, a Carolina ad Floridam.
M: Lieux humides en Caroline et en Georgie.
Helenium drummondii H. Rock

2:142 *Galardia lanceolata* Michx.
Gaillardia aestivalis (Walt.) H. Rock

2:143 *Rudbeckia chrysomela* Michx. 104:16
T: a Pensylvania ad Carolinam.
M: Pensylvania, Illinois.
Rudbeckia fulgida Ait. var. *fulgida*

2:144 *Rudbeckia pinnata* Michx. 104:17
T: in apricis Canadae et in collibus regionis Illinoensis.
M: regionis Illinoensis juxta Wabash. (A Canadian specimen, juxta Batiscan ad versus les Trois Rivierres, 104:18, is a paratype - auth.)

2:144 *Rudbeckia spathulata* Michx. 105:1
Rudbeckia fulgida Ait. var. *fulgida*

2:146 *Silphium integrifolium* Michx. 105:6
Silphium integrifolium Michx. var. *integrifolium*

2:145 *Silphium compositum* Michx.

2:146 *Silphium ternifolium* Michx. 105:14
T: in montibus Virginiae et Carolinae.
M: Montagnes des Carolines.
Silphium trifoliatum L. var. *trifoliatum*

2:146 *Silphium pumilum* Michx. 105:18
T: in Florida.
M: in Georgia et florida.
Berlandiera pumila (Michx.) Nutt.

2:149 *Viola hastata* Michx. 106:15
T: in altis montibus Carolinae.
M: A l'ouest de la Caroline dans les Montagnes elevées des Appalaches.

2;150 *Viola debilis* Michx. 106:20
T: in montibus Alleghanis.
M: in montib. altis America Septentrion.
Viola striata Ait.

2:150 *Viola rotundifolia* Michx. 106:21

2:153 *Lobelia claytoniana* Michx. 107:12
T: a Pensylvania ad Carolinam.
M: Pensylvania. Hab in Montibus Carolinae.
Lobelia spicata Lam. var. *spicata*

2:152 *Lobelia crassiuscula* Michx. 107:15
T: in paludosis herbosis Carolinae maritimae usque ad Floridam.
M: in paludosis Carolina, Basse Carol.
Lobelia glandulosa Walt.

2:152 *Lobelia puberula* Michx. 107:16
T: in Carolina.
M: in Carolina amnia maritimis.
Lobelia puberula Michx. var. *puberula*

2:153 *Lobelia amoena* Michx.

2:155 *Orchis humilis* Michx. 107:17
T: in excelsis montibus Carolinae.
M: Hautes Montagnes.
Orchis rotundifolia Banks ex Pursh*

2:156 *Orchis lacera* Michx. 107:18
Habenaria lacera (Michx.) Lodd*

2:156 *Orchis cristata* Michx. 107:19
Habenaria cristata (Michx.) R. Br.*

2:155 *Orchis clavellata* Michx. 107:20
Habenaria clavellata (Michx.) Spreng.*

2:155 *Orchis quinqueseta* Michx. 107:21
Habenaria lacera (Michx.) R. Br.*

2:157 *Malaxis unifolia* Michx. 108:3
T: in umbrosis sylvarum, a Carolina ad Floridam.
M: Basse Caroline.

2:158 *Ophrys pubera* Michx. 108:7
Liparis loeselii (L.) L. C. Rich.

2:159 *Limodorum trifidum* Michx.
Bletia purpurea (Lam.) DC.

2:160 *Arethusa parviflora* Michx. 108:13
Triphora trianthophora (Sw.) Rydb.

2:161 *Cypripedium canadense* Michx.
Cypripedium reginae Walt.

2:162 *Pistia spathulata* Michx. 109:3
T: none given

M: in rivulis ad Lacus Georgie, Florida.
Pistia stratiotes L.

2:165 *Podostemon ceratophyllum* Michx. 109:7

2:166 *Eriocaulon villosum* Michx. 109:9
Lachnocaulon anceps (Walt.) Morong

2:165 *Eriocaulon gnaphalodes* Michx.
T: in Carolina.
M: in Carolina, Georgia.
Eriocaulon compressum Lam.

2:166 *Eriocaulon pellucidum* Michx. 109:13
T: in septentrionalibus Canada.
M: Route de Chicoutoumé au Lac St. Jean, Chicoutoumé.
Eriocaulon septangulare With.

2:167 *Scleria reticularis* Michx. 109:19
Scleria reticularis Michx. var. *reticularis*

2:167 *Scleria oligantha* Michx. 109:14

2:168 *Scleria triglomerata* Michx. 109:16
T: in Carolina.
M: in pratis sylvaticus Carolina.

2:167 *Scleria ciliata* Michx. 109:18
T: in Carolina.
M: in umbrosis aridis Carolinae.
Scleria ciliata Michx. var. *ciliata*

2:173 *Carex subulata* Michx. 109:20
(Erroneously attributed to Canada by both Richard and Michaux; normal range Rhode Island to Georgia - auth.)
Carex collinsii Nutt.

2:174 *Carex militaris* Michx.* 110:2

2:170 *Carex viridula* Michx. 110:3
T: in Canada.
M: in Canada, entre Montreal et les Tres Rivierres.

2:172 *Carex paupercula* Michx. 110:4

2:169 *Carex typhina* Michx. 110:6
T: in regione Illinoense.
M: in humidior sylvarum Illinoensium.

2:172 *Carex lenticularis* Michx. 110:7

2:174 *Carex oligosperma* Michx. 110:8
T: in Canada.
M: ad Lacus Mistassin dictos.

2:169 *Carex vulpinoidea* Michx. 110:9
T: in Canada et Nova Anglia.
M: Montreal.

2:175 *Carex lanuginosa* Michx. 110:12
Carex lasiocarpa var. *americana* Fern.

2:171 *Carex scirpoidea* Michx. 110:13
T: ad sinum Hudsonis.
M: Mistassin.

2:172 *Carex debilis* Michx. 111:1
T: none given
M: Basse Caroline?
Carex debilis Michx. var. *debilis*

2:170 *Carex triceps* Michx. 111:2
T: in Carolina.
M: in Carolina inferiore.
Carex complanata Torr. & Hook.

2:173 *Carex striatula* Michx. 111:3

2:176 *Tragia cordata* Michx. 111:4
T: in Kentucky.
M: entre le ville et Piercetown, a moitis de distance (Danville, 22 miles en route to Bardstown, 15 Sept. 1793, from Michx. journal - auth.)

2:176 *Tragia urticifolia* Michx. 111:7
T: in Georgia.
M: (no locality given - auth.) le 15 May 1784.

2:178 *Pachysandra procumbens* Michx. 111:8

2:180 *Betula glandulosa* Michx. 111:19
Betula glandulosa Michx. var. *glandulosa*

2:183 *Ambrosia absynthifolia* Michx. 112:16
Ambrosia artemisiifolia L. var. *artemisiifolia*

2:182 *Ambrosia bidentata* Michx. 112:19
T: in regione Illinoensi.
M: Priaries des Illinois.

2:183 *Ambrosia paniculata* Michx.
Ambrosia artemisiifolia L. var. *artemisiifolia*

2:186 *Crotonopsis linearis* Michx. 113:3
T: in maritimis Carolinae, juxta Long-Bay, et in regione Illinoensi.
M: Priaries des Illinois.

2:187	*Calla sagittifolia* Michx. *Peltandra sagittifolia* (Michx.) Morong	113:7
2:189	*Sparganium angustifolium* Michx.	113:14
T:	in amnibus Canadae.	
M:	in amnibus a Quebec ad Lacus Mistassins.	
2:190	*Sagittaria graminea* Michx. *Sagittaria graminea* Michx. var. *graminea*	113:15
2:190	*Sagittaria natans* Michx. *Sagittaria stagnorum* Small	113:17
2:191	*Myriophyllum heterophyllum* Michx.	113:19
T:	in Carolina et Georgia.	
M:	in Amne Santee (et) in amne ogechee	
2:190	*Myriophyllum scabratum* Michx. *Myriophyllum pinnatum* (Walt.) BSP.	113:20
2:192	*Juglans pterocarpa* Michx.	114:4
T:	in umbrosis humidis sylvarum, juxta mare Caspium.	
M:	in humidis umbrosis juxta Angely ad mare Caspium. In Insula senseli. *Pterocarya fraxinofolia* Lam. (Apparently inexplicable inclusion of a Eurasian species in *F. b.-a.* by Richard - auth.)	
2:192	*Juglans mucronata* Michx.	115:3
T:	in humidis sylvarum Virginiae, Carolinae.	
M:	Pensylvania, Virginie et Caroline. *Carya lacinosa* (Michx. f.) Loudon	
2:192	*Juncus olivaeformis* Michx.	115:7
T:	in regione Illinoensium.	
M:	Clarksville vis a vise Louisville au Kentucky, 1793. (Indiana side of Kentucky River, in Clark County - auth.) *Carya illinoensis* (Want.) K. Koch	
2:193	*Castanea vesca* var. *americana* Michx. *Castanea dentata* (Marsh.) Borkh.	115:13
2:197	*Quercus laurifolia* Michx.	115:19
T:	in Carolina meridionali et Georgia.	
M:	in Carolina.	
2:199	*Quercus catesbaei* Michx.	115:20
T:	in Marilandia, Virginia et Carolinis.	
M:	in aridis, sabulosis Carolinae. *Quercus nigra* L.	

2:199 *Quercus triloba* Michx. 116:10
T: a Nova Anglia ad Georgiam.
M: Carol. in Pensylvania.
Quercus falcata Michx. var. *falcata*

2:199 *Quercus falcata* Michx. 116:12
T: a Virginia ad Floridam.
M: Haute et Basse Caroline.
Quercus falcata Michx. var. *falcata*

2:197 *Quercus cinerea* Michx. 117:12
T: in montibus Alleghanis.
M: in montibus Pensylvaniae et in regione Illinoensium.

2:194 *Quercus obtusiloba* Michx. 117:15;
T: a Canada et Nova Anglia ad Floridam.
M: Pensylvania.
Quercus stellata Wang. var. *stellata.*

2:194 *Quercus macrocarpa* Michx. 117:21
T: in montibus Alleghanis, Kentucky, Tennassée, regione Illinoense, etc.
M: Illinois, Cumberland et Kentucky.

2:197 *Quercus imbricaria* Michx.

2:199 *Quercus banisteri* Michx.
Quercus ilicifolia Wang.

2:204 *Pinus mitis* Michx. 119:1
T: in Virginia, Kentucky et Carolina.
M: in Carolina.
Pinus echinata Mill.

2:205 *Pinus serotina* Michx. 119:5

2:206 *Abies denticulata* Michx. 119:7
T: in Canada et Nova Anglia.
M: Baye d'Hudson et Lacs Mistassins. In monte excelsiore Carolinae dicto Grand Father Mountain et in Canada (The latter sentence is partly wrong as it is evident Michaux confused *Picea rubens* Sarg. in the south with this species. On his label he has "Epinette noire des Canadiens" - auth.)
Picea mariana (Mill.) BSP.

2:213 *Stillingia ligustrina* Michx. 119:17
Sebastiana fruticosa (Bartr.) Fern.

2:210 *Euphorbia graminifolia* Michx. 119:19
T: in maritimis Floridae et Georgiae.
M: Parites maritimes et les plus meriodionales de la Georgie.
Euphorbia heterophylla var. *graminifolia* (Michx.) Engelm.

2:215 *Croton monanthogynum* Michx. 120:7
Croton monanthogynus Michx.

2:214 *Croton disjunctiflorum* Michx. 120:8
Croton punctatus Jacq.

2:214 *Croton capitatum* Michx. 120:11
Croton capitatus Michx. var. *capitatus*

2:215 *Croton argyranthemum* Michx. 120:12
Croton argyranthemus Michx.

2:220 *Najas canadensis* Michx. 120:19
Najas flexilis (Willd.) Rostk. & Schmidt

2:220 *Vallisneria americana* Michx. 120:20

2:222 *Ceratiola ericoides* Michx. 120:21
T: in aridis sabulosis Georgiae et Floridae.
M: in Georgia, Florida.

2:224 *Adelia ligustrina* Michx. 121:2
T: in fruticetis Illinoensibus, Tennassée, etc.
M: in fruticetis Illinoensium et Colligus Tennassee juxta Nashville.
Forestiera acuminata (Michx.) Poir. in Lam.

2:225 *Adelia acuminata* Michx. 121:3
Forestiera acuminata (Michx.) Poir. in Lam.

2:224 *Adelia porulosa* Michx. 121:4
Forestiera segregata (Jacq.) Krug & Urban

2:225 *Salix eriocephala* Michx. 121:6
Salix discolor Muhl. var. *discolor*

2:225 *Salix cordata* Michx. 121:9

2:226 *Salix carolina* Michx. 121:10
T: in Carolina et Georgia.
M: Caroline.

2:225 *Salix incana* Michx. 121:13
T: in Canada, juxta lacum S. Joannis.
M: in Canada, juxta lacum S. Joannis et Riv des Goelands.
Salix candida Fluegge ex Willd. var. *candida*

2:226 *Salix longirostris* Michx. 121:14
T: a Nova Anglia ad Carolinam, copiose in demetosis apricis Tennassee.
M: a Canada ad Carolinam.

2:229 *Ilex canadensis* Michx. 121:13
T: in praeruptis montibus, a sinu Hudsonis ad lacum Champlain.
M: Quebec, Tadoussack, Lac St. Jean, Mistassins dans les

	lieux humid. et fert.	
	Nemopanthus mucronatus (L.) Trel.	
2:230	*Vitis aestivalis* Michx.	122:17
T:	in sylvis, a Virginia ad Carolinam.	
M:	a pensylvania ad Carolinam.	
	Vitis aestivalis Michx. var. *aestivalis*	
2:231	*Vitis riparia* Michx.	122:20
T:	ad ripas et in inusulis fluviorum Ohio, Misissipi, etc.	
M:	idem, plus Missouri.	
	Vitis riparia Michx. var. *riparia*	
2:231	*Vitis rotundifolia* Michx.	122:21
2:231	*Vitis cordifolia* Michx.	123:3
T:	a Pensylvania ad Floridam.	
M:	a Nova Anglia ad Carolinam.	
	Vitis vulpina L.	
2:233	*Pyrularia pubera* Michx.	123:11
T:	in montibus Carolinae occidentalis et in Virginia.	
M:	in Montium excelsorum umbrosis Virginia, Carolinae.	
2:234	*Acnida nisocarpa* Michx.	123:13
T:	none given	
M:	Carolina.	
	Amaranthus cannabinus (L.) Sauer	
2:235	*Zanthoxylum ramiflorum* Michx.	123:14
T:	a Canada ad Virginiam et in Kentucky.	
M:	in Canada juxta Montreal et in Noveboraco ad riparias fluvii Hudsonis. Distr Canada, Pensylvania, Kentucky, Ilinoese et raro in Carolina.	
	Zanthoxylum americanum Mill.	
2:235	*Zanthoxylum tricarpum* Michx.	123:15
	Zanthoxylum clava-herculis L.	
2:236	*Prinos ambiguus* Michx.	123:18
	Ilex ambigua (Michx.) Torr.	
2:236	*Prinos gronovii* Michx.	123:19
	Ilex verticillata (L.) A. Gray	
2:238	*Smilax pulverulenta* Michx.	124:4
T:	in Canada et Pensylvania.	
M:	a Canada ad Virginiam.	
	Smilax herbacea var. *pulverulenta* (Michx.) A. Gray*	
2:238	*Smilax tamnifolia* Michx.*	124:5
2:238	*Smilax pubera* Michx.	124:13
	Smilax pumila Walt.	

2:239 *Dioscorea paniculata* Michx. 124:14
T: a Canada ad Carolinam.
M: N. Jersey.
Dioscorea villosa L. var. *villosa*

2:241 *Polygonella parvifolia* Michx. 124:17
T: in aridissimis Carolinae.
M: Sables arides aux environs de Wilmington dans la Caroline Septentrionale.
Polygonella polygama (Vent.) Engelm. & Gray

2:241 *Gymnocladus canadensis* Michx. 124:19
T: none given
M: in regione Illinoensium.
Gymnocladus dioicus (L.) K. Koch

2:243 *Populus angulosa* Michx. 125:7
Populus deltoides Marsh. ssp. *deltoides*

2:243 *Populus tremuloides* Michx.* 125:12

2:243 *Populus grandidentata* Michx. 125:13

2:248 *Planera gmelini* Michx. 126:9
T: ad ripas fluviorum Ohio, Misissipi et Carolinae.
M: Caroline et Georgie.
Planera aquatica Walt. ex J. F. Gmel.

2:250 *Veratrum parviflorum* Michx.* 126:16
T: in excelsis montibus Carolinae.
M: Tres hautes montannes.

2:251 *Melanthium racemosum* Michx. 126:19
T: in excelsis montibus Carolinae septentrionalis.
M: Yellow Mountain.
Melanthium virginicum L.

2:253 *Acer eeriocarpum* Michx. 127:2
T: none given
M: Rives de l'Ohio
Acer saccharinum L.

2:254 *Mimosa glandulosa* Michx. 127:14
T: ad ripas fluvii Tennassée; etrain juxta Misissipi.
M: Isles du Misissipi et Rivierre Tenassée.
Desmanthus illinoensis (Michx.) MacMill. ex B. Rob. & Fern.

2:254 *Mimosa horridula* Michx. 127:11
Schrankia microphylla (Dryand.) Macbr.

2:256 *Fraxinus epiptera* Michx. 128:3
T: in Virginia et Carolina.
M: Il commence a 15 li. (French abbreviation of "league",

approximately 3 miles - auth.) au dessus du Lac St Jean.
Fraxinus americana L. var. *americana*

2:255 *Fraxinus quadrangulata* Michx. 128:6

2:256 *Fraxinus platicarpa* Michx. 127:16
Fraxinus caroliniana Mill.

2:259 *Nyssa candicans* Michx. 128:21
T: ad amnens Ogeeche.
M: Rivierre Ogeeche.
Nyssa ogechee Bartr. ex Marsh.

2:258 *Nyssa villosa* Michx.
T: a Nova Anglia ad Carolinam.
M: a Connecticut ad Carolinam.
Nyssa sylvatica Marsh. var. *sylvatica*

2:259 *Nyssa tomentosa* Michx. 129:4
T: ad amnem St. Mary et in Florida.
M: Riv. Altahama, St. Mary et Floride.
Nyssa aquatica L.

2:259 *Nyssa angulisans* Michx. 129:8
Nyssa aquatica L.

2:261 *Vittaria angustifrons* Michx. 129:10
T: in Florida, juxta amnen Aisa-hatcha.
M: Sur les Bords de la Riv. Aisahatcha le 1er Avril (1787 - auth.) Floride.
Vittaria lineata (L.) Sm.

2:262 *Pteris gracilis* Michx. 129:13
Cryptogramma stelleri (S. G. Gmel.) Prantl

2:263 *Woodwardia banisteriana* Michx. 129:16
Osmunda cinnamomea L.

2:271 *Polypodium hexagonopterum* Michx. 130:16
Thelypteris hexagonoptera (Michx.) Weatherby

2:270 *Nephrodium lanosum* Michx. 130:17
T: in montibus saxosis Tennassée et Carolinae septentrionalis.
M: in excelsis - then same as T.
Cheilanthes lanosa (Michx.) D. C. Eaton

2:269 *Nephrondium ruficulum* Michx. 130:4
T: in rupibus Canada et Nova Caesareae.
M: in rupibus Canada, Nova Angliae et Nova Caesareae.
Cheilanthes lanosa (Michx.) D. C. Eaton

2:271 *Polypodium connectile* Michx. 130:5
Thelypteris hexagonoptera (Michx.) Weatherby

2:269 *Nephrodium tenue* Michx. 130:6

T: in Canada.
M: Quebec.
Cystopteris fragilis (L.) Bernh.

2:269 *Nephrodium asplenioides* Michx. 130:9
Athyrium asplenioides (Michx.) A. A. Eaton*

2:268 *Nephrodium punctilobum* Michx. 130:11
Dennstaedtia punctiloba (Michx.) Moore

2:267 *Nephrodium acrostichoides* Michx. 130:15
T: in Pennsylvania, Carolina et Tennassée.
M: same plus et Carolin. maritimis.
Polystichum acrostichoides (Michx.) Schott

2:265 *Asplenium thelpteroides* Michx. 130:1
T: in montibus Virginiae et Carolinae septentrionalis.
M: same plus Lac Champlain.
Athyrium thelypteroides (Michx.) Desv.

2:265 *Asplenium angustifolium* Michx. 130:2
Athyrium pycnocarpon (Spreng.) Tidest.

2:276 *Ophioglossum bulbosum* Michx. 131:11
T: in sabulosis Carolina inferioris.
M: in sabulosis Carolina.
Ophioglossum crotalophoroides Walt.

2:274 *Botrypus lunarioides* Michx.
T: in pascuis, circa Charlestown.
M: in pascuis sabulosis juxta Charleston.
Botrychium lunarioides (Michx.) Sw.

2:275 *Cteisium paniculatum* Michx. 131:9
T: in occidentalibus Virginiae ad fines Kentucky et in Tennassée.
M: Dady's Creek et plusi. creeks a 25 miles de West Point SW Clinch River.
Lygodium palmatum (Bernh.) Sw.

2:273 *Osmunda interrupta* Michx. 131:4
T: in Canada, Pensylvania et Kentucky.
M: Canada, Kentucky.
Osmunda claytoniana L.

2:281 *Equisetum scirpoides* Michx. 132:8

2:284 *Lycopodium lucidulum* Michx. 132:11
T: a Canada ad Carolina montosum.
M: New Jersey.

2:282 *Lycopodium dendroideum* Michx. 133:4
T: a Canada et Nova Anglia ad Carolinam montosam.
M: Montagne de Carol. Sept.

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ADDITIONS TO THE FLORA OF CAPE BRETON HIGHLANDS NATIONAL PARK, NOVA SCOTIA

Harold R. Hinds

ABSTRACT

Ten species and one hybrid are here reported as new or from additional sites in Cape Breton Highlands National Park. The hybrid *Solidago bicolor* × *S. canadensis* is reported for the first time.

Key Words: vascular plants, new records, Cape Breton

While doing field work for a study of the rare plants of Cape Breton Highlands National Park from August 1980 to August 1981, the following vascular plants were found that had not previously been reported from Cape Breton or had only been found once or twice.

Three species are here reported as new to Nova Scotia and are marked with an asterisk. The species are listed in alphabetical order with their collection data and brief distributional notes. The acronym, CBHNP, refers to the herbarium of Cape Breton Highlands National Park, Ingonish Beach, Nova Scotia, BOC 1LO.

Anemone multifida Poir.

Uncommon on dry loose, coarse, gravelly conglomerate ledges in small crevices and on shelves, area of Le Buttereau and La Grande Falaise about 1 km north of park entrance, Inverness County, 15 June, 1981, *H. Hinds 4911* (CBHNP); gravelly bluff north of Chéticamp, Inverness County, 8 July, 1938, *A. S. Pease 26,627* (GH).

This latter collection by A. S. Pease is certainly from the same area, but was never published. It was misplaced in the Gray herbarium and so overlooked by previous researchers.

The nearest populations to this station on the mainland are in the vicinity of Hartland, New Brunswick on gravel strands of islands in the Saint John River. This species also occurs in Newfoundland (Rouleau, 1978).

***Anemone parviflora** Michx.

A small colony on north-northeast facing wet limestone cliffs below waterfall, Corney Brook gorge south of French Lake, Inverness County, 10 June, 1981, *H. Hinds 4477* (CBHNP).

This species occurs in Newfoundland (Rouleau, 1978) and on the mainland the nearest population occurs on wet gypsum near Wilson Brook, Albert Mines, Albert County, New Brunswick.

Diapensia lapponica L.

Rare on horizontal granitic shelf facing north on high shoulder of upper Chéticamp River gorge above series of waterfalls, Inverness County, 25 August, 1981, *H. Hinds 4541* (CBHNP).

One other collection is known from Nova Scotia in Victoria County, Lockhart Brook, tributary of Salmon River (Smith & Erskine, 1954). Not known from New Brunswick. Closest populations in Newfoundland (Rouleau, 1978) and the Gaspé (Scoggan, 1950).

Draba norvegica Gunner var. **clivicola** (Fern.) Boivin

Rare on dry shelves of limestone ledges close to upper Corney Brook south of French Lake, Inverness County, 24 July, 1981, *H. Hinds 4480* (CBHNP).

Previously reported from Cape Breton on dry, exposed shelves of limestone cliffs, Big Southwest Brook (Smith & Schofield, 1952). Also reported from Big Intervale, Margaree, Inverness County (Macoun, 1898). Reported from the Gaspé (Scoggan, 1950) but from neither New Brunswick nor Nefoundland.

***Drosera rotundifolia** L. var. **comosa** Fern.

Rare on calcareous gravels, east shore of Paquette Lake, Victoria County, 12 August, 1980, *H. Hinds 3818* (CBHNP).

Not previously reported from Nova Scotia. Nearest populations are reported from marly bogs at the mouth of Grand River, Gaspé (Scoggan, 1950) and from Ross Island, Grand Manan archipelago, New Brunswick (Weatherby & Adams, 1945).

Minuartia groenlandica (Retz.) Ostenf.

Rare on south-southeast facing dryish, loose calcareous ledges, Corney Brook gorge south of French Lake, Inverness County, 15 August, 1981, *H. Hinds 4471* (as *Arenaria groenlandica*) (CBHNP).

Nearest populations in Newfoundland (Rouleau, 1978) and in Halifax County, Nova Scotia (Roland & Smith, 1969).

Oxytropis campestris (L.) DC. var. **johannensis** Fern.

Frequent on open, gravelly scree, seaward side of southeast tip of promontary north of Jumping Brook, Inverness County, 12 August, 1980, *H. Hinds 3205* (CBHNP); rare in rock scree, south shoulder of

La Grande Falaise about 1 km north of park entrance, Inverness County, 10 June, 1981, *H. Hinds 4912* (CBHNP).

Reported in Nova Scotia from Saint Paul Island off the northern tip of Cape Breton (Perry & Roscoe, 1931) and from Cape d'Or in Cumberland County (Schofield, 1955). This taxon is also found in Newfoundland (Rouleau, 1978) and in New Brunswick on gravel strands of the Saint John and Restigouche Rivers, as well as the Gaspé and northern Maine.

Pinguicula vulgaris L.

Rare on moist south-southeast facing ledges above large waterfall, upper Corney Brook gorge south of French Lake, Inverness County, 1 August, 1981, *H. Hinds 4529* (CBHNP); frequent on wet limestone ledges, upper Chéticamp River, Inverness County, 1 August 1981, *H. Hinds 4529* (CBHNP).

Also reported in Nova Scotia from Saint Paul Island (Perry & Roscoe, 1931) and from Big Southwest Brook, Inverness County (Hounsell & Smith, 1968). This species is found in Newfoundland (Rouleau, 1978) and on the Restigouche River in Northern New Brunswick.

***Rhododendron lapponicum** (L.) Wahl.

Rare on south facing shelves of calcareous ledge, Corney Brook gorge south of French Lake, Inverness County, 19 June 1981, *H. Hinds 4302* (CBHNP).

Nearest populations reported from Newfoundland (Rouleau, 1978), the Gaspé (Scoggan, 1950), and from alpine mountain summits of northern New England (Seymour, 1969). Not known from New Brunswick.

Salix uva-ursi Pursh

Rare and local on south facing shelves of calcareous ledge, Corney Brook gorge south of French Lake, Inverness County, 19 June 1981, *H. Hinds 4305,* 14 July, 1981, *H. Hinds 4478* (CBHNP).

Previously reported in Nova Scotia from Saint Paul Island (Perry & Roscoe, 1931). The nearest other populations occur in Newfoundland (Rouleau, 1978), the Gaspé (Scoggan, 1950) and the mountains of New York (Mitchell *et al.* 1980) and northern New England (Seymour, 1969). Not known from New Brunswick.

Saxifraga aizoides L.

Locally abundant on north facing limestone ledges dripping with water from above and also within the spray of a large waterfall, Corney Brook gorge south of French Lake, Inverness County, 14 August 1980, *H. Hinds 3755* (CBHNP).

Previously reported in Nova Scotia only from the Big Southwest Brook, Inverness County (Smith & Schofield, 1952). Nearest other populations occur in Newfoundland (Rouleau, 1978), the Gaspé (Scoggan, 1950), the mountains of New York (Mitchell *et al.* 1980), and Vermont (Countryman, 1978). Not known from New Brunswick.

Solidago bicolor L. × **S. canadensis** L.

One large plant on open gravelly roadside along the Chéticamp River about 2 km above Chéticamp campground, Inverness County, 11 August 1980, *H. Hinds 3828* (CBHNP, UNB).

The hybrid occurred with both parents growing nearby and combined the characteristics of both. This hybrid has apparently not previously been reported anywhere.

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STUDIES IN THE GENUS *ARISTIDA* (GRAMINEAE) OF THE SOUTHEASTERN UNITED STATES. I. SPIKELET VARIATION IN *A. PURPURESCENS*, *A. TENUISPICA*, AND *A. VIRGATA*

KELLY W. ALLRED

ABSTRACT

Morphologic variation in *Aristida purpurescens*, *A. tenuispica*, and *A. virgata* was assessed by principal components and step-wise discriminant analyses. Although well-defined clusters corresponding to the three taxa were defined by principal component analysis (PCA), extensive morphologic overlap was also evident. Both the PCA and discriminant analyses assigned some spikelets from the same panicle to different taxa. A single morphologic species is suggested.

Key Words: *Aristida*, taxonomy, principal components, discriminant analysis

North American *Aristida* have been classed within three sections: 1) Arthratherum, wherein the lemma is prolonged into a column or beak that disarticulates at its base, just above the lemma; 2) Streptachne, in which the lateral awns are much reduced or obsolete and without an articulated column; and 3) Chaetaria, with well-developed lateral awns and also without an articulated column (Henrard, 1929). Hitchcock (1924) further divided the section Chaetaria into four rather informal groups, Dichotomae, Adscensiones, Divaricatae, and Purpureae, but left about 25 species, mostly from the southeastern United States and West Indies, unplaced as to group.

While working with some of these unplaced species for the Vascular Flora of the Southeastern United States, I experienced difficulty in distinguishing some members of the taxa *A. purpurescens* Poir., *A. tenuispica* Hitchc., and *A. virgata* Trin. These are perennial, cespitose, three-awn grasses with mostly flat blades, narrow contracted panicles, and more-or-less equal glumes. Apparently typical forms of each species were relatively distinct from the others, and from other species as well, but there occurred numerous specimens with confusing and seemingly random combinations of features from the three taxa. This situation prompted the following queries. What is the pattern of morphologic variation within this complex? Are the three taxa delimited by consistent combinations of morphologic features, or does there exist an admixture of features? How extensive is any morphologic overlap among the taxa?

MATERIALS AND METHODS

Over 400 herbarium specimens from throughout the geographic range of the three taxa were examined in a preliminary study of the morphologic features. Of these, 74 specimens were selected that represented well the morphologic variation within the complex, including "extremes" as well as "typical" material. These specimens were assigned to one of four groups: three groups contained typical *purpurescens, tenuispica,* or *virgata* based upon conformity with the original descriptions and descriptions of the types in Henrard (1932); the fourth group was composed of unassigned specimens that were difficult to identify or exhibited unusual character combinations. Each of the three typical groups contained 16 operational taxonomic units (OTUs), one OTU from each of 16 specimens. The unassigned group contained 52 OTUs, representing two OTUs (scorings) from each of 26 specimens. The duplicate scoring of each of the unassigned specimens would give some indiction of variability within a single plant. A total of 100 OTUs was used in the analysis.

Following the survey of all herbarium specimens, and after consulting the major reference works dealing with this group of *Aristida,* 12 spikelet features were selected for analysis. They were number of nerves on glume I, lengths of glumes I and II, lemma length, callus length, cnetral and lateral awn lengths, central and lateral awn angles of divergence, and awn contortion. For each of the three typical groups of specimens, measurements were taken from a well-formed spikelet in the upper ¼ of the panicle. For the unassigned group, with 2 OTUs per specimen, measurements were taken from spikelets at both ends of the central ⅓ of the panicle.

Analysis was by principal components (PCA) using standardized data and by step-wise discriminant analysis (SDA) from the BMDP Statistical Software package (Dixon, 1981). For the SDA, the typical groups were used to establish the discriminant equation, and the members of the unassigned group were then given a phenetic identification to one of the three groups based on this equation.

RESULTS AND DISCUSSION

Principal components analysis resulted in a fairly clear distinction of the three typical groups of specimens (Figure 1). This, of course, was the result of the a priori selection of morphologically separable

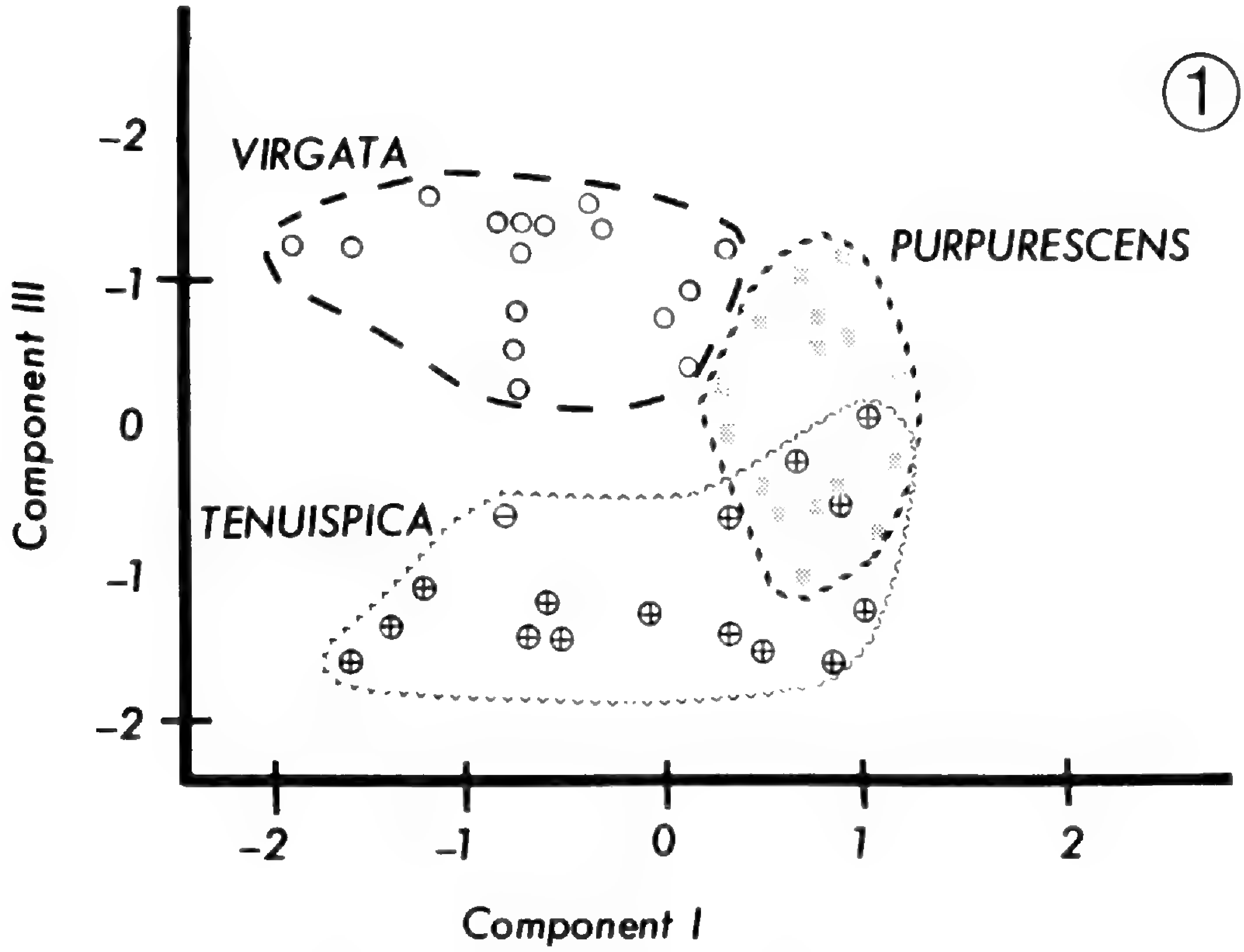

Figure 1. PCA of only the typical groups.

specimens. Greatest resolution was found along axes I and III, reflecting distinctions in glume and lemma lengths (strongly weighted on axis I) and lateral awn angle, central awn width, and awn contortion (strongly weighted on axis III). Axis II reflected a strong weighting with awn length, but did not distinguish the taxa. The first three axes accounted for 54% of the variation; axes I and III for 27% and 12%, respectively. Relative to the other groups, the *purpurescens* entity was characterized by long lemmas and glumes, the first glume longer than the second (inverse), equal awn widths, and equal divergence of the awns with little or no contortion. Typical *virgata* possessed a wide central awn reflexed or divergent between the two erect lateral awns. Typical *tenuispica* had markedly contorted awns with nearly equal divergence, and subequal glumes.

Of note was the phenetic overlap of the typical *purpurescens* and *tenuispica* groups. Specimens within the zone of overlap were rechecked for proper identification: they did seem to fit well the morphologic "concept" of *purpurescens* or *tenuispica,* although differences in awn contortion were less pronounced than among the other specimens.

There were few high correlations of features. Correlations greater than ±0.50 were glume I and II lengths, glume and lemma lengths, central and lateral awn lengths, and awn contortion and lateral awn angle. These were all less than ±0.80, however. The number of nerves on the first glume, callus length, and central awn angle all lacked any meaningful correlation with any other features, and seemed to vary randomly.

Upon addition of the unassigned OTUs to the PCA grid, distinctions between the three taxa are blurred (Figure 2). Identification of these OTUs to *purpurescens, tenuispica,* or *virgata* was by SDA. Of the 26 pairs of OTUs in the unassigned group, 12 were congruous, that is, both OTUs from each pair were assigned to the same taxon by the SDA and fell roughly within that cluster on the PCA grid. However, 14 pairs of OTUs were incongruous, with the OTUs from each pair being assigned to different taxa by the SDA and with generally a corresponding placement by PCA. These incongruous pairs are linked by a solid line in Figure 2. The phenetic similarities of the three taxa are circular, with only slightly more

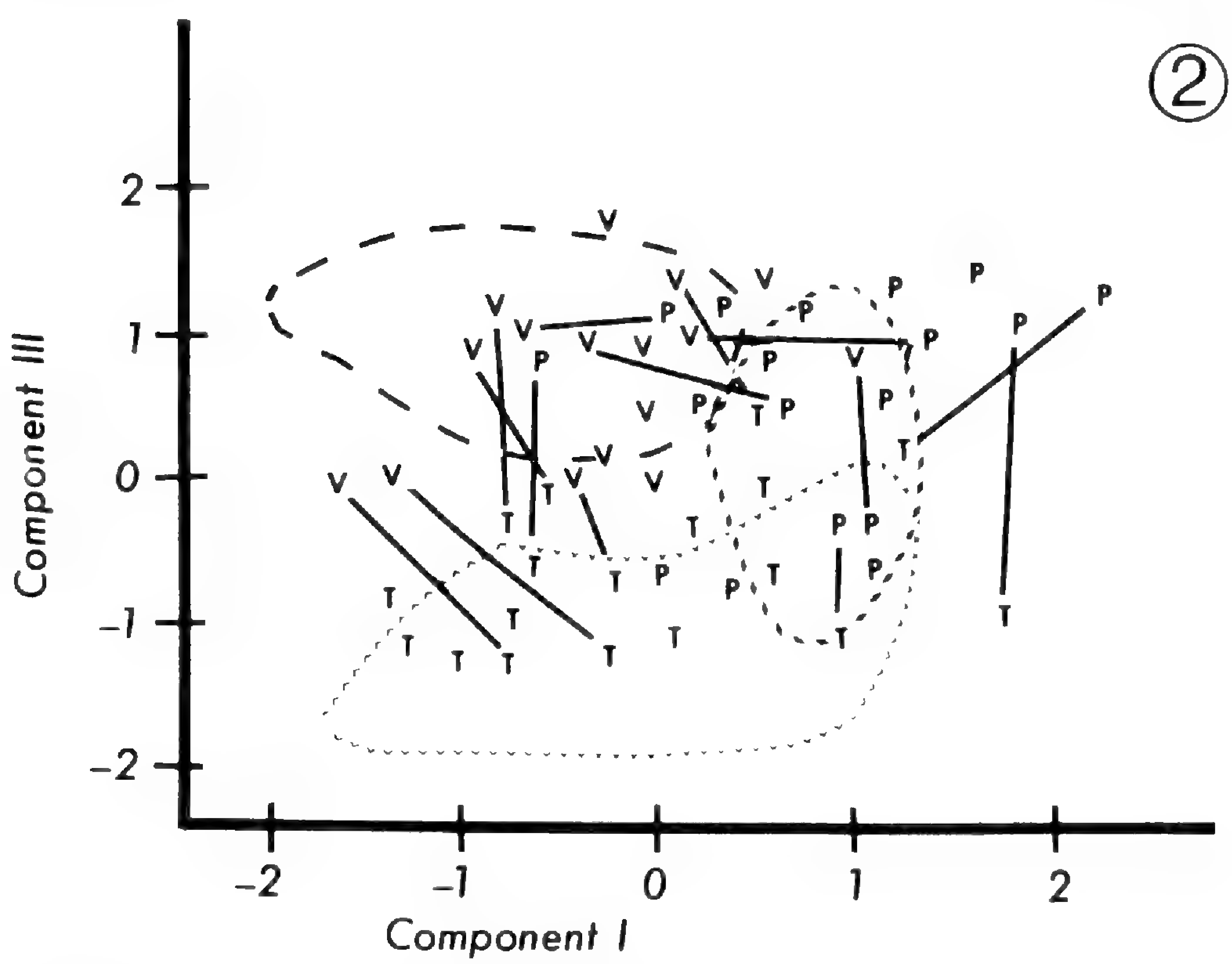

Figure 2. PCA of the unassigned OTUs. The dashed lines delimit the boundaries of typical *virgata,* typical *purpurescens,* and typical tenuispica from Figure 1. The OTUs are assigned to *virgata* (V), *purpurescens* (P), or *tenuispica* (T) by the SDA. OTUs linked by a solid line are incongruous pairs.

incongruous pairs involving *virgata* and *tenuispica* (6 pairs) than *virgata-purpurescens* or *purpurescens-tenuispica* (4 pairs each).

No consistent combination of features serves to distinguish the taxa. The spikelet variability within a single plant, represented by conformity to one of the typical groups, was just as great for some specimens as the variability between taxa. The incongruous pairs in particular had atypical combinations, such as inverse glumes with strongly contorted awns on the same spikelet, or one spikelet typical of *virgata* and one spikelet typical of *purpurescens* within the same panicle. Although material typical of each taxon is common, morphologic intermediates are certainly not rare, and represent a significant phenetic shuffling of features. Clearly, only one morphologic taxon is present here. The original three entities may deserve recognition at the infraspecific level, but even this is questioned by the presence of incongruous pairs within the same panicle. At this point nothing is known about the chromosome numbers for these taxa or about the reproductive mechanism. Final disposition of the taxa must await these further investigations.

ACKNOWLEDGMENTS

Thanks to John Ludwig for comments on an earlier draft, and to the following herbaria for their generous loans of specimens: APSC, ARK, AUA, FLAS, FSU, KY, LAF, LSU, MARY, MO, NCSC, NCU, NLU, NO, SMU, TENN, US, USCH, USF, VDB, VPI, WVA. This work was supported in part by grants from the New Mexico Agricultural Experiment Station and is Journal Article 1034.

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INFRASPECIFIC VARIATION IN *GRATIOLA VISCIDULA* PENNELL (SCROPHULARIACEAE)

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ABSTRACT

Gratiola viscidula Pennell was separated into two subspecies by Pennell (1935): *G. viscidula* subsp. *viscidula*, and *G. viscidula* subsp. *shortii* Durand ex Pennell. The latter subspecies, which was distinguished by its larger corollas, calyces, and leaves, was only known from southeastern Ohio and from an unspecified site in Kentucky. Examinations of herbarium specimens and field populations have demonstrated that the sizes of various plant parts are highly variable, both within individual populations and throughout the range of the species. Infraspecific categories are unwarranted. The chromosome number of the species is here first reported as $n = 7$.

Key Words: *Gratiola*, Scrophulariaceae, chromosome counts

INTRODUCTION

Pennell (1935) separated *Gratiola viscidula* into two subspecies: *G. viscidula* subsp. *viscidula* [as "*G. viscidula typica*"] and *G. viscidula* subsp. *shortii* [as "*G. viscidula shortii* (Durand) Pennell"]. The latter subspecies was distinguished by its larger corollas, calyces, and leaves and was known only from two collections, one in southeastern Ohio (Jackson County) and one from an unspecified site in Kentucky.

Later workers (Cooperrider, 1976; Cusick and Silberhorn, 1977; McCready and Cooperrider, 1978; Kartesz and Kartesz, 1980; Roberts and Cooperrider, 1982; Spooner, 1982; United States Department of Agriculture, 1982) accepted the validity of these infraspecific taxa. *Gratiola viscidula* was collected in many new localities in extreme southeastern Ohio and immediately adjacent northern Kentucky and West Virginia. Almost all of these populations are located in wetland habitats associated with preglacial Teays-age valleys, and the "*shortii*" entity was believed to be a disjunct taxon associated with these sites (Cusick and Silberhorn, 1977; Spooner, 1982).

Others, however, either did not accept these infraspecific taxa (Fernald, 1950), or did not mention them (Fernald, 1937; Gleason and Cronquist, 1963; Radford et al., 1968; Silberhorn, 1970; Godfrey and Wooten, 1981; Brumfield et al., 1982). The purpose of my study was to determine the taxonomic validity of the above infraspecific taxa by assessing both inter- and intrapopulational morphological variation of *G. viscidula.*

MATERIALS AND METHODS

Numerous specimens, including the types, were borrowed from 22 herbaria (see ACKNOWLEDGMENTS). Fifty-four mature individuals at full anthesis were measured from throughout the range of the species to ascertain the limits of morphological variability (Table 1).

Table 1. **Specimens measured for size variation within *Gratiola viscidula*** (Fig. 2).

Locational Vouchers
DELAWARE: Newcastle Co., *Commons 12* (PH); 2 Sep 1897, *Commons s.n.* (PH).
DISTRICT OF COLUMBIA: *Pennell 12415* (OS); 11 Aug 1900, *Steele s.n.* (PH).
FLORIDA: Duval Co., Mar 1882, *Smith s.n.* (F).
GEORGIA: Floyd Co., 1890, *Chapman s.n.* (US, two plants measured from this sheet); McDuffie Co., *Bartlett 1082* (VDB); Wilkes Co., s.d., *Chapman s.n.* (PH).
KENTUCKY: Estill Co., *Lasseter 3054* (EKU); Knox Co., *Stamper 30* (EKU).
MARYLAND: Prince Georges Co., *Hotchkiss 7185* (US); St. Mary's County, 20 Aug 1904, *Chrysler s.n.* (MARY).
MISSOURI: Shannon Co., *Steyermark 72109* (F,GA).
NORTH CAROLINA: Anson County, *Beal 4239* (DK); Bertie Co., *Ahles and Haesloop 52150* (UNC); Bladen Co., *Ahles and Leisner 33341* (UNC); *Biltmore 471b* (US); Buncombe Co., *Biltmore 461c* (PH); Columbus Co., *Beal 1805* (DK); Gates Co., *Correll 2249* (DK); Henderson Co., 23 Aug 1881, *Smith s.n.* (US); *Radford 4848* (UNC); Jackson Co., *Radford 4759* (UNC); Lee Co., *Beal 4284* (DK); Moore Co., *Ahles 59588* (UNC); New Hanover Co., Aug 1892, *Williamson s.n.* (PH); Rowan Co., *Heller 135* (PH, two plants measured from this sheet); Stokes Co., *Radford 41497* (UNC); Swain Co., Aug 1891, *Beardslee and Kofoid s.n.* (OS); Transylvania Co., *Beal 5826* (DK); county unspecified; Aug 1841, *Rugel s.n.* (US, three plants measured from this sheet).
SOUTH CAROLINA: Anderson Co., *Radford 13937* (UNC); Chesterfield Co., *Radford 15824* (TENN); Darlington Co., *Smith 639* (UNC); Kershaw Co., *House 2680* (US); Richland Co., 9 Jun (without year), *Taylor s.n.* (PH).
TENNESSEE: Blount Co., *Sharp and Veloira 21520* (VDB); Carter Co., *Fairchild et al. 11741* (TENN); Cocke Co., *Kearney 854* (OS, UNC, US); Morgan Co., *Webb et al. 1056* (TENN); White Co., *Shaver 4228* (TENN).
VIRGINIA: Cumberland Co., *Wells 38* (UNC); Dinwiddie Co., *Kral 11353* (UNC); Greensville Co., *Harvill 17601* (UNC); *Fernald and Long 10818* (DK); Nansemond Co., *Fernald and Long 7602* (PH); Powhatan Co., *Corcoran and Diggs 634* (UNC); *Corcoran and Diggs 1147* (UNC); Southampton Co., *Fernald et al. 5917* (PH); Sussex Co., *Fernald and Long 6390* (PH).

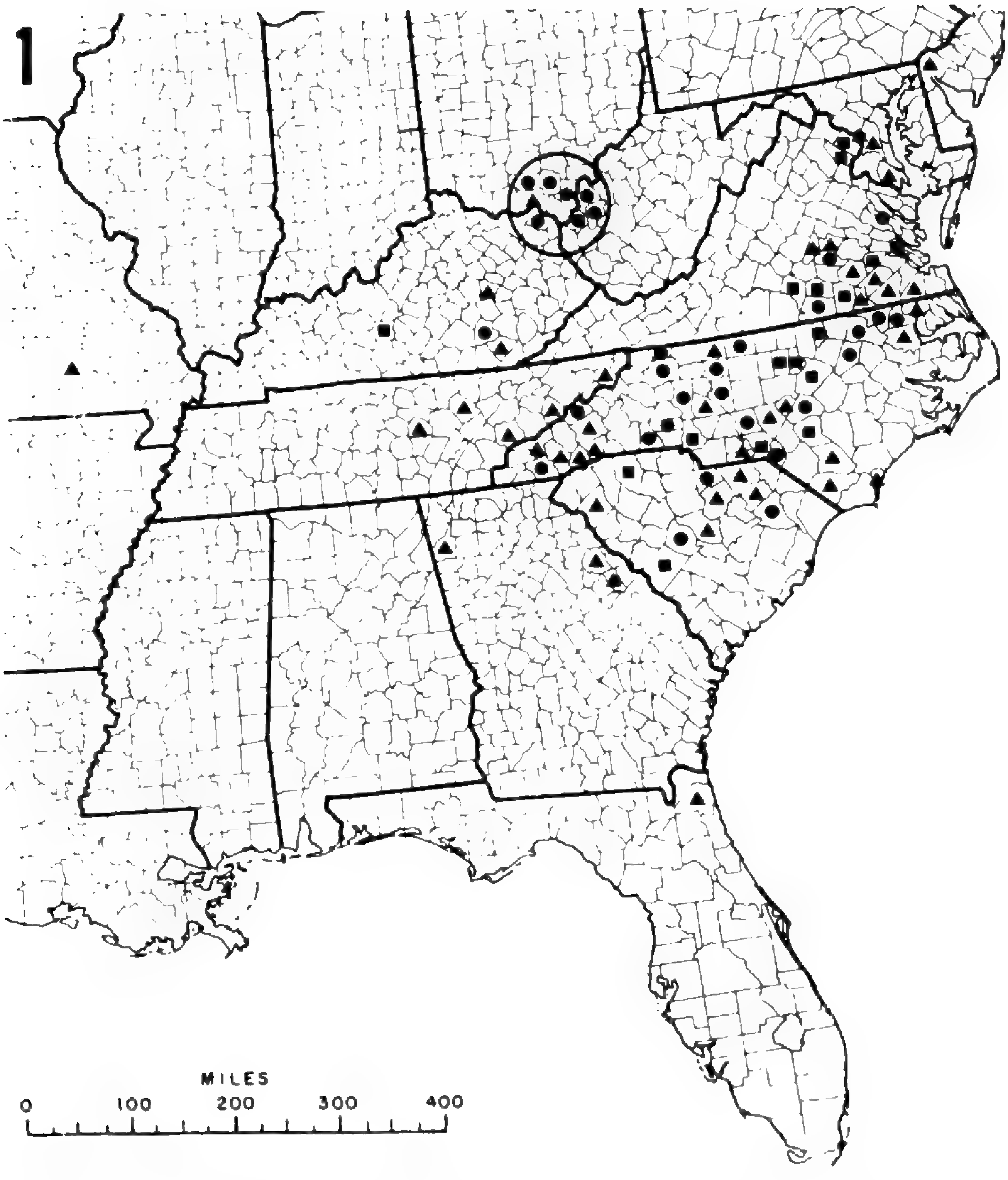
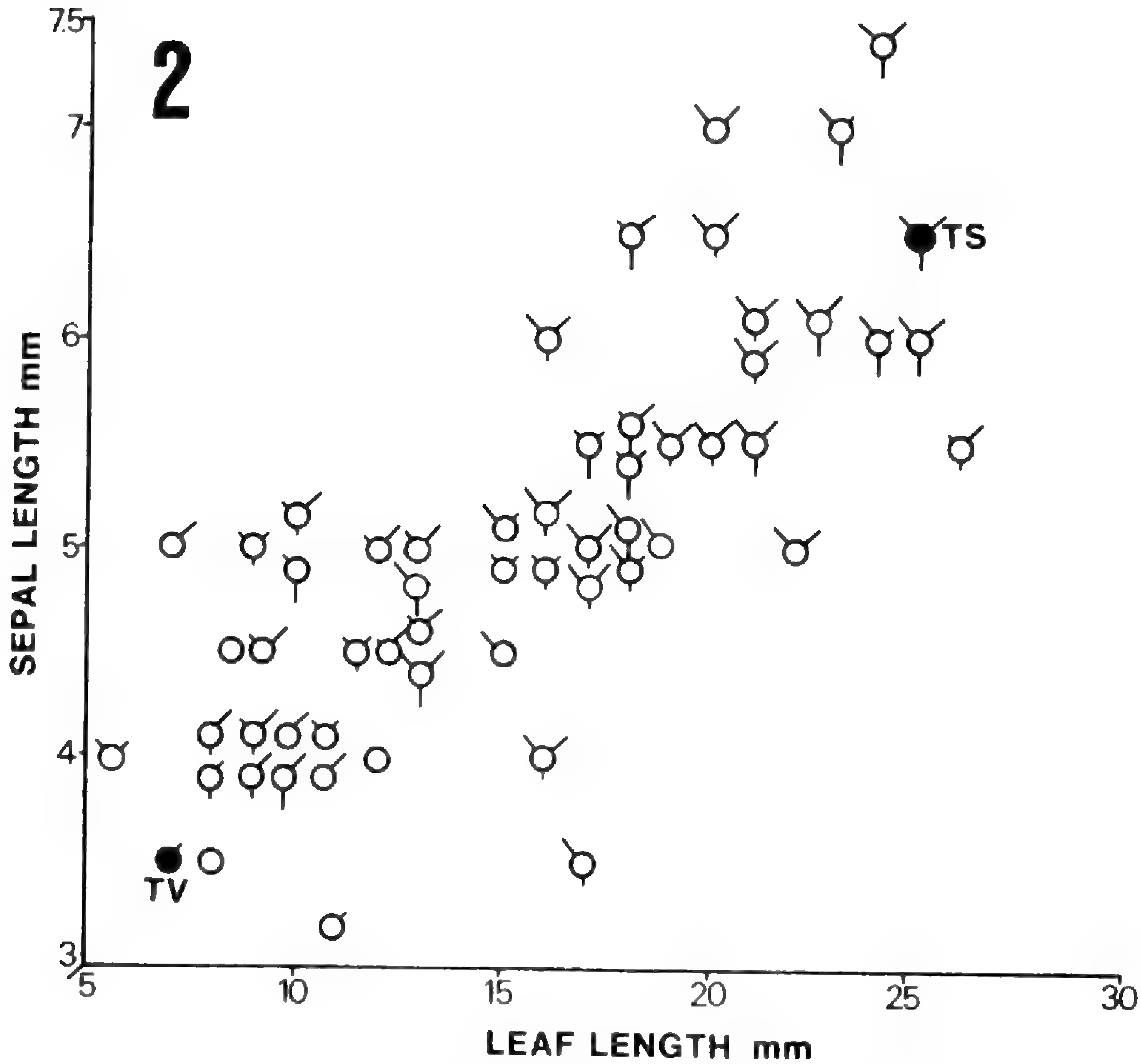


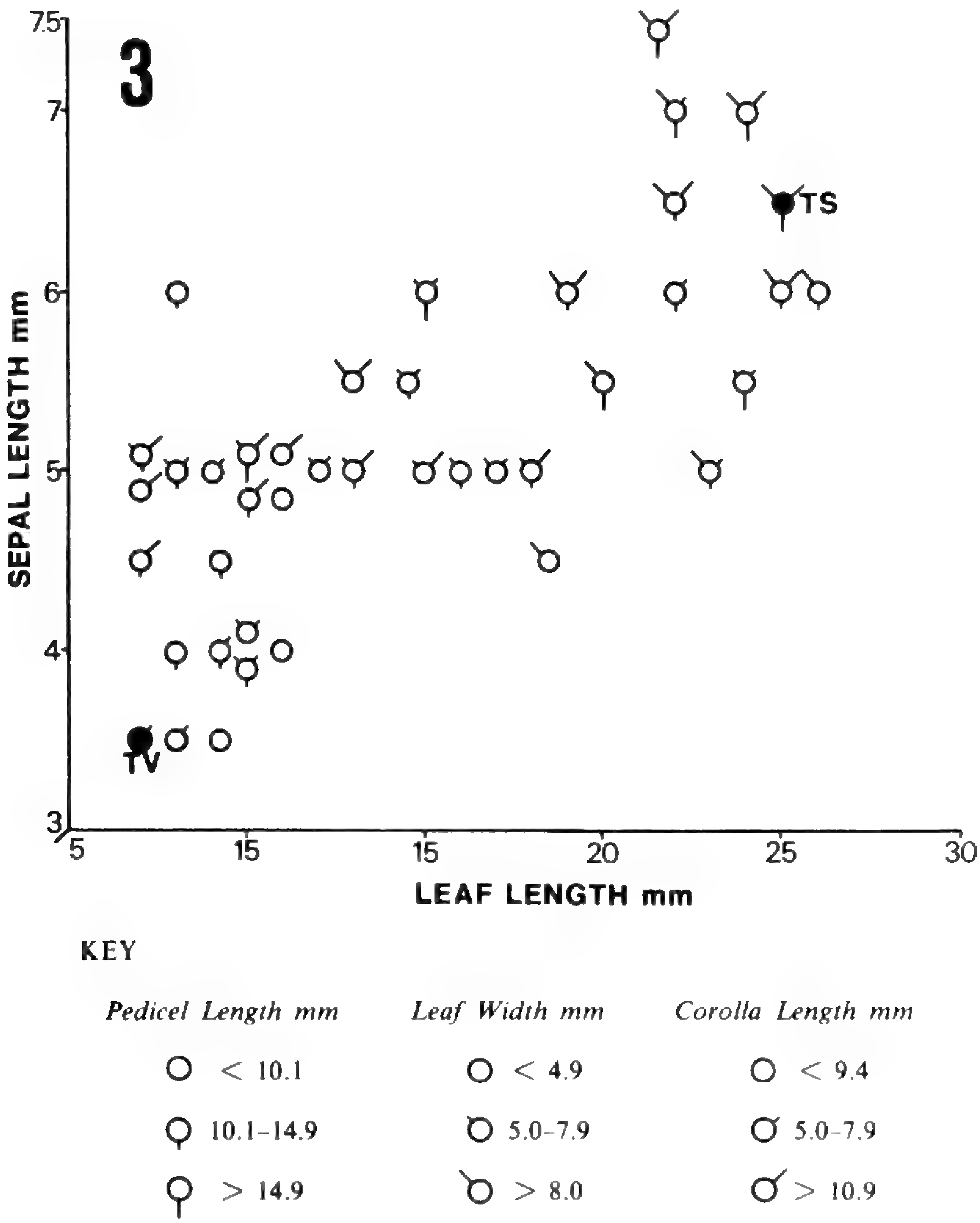
Figure 1. **County distribution of *Gratiola viscidula*.** Circles and triangles represent specimens examined in this study, with the latter representing populations measured for Figs. 2 and 3. Squares are records from literature references. Circled records represent the previously presumed range of the "*shortii*" entity in wetland habitats associated with preglacial Teays-age valleys.

These individuals were chosen to represent the morphological variation within the known range of the species (Fig. 1). Additional distributional data were obtained from Pennell (1935), Radford et al. (1968), Harvill et al. (1981), and Medley and Thieret (in litt., 1982). Thirty-nine mature individuals from a population within the presumed "*shortii*" range [OHIO: Scioto Co., *Spooner 2153* (OS)]



Figures 2 and 3. **Pictorialized scatter diagrams of measurements from selected populations of *Gratiola viscidula*.** From throughout its range, (Fig. 2). Individuals from a single population in Scioto Co., Ohio, *Spooner 2153* (Fig. 3). Measurements of the types of *G. viscidula* subsp. *viscidula* (TV), and of *G. viscidula* subsp. *shortii* (TS) are included for comparison. (See Key at end of Figure 3 - facing page)

were chosen to determine the limits of intrapopulational morphological variation. The largest measurements per individual were taken of corolla length, calyx length, pedicel length, leaf length and leaf width, as these were the characters that Pennell (1935) used to distinguish the infraspecific taxa. Other populations in this area were also collected for visual comparison: KENTUCKY: Greenup Co., *Spooner 2150, 2151* (OS); OHIO: Gallia Co., *Spooner 2155* (OS); Jackson Co., *Spooner 2156* (OS). For chromosome number determinations, the procedures involving conventional squash techniques of flower buds for meiotic stages outlined in Keil and Stuessy (1975) were used.



RESULTS AND DISCUSSION

Measurements of individuals from throughout the range of the species, exclusive of southeastern Ohio and immediately adjacent northern Kentucky and West Virginia (the *"shortii"* range), are presented in Fig. 2. It is evident from these data that *G. viscidula* exhibits a wide range of size variation with the extremes connected by a continuous series of intermediates. The type of *G. viscidula* subsp. *viscidula* [NORTH CAROLINA: Forsyth Co., s.d., Schweinitz s.n. (PH), (*see* Stuckey, 1979, for a discussion of this specimen)] falls on the small end of this size range. The type of *G. viscidula* subsp. *shortii* [KENTUCKY: s.d., *Short s.n.* (PH), (Specimen marked as *Gratiola shortii* by Elias Durand)] falls on the large end of this size range. Both specimens are marked as types by Pennell.

Measurements of individuals of the Scioto County, Ohio population are presented in Fig. 3. The degree of size variation in this population is similar to that from throughout the range of the species, with extremes encompassing measurements of the types as above. The range of size variation of the other populations that I collected in the field is similar.

The new distribution map (Fig. 1) fills in considerable gaps in Pennell's (1935) map of the species. There are now in excess of thirty populations known for this species in southeastern Ohio and immediately adjacent northern Kentucky and West Virginia. Pennell (1935) was influenced by the disjunct nature of the *"shortii"* populations, less disjunct now in light of the new distributional data. Other disjunct records are known for this species: (1) MISSOURI: Shannon Co., *Steyermark 72109* (F, GA, MO, US). These specimens were collected from Gilmore Pond, an upland sinkhole pond. My efforts to relocate the plant at the site were unsuccessful, and the plant is possibly extirpated. The last known collection there was in 1975 [MISSOURI: Shannon Co., *Christ s.n.* (pers. herb.)]. This region of Missouri is dotted with such habitats, however, and the plant possibly occurs in other ponds in the area. Other examples of Coastal Plain and Piedmont disjuncts are known from this portion of Missouri (Steyermark, 1952).(2) FLORIDA: Duval Co., Mar 1882, *Smith s.n.* (F). This specimen bears Pennell's annotation as *G. viscidula* dated 1931; it is not known why he did not mention it in his monograph (Pennell, 1935). The Crittenden Co. Arkansas record mentioned in Wilcox (1973) is apparently in error, as was suggested by Smith (1978). I requested a loan of the specimen from MEM, where Wilcox deposited his vouchers, but it has not been located.

Current nomenclatural errors exist with the above infraspecific taxa of *G. viscidula.* Pennell (1935) treated the two taxa as subspecies. Gleason (1952) regarded these taxa as varieties, but did not formally treat them in a manner indicating his acceptance of them (*see* Gleason, 1952, Vol. 1, p. xxxv). Cooperrider (1976) accepted the taxonomic validity of these subspecific taxa at the varietal level, but incorrectly cited the "*shortii*" entity as *G. viscidula* var. *shortii* (Pennell) Gleason. This citation continues to be accepted (McCready and Cooperrider, 1978; Roberts and Cooperrider, 1982; Spooner, 1982; United States Department of Agriculture, 1982). Kartesz and Kartesz (1980) incorrectly cited *G. viscidula* var. *shortii* (Durand) Gleason. If these infraspecific taxa are recognized at the varietal level, a new combination is required.

The chromosome number of *G. viscidula* is here first reported as $n = 7$ from two populations: (1) KENTUCKY: Greenup Co., *Spooner 2150* (OS); and (2) OHIO: Gallia Co., *Spooner 2156* (OS). This base number is in agreement with previous counts for the section *Gratiolaria* Bentham (Lewis et al., 1962).

In view of the continuous degree of size variation represented both within individual populations and throughout the range of the species, recognition of infraspecific categories based on the above size characters is unwarranted. In addition, no other consistent differences were observed in any other features that would warrant recognition of infraspecific categories.

The consistent and widespread occurrence of this variation seen both in the field and on herbarium specimens indicates that this is an inherent feature of this species, and is not due to localized introgression with related taxa. The most closely related taxa are *G. brevifolia* Raf., *G. ramosa* Walt., and *G. aurea* Muhl. ex Pursh (*G. lutea* Pursh) (Pennell, 1935), but these species are largely allopatric with *G. viscidula* and not notably different in size from this species.

ACKNOWLEDGMENTS

I gratefully acknowledge the Ohio Department of Natural Resources, Division of Natural Areas and Preserves, for support for field work, and the curators of the following herbaria for making material available for study: ALU, DUKE, EKY, F, FSU, GA, GFND, KE, MARY, MO, MUHW, NCSC, OS, PENN, PH, TENN, UNA, UNCC, US, VDB, WVA. Use of the personal herbarium of Arthur Christ, St. Louis, MO is also acknowledged. Dr. Edward T. Browne searched MEM for the Crittenden Co., Arkansas voucher. Dr. John W. Thieret and Max E. Medley alerted me to recent Kentucky records of *G. viscidula;* Virginia Wallace and John E. Wylie provided information about the species in Missouri. Dr. Robert K. Jansen, Thomas G. Lammers, Dr. Ronald L. Stuckey, and Dr. Tod F. Stuessy provided suggestions on the final manuscript.

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ADDITIONS TO THE FLORA OF ULSTER COUNTY, NEW YORK

MARY DOMVILLE

Since the publication of the "Flora of Ulster County, New York" by Domville and Dunbar[1], the following plants have been collected. Most were collected by Karl L. Brooks, the late Stanley J. Smith and Mary Domville. Most are deposited in the State Museum in Albany, N. Y.

ISOETACEAE—QUILLWORT FAMILY

Isoetes tuckermanii A. Br. Quillwort
Infrequent in tidal shores

POLYPODIACEAE—FERN FAMILY

Dryopteris ×triploidea Wherry **(D. intermedia × D. spinulosa)** Triploid wood fern
Rare in mountain woods

POACEAE—GRASS FAMILY

Deschampsia caespitosa (L.) Beauv. Tufted hair-grass Natzd.
Very rare in sand plains

Digitaria filiformis (L.) Koel. Slender crabgrass
Very rare in sand plains

Panicum acuminatum Sw. Panic grass
Frequent in sterile soil

P. lanuginosum Ell. Panic grass
Frequent in Hudson Valley

Puccinellia distans (Jacq.) Parl. Goose-grass
Rare in moist soil

CYPERACEAE—SEDGE FAMILY

Carex crawfordii Fern. Sedge
Frequent in meadows and edges of woods

C. grayii Cary Sedge
Frequent in lowlands

C. lacustris Willd. Sedge
Infrequent in swampy area of Hudson Valley

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[1]The book may be purchased from J. Donald Adams, 8 Maple Lane, Hyde Park, NY 12538. $4.00 postage paid.

C. ormostachya Wieg. Sedge
Infrequent in woods of Hudson Valley
C. sprengelii Dew. ex Spreng. Sedge
Infrequent in open woods and damp places
C. tenuiflora Wahl. Sedge
Infrequent in bogs of mountains
Rhynchospora fusca (L.) Ait. Beak-rush
Infrequent in swamps

COMMELINACEAE—SPIDERWORT FAMILY

Tradescantia ohiensis Raf. Spiderwort
Frequent in thickets and meadows

JUNCACEAE—RUSH FAMILY

Juncus gerardi Loisel. Black grass
Rare on roadside where salt for snow removal was stored
J. greenei Oakes and Tuckerm. Greene's rush
Rare in sandy places
J. pelocarpus Mey. Rush
Infrequent in damp places

LILIACEAE—LILY FAMILY

Allium porrum L. Leek
Spread from cultivation
Scilla hispanica Mill. Spanish bluebells Natzd.
Spread from cultivation

AMARYLLIDACEAE—AMARYLLIS FAMILY

Leucojum vernum L. Snowflake Natzd.
Frequently naturalized

ORCHIDACEAE—ORCHID FAMILY

Isotria medeoloides (Pursh) Raf. Small whorled pogonia
Collected only in 1920 by H. M. Denslow

SALICACEAE—WILLOW FAMILY

Salix pentandra L. Laurel-leaved willow
Frequent in Catskills

MORACEAE—MULBERRY FAMILY

Cannabis sativa L. Marijuana Natzd.
Frequently escapes from cultivation
Humulus japonicus Sieb. & Zucc. Japanese hop Natzd.
Frequent in waste places

POLYGONACEAE—BUCKWHEAT FAMILY

Rumex altissimus Wood. Pale dock
Frequent in rich soil

R. ×acutus L. **(R. crispus × R. obtusifolius)**
Infrequent in the Hudson Valley

CARYOPHYLLACEAE—PINK FAMILY

Gypsophila paniculata L. Baby's-breath
Frequently escapes from cultivation

Spergularia media (L.) Presl. ex Griseb. Sand-spurrey
Infrequent in sand plains

RANUNCULACEAE—BUTTERCUP FAMILY

Ranunculus repens L. Creeping buttercup
Locally abundant

PAPAVERACEAE—POPPY FAMILY

Macleaya cordata (Willd.) R. Br. Plum poppy Natzd.
Frequently escapes from cultivation

FUMARIACEAE—FUMITORY FAMILY

Dicentra formosa (Haw.) Walp. Bleeding-heart Natzd.
Frequent

BRASSICACEAE—MUSTARD FAMILY

Arabis hirsuta (L.) Scop. Hairy cress
Saugertie's Point

Iberis umbellata L. Globe candytuft Natzd.
Spread from cultivation

Brassica oleracea L. var. **acephala** DC. Common kale Natzd.
Spread from cultivation

Sinapis arvensis L. Charlock Natzd.
Spread from cultivation

ROSACEAE—ROSE FAMILY

Amelanchier sanguinea (Pursh) DC. Red-branched shad
Infrequent in mountains

Crataegus pedicellata (Sarg.) Palmer. Hawthorn
Ashokan campus of New Paltz College (In herbarium of New Paltz College)

C. pruinosa (Wendl.) K. Koch. Hawthorn
Infrequent (Collected by N. L. Britton in Shokan)

Filipendula rubra Rob. Queen-of-the-prairie Natzd.
Frequently spreads from cultivation

Prunus nigra Ait. Canada plum
Infrequent in Hudson Valley

Pyrus prunifolia Willd. Crab-apple — Natzd.
Self-seeded in Hudson Valley

Rosa centifolia L. Cabbage rose — Natzd
Frequent

R. cinnamomea L. Cinnamon rose — Natzd.
Spread from cultivation

R. wichuraiana Crep. Memorial rose — Natzd.
Spread from cultivation

GERANIACEAE—GERANIUM FAMILY

Geranium bicknellii Britt. Bicknell's geranium
Infrequent in disturbed soil

EUPHORBIACEAE—SPURGE FAMILY

Euphorbia epithymoides L. Cushion spurge — Natzd.
Spread from cultivation

ANACARDIACEAE—CASHEW FAMILY

Toxicodendron radicans var. **negundo** (Green) Fern. Poison ivy
Observed in Hudson Valley and lowlands by M. Domville

T. radicans var. **rydbergii** Small ex Rydb. (Gillis, 1971)
Poison ivy

CELASTRACEAE—STAFF-TREE FAMILY

Celastrus orbiculatus Thunb. Oriental bittersweet — Natzd.
Frequently escapes in lowlands

HIPPOCASTANACEAE—HORSE CHESTNUT FAMILY

Aesculus hippocastanum L. Horse chestnut
Self-seeded in Hudson Valley

BALSAMINACEAE—TOUCH-ME-NOT FAMILY

Impatiens glandulifera Royle. Snapweed — Natzd.
Spread from cultivation in lowlands

MALVACEAE—MALLOW FAMILY

Sida spinosa L. Prickly mallow — Natzd.
Flood plains in New Paltz

HYPERICACEAE—ST. JOHN'S WORT FAMILY

Hypericum pyramidatum Ait. Great St. John's wort
Flood plains in New Paltz

VIOLACEAE—VIOLET FAMILY

Viola renifolia Gray. Kidney-leaved violet
(Collected by S. J. Smith)

V. ×convicta House **(V. fimbriatula × V. palmata)**
Many plants at top of Hickory Hill

V. ×peckiana House **(V. palmata × V. sororia)**
Locally abundant

ONAGRACEAE—EVENING-PRIMROSE FAMILY

Oenothera tetragona Roth. Sundrop
Infrequent (Collected in town of Olive)

ARALIACEAE—GINSENG FAMILY

Aralia spinosa L. Prickly ash or Hercules' club
(Collected near Bearsville)

APOCYNACEAE—DOGBANE FAMILY

Apocynum cannabinum L. var. **pubescens** (Mitchell) A. DC. Indian hemp
Frequent in thickets

ASCLEPIADACEAE—MILKWEED FAMILY

Asclepias purpurascens L. Purple milkweed
Infrequent in Hudson Valley

BORAGINACEAE—BORAGE FAMILY

Borago officinalis L. Borage Natzd.
Spread from cultivation

LAMIACEAE—MINT FAMILY

Ajuga genevensis L. Bugleweed Natzd.
Spread from cultivation

Pyananthemum verticillatum (Michx.) Pers. Whorled mountain mint
Infrequent

Scutellaria integrifolia L. Hyssop skullcap
Open fields (Collected in town of Olive)

SOLANACEAE—NIGHTSHADE FAMILY

Solanum nigrum L. var. **virginicum** L. Nightshade Natzd.
Disturbed soil in Hudson Valley

SCROPHULARIACEAE—FIGWORT FAMILY

Digitalis lanata Ehrh. Grecian foxglove Natzd.
Escaped from cultivation

Gratiola aurea Muhl. Golden-pert
Infrequent in wet areas

RUBIACEAE—MADDER FAMILY

Galium sylvaticum L. Scotch-mist Introduced
Observed at Saugertie's Point by M. Domville

CAPRIFOLIACEAE—HONEYSUCKLE FAMILY

Lonicera caprifolium L. Italian woodbine Natzd.
Frequently escapes (Collected by P. Huth near Esopus)

ASTERACEAE—ASTER FAMILY

Anthemis tinctoria L. Yellow chamomile Natzd.
Frequent on roadsides

Echinacea purpurea (L.) Moench. Purple coneflower
Introduced from the west

Helianthus microcephalus T. & G. Small wood sunflower Natzd.
Infrequent in southern part of county

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VERBASCUM DENSIFLORUM IN SOUTHEAST WISCONSIN

JAMES A. REINARTZ

ABSTRACT

Nine of 260 species of the Eurasian genus *Verbascum* have been reported from America; only two (*V. thapsus* and *V. blattaria*) are common. *Verbascum densiflorum* is well established in the U.S. only in southeast Wisconsin where it is an aggressive weed. It differs morphologically, phenologically and ecologically from either *V. thapsus* or *V. phlomoides*, the two more common species which it superficially resembles.

Key Words: *Verbascum*, adventive weed, restricted range

Verbascum is a Eurasian genus of over 260 species. Nine species (*V. thapsus* L., *V. blattaria* L., *V. phlomoides* L., *V. lychnitis* L., *V. phoeniceum* L., *V. virgatum* Stokes, *V. nigrum* L., *V. sinuatum* L. and *V. densiflorum* Bertoloni) have been reported from North America. These nine mullein species are among the most widespread of *Verbascum* species in Europe and Asia (Murbeck, 1939). Two hundred species of *Verbascum* are confined to a relatively small area in Greece, southern Yugoslavia, Bulgaria, Rumania, Turkey, Syria, Jordan, Iraq and northwest Iran. Only *V. thapsus* and *V. blattaria* are common throughout North America. *Verbascum sinuatum* and *V. densiflorum* have previously been reported only as rare waifs on ballast along the east coast (Gleason, 1952).

A large, well established population of *Verbascum densiflorum* (syn *V. thapsiforme*[1] Schrader) has been found in southeast Wisconsin. Within an area of about 30 square miles in Ozaukee and Washington Counties, Wisconsin (Figure 1) essentially 100% of the *Verbascum* is *V. densiflorum*. In three years I have never observed a *V. thapsus* growing in this zone. Surrounding this zone of exclusively *V. densiflorum* is an area of about 25 square miles in which both *V. thapsus* and *V. densiflorum* and some mixed populations are found. Outside of this area *V. densiflorum* is not found but *V. thapsus* is common.

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[1] *Verbascum thapsiforme* Schrader, Monogr. gen. Verb., 1 (1813) is the name in more common usage, but *V. densiflorum* Bertoloni, Rar. it. pl., (1810) is an older, and therefore, the valid species name (Ferguson, 1972).

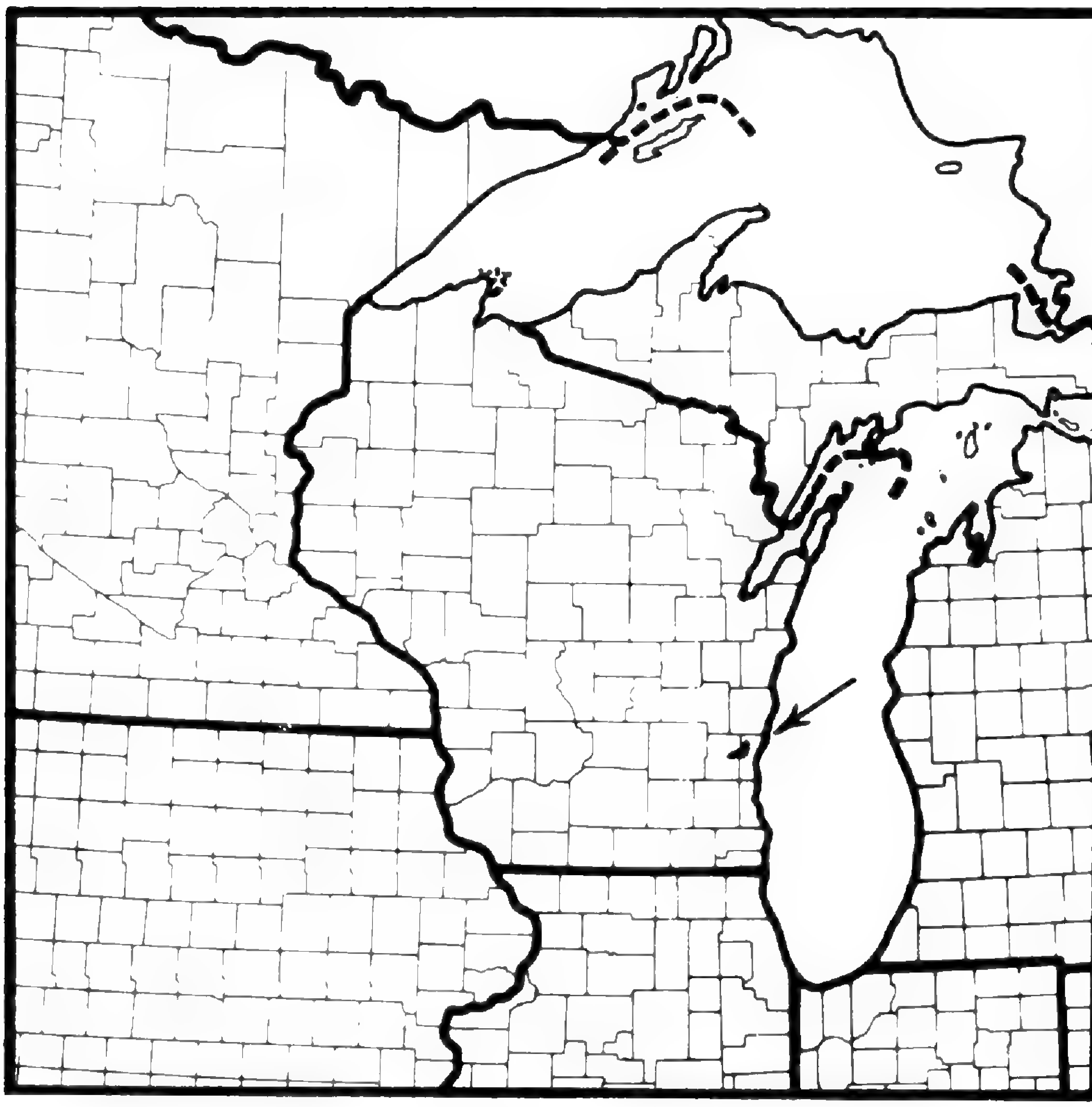

Figure 1. Location of southeast Wisconsin population of *Verbascum densiflorum*.

In an average year, flowering individuals of *Verbascum densiflorum* in this area number in the thousands. The species has grown in this area for at least 17 years as documented by a 1967 specimen in the University of Wisconsin-Milwaukee Field Station herbarium. The species may well have been established in this area for a long time.

Verbascum densiflorum is distinct morphologically, phenologically and ecologically from either *V. thapsus* or *V. phlomoides*, the two more common species which it superficially resembles (Figure 2). *Verbascum densiflorum* is very similar to *V. phlomoides* except that the upper cauline leaves are distinctly decurrent down the stem in *V. densiflorum* and are not at all decurrent in *V. phlomoides*. The

Figure 2. Population of *Verbascum densiflorum* at the University of Wisconsin–Milwaukee Field Station in Ozaukee Co., Wisconsin.

inflorescence of *V. phlomoides* is somewhat more open with more stalk being exposed between capsules than that of *V. densiflorum.* Also, the inflorescence bracts and upper cauline leaves of *V. densiflorum* tend to be longer acuminate than those of *V. phlomoides.*

Anderson (1947) described an Iowa City, Iowa population of *Verbascum phlomoides* and concluded that *V. phlomoides* and *V. densiflorum (thapsiforme)* are not separate species. *Verbascum phlomoides, V. thapsus* and sterile hybrids between the two species were collected from the Iowa City population by the author during the summer of 1983. Hybrids form readily between *V. thapsus* and *V. phlomoides* (Wagner, Daniel & Hansen, 1980) and are intermediate in the extent of leaf decurrence. Since Anderson (1947) described *V. phlomoides* as more or less decurrent and did not mention *V. thapsus* × *V. phlomoides* hybrids, the author is led to believe that Anderson may have been interpreting these hybrids as his *V. densiflorum*-like plants.

While *Verbascum phlomoides* and *V. densiflorum* are very similar they are unambiguously separated by the extreme leaf decurrence in *V. densiflorum* and complete lack of decurrence in *V. phlomoides.* Although hybrids can occur naturally between *V. densiflorum* and *V. phlomoides* (Murbeck, 1933), the hybrids are always infertile, indicating that these are separate species.

Verbascum densiflorum differs morphologically from *V. thapsus* in having much larger flowers (25–45 mm diam.), a spathulate rather than capitate stigma, and a longer, less crowded inflorescence. *Verbascum densiflorum* tends to branch more freely producing many inflorescence spikes, and its leaves tend to be more dentate and more acuminate. Hybrids also occur naturally between *V. densiflorum* and *V. thapsus,* but are completely infertile (Murbeck, 1933).

Verbascum densiflorum differs from *V. thapsus* in its flowering phenology. In southeast Wisconsin *V. thapsus* blooms from late June to late August, while *V. densiflorum* begins to bloom in early July and continues until the time of a hard frost (often mid- to late October).

Verbascum thapsus and *V. densiflorum* in Wisconsin also differ ecologically. *V. thapsus* can often be killed by cutting after it has bolted; however, *V. densiflorum* is able to withstand repeated cutting with plants branching from the base and growing many shorter inflorescence stalks. Repeated cutting can delay flowering but the plants usually survive to flowering even if mowing continues for 3 or 4 years. Because of its ability to withstand mowing, *V. densiflorum* is a much more aggressive weed in agricultural land in Ozaukee and Washington Counties, Wisconsin than is *V. thapsus*. Populations are quite common even in regularly mowed hay fields or sparse, weedy lawns.

It is curious that this species, which occurs nowhere else in North America, here appears to be a more aggressive weed than *Verbascum thapsus*. Thousands of individuals grow in this 30-square-mile area to the apparent exclusion of the generally more common *V. thapsus*.

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OBSERVATIONS OF *POTAMOGETON HILLII* MORONG IN NORTH AMERICA

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ABSTRACT

Potamogeton hillii Morong has been considered as either a rare or endangered species in all states and provinces where it occurs. Currently it is under review by the United States Fish and Wildlife Service for possible listing under the Endangered Species Act of 1973. Prior to 1960 it was collected at 25 localities. Since 1970, 78 new localities have been discovered. Throughout its range this species is mostly found in regions of limestone bedrock. Presently it is most abundant in western New England and northern Michigan, and during 1982 was relocated in Connecticut and Ohio. *Potamogeton hillii* appears to be spreading in the limestone regions where it presently occurs. This taxon is found growing in clear, cold waters of small streams, ponds, and beaver ponds with muddy substrates. The abundant winter buds and fruits produced apparently guarantee the continued spread of this species. *Potamogeton hillii* should not be considered further for protection nationally, nor should it be so listed in the states where locally abundant.

Key Words: *Potamogeton hillii, Potamogeton porteri,* Potamogetonaceae, *Pusillii,* rare, endangered species

Potamogeton hillii Morong (including *P. porteri* Fern.) is a distinct member of the subsection *Pusillii* of the Potamogetonaceae. It was named for Rev. Ellsworth J. Hill (1833–1917) who was first credited for collecting it near Manistee, Michigan on August 5, 1882 (Fernald, 1932). A study of specimens produced four earlier collections, originally identified as other taxa. The oldest known locality is from East Dorset, Vermont in 1857. *Potamogeton porteri* described by Fernald (1932) from Lancaster, Pennsylvania has been shown by Haynes (1974) to be *P. hillii.*

Fernald (1932) knew of nine localities for *Potamogeton hillii* in northeastern United States. Voss (1965) discussed the failure to relocate the type locality in Manistee, Michigan, but noted that only two new populations had been located up to 1965 in Michigan. Haynes (1974) indicated the presence of a number of new localities from Michigan and New York. Weber (1940) first reported *P. hillii* from Massachusetts, and Hellquist (1977) reported eight new localities for Massachusetts.

The apparent rarity of this species led to its listing by the Smithsonian Institution (1975) and Ayensu & DeFilipps (1978) as a threatened species in the United States. Individual state, provincial, and regional lists have variously classified *Potamogeton hillii* as rare, threatened, endangered, or extinct. These lists are: Vermont (Countryman, 1978); Massachusetts (Coddington & Field, 1978); New England (Crow, 1982; Crow *et al.*, 1981); New York (Mitchell *et al.*, 1980; Mitchell & Sheviak, 1981); Pennsylvania (Wiegman, 1979); Ohio (Ohio Department of Natural Resources, 1982); Michigan (Wagner *et al.*, 1977); and Ontario (Argus & White, 1977). *Potamogeton hillii* was omitted from the Connecticut list (Mehrhoff, 1978) even though only a single location was known at the time. The results of these surveys prompted its appearance in the Notice of Review published by the United States Fish and Wildlife Service, Office of Endangered Species in the Federal Register (FR, 15 December 1980, Vol. 45, No. 247) as a potential candidate for listing, but needing further study.

Observations made in the field from 1972–1976 (Hellquist, 1977) indicated population patterns that led to increased success in locating this species. The result of the field work was the discovery of 54 new localities for *Potamogeton hillii* since 1976.

Field observations on *Potamogeton hillii* have shown it to be a species found in clear, cold, alkaline water in small, slow flowing streams, ponds, and beaver ponds with a muddy substrate. In streams, it often appears on the upstream side of road culverts where more marshy conditions occur. In beaver ponds and marshes, it often grows among stumps and fallen trees, or in shallow water among rushes and sedges. In ponds, *P. hillii* is occasionally found in deeper waters up to 1.5 meters.

Potamogeton hillii has rarely been reported from lakes. Specimens previously identified as being collected from Cayuga Lake, N.Y. were studied by Fernald (1932) and found to be the Red Mills Pond population. No other specimens have been seen from the lake. Wiegand and Eames (1925) listed locations previously reported from central New York in a work by Dudley (1886). These localities were: Dryden Lake, Red Mills Pond, pools north of Ithaca, and Myers Point. Richard Mitchell (pers. comm.) indicated that Clausen had observed *P. hillii* in the marshes at the south end of Cayuga Lake. This area has been recently filled and commercially developed. *Potamogeton hillii* occurs around the Great Lakes at Manitoulin Island, Lake Huron and Cecil Bay, Lake Michigan. The Cecil Bay population was along the shore at the outlet to French

Farm Creek. I observed in 1975 a few plants directly at the mouth of the creek. In 1977 the waters of Lake Michigan had receded and I located no plants; a subsequent check in 1983 also failed to locate any *P. hillii.*

The alkalinity of the water is an extremely important chemical character controlling the distribution of *Potamogeton hillii.* Water samples from 35 localities indicate that *P. hillii* occurs in waters ranging from 53.0–290.0 mg/l $CaCO_3$ with a mean of 124.1 mg/l $CaCO_3$. A survey of the geological maps and reports of the states, provinces, and regions where *P. hillii* is known to occur have shown that 79% of the locations coincide with bedrock of dolomitic limestone, 15% of calcitic marble, micacous crystalline marble, and limestone, 3% of shale, 1% of gneiss, 1% of conglomerates, and 1% of sandstone [Vermont (Doll, 1961); Massachusetts (Emerson, 1916; Dale; 1923); Connecticut (Dale, 1923); New York (Dale, 1923; Fischer *et al.*, 1970); Pennsylvania (Frazer, 1877; Lesley, 1885; Pennsylvania Geological Survey, 1960; Stevenson, 1882); Ohio (Bownocker, 1947); Ontario (Morton, 1977; Salterly, 1958; Stauffer, 1914); Michigan (Marten, 1936a; 1936b)].

Water quality also appears to influence distribution of the taxon. *Potamogeton hillii* is mostly found in clear, cold waters, often around springs and small inlets in ponds and marshes. This taxon is only occasionally found encrusted with marl even though growing in highly alkaline waters. *Potamogeton hillii* is rarely found in turbid, stagnant, or polluted waters.

Potamogeton hillii most typically occurs with *P. foliosus* Raf., *P. natans* L., *P. pusillus* L. var. *tenuissimus* Mert. & Koch., *P. amplifolius* Tuckerm., and *P. gramineus* L. It is rarely found with other alkaline water species such as *P. strictifolius* Benn., *P. friesii* Rupr., and *P. pectinatus* L. (Hellquist, 1980) which are often associated with more eutrophic waters.

Potamogeton hillii is characterized by having short axillary peduncles and fruits with a small dorsal keel. The fruits of *P. hillii* are much larger than those of the closely related *P. foliosus* (see Haynes, 1974). The leaf tips are mostly bristled; this trait helps to distinguish it from sterile *P. foliosus* in which the leaf tips are merely acute. *Potamogeton strictifolius* typically forms bristle-tipped leaves but may be separated from sterile *P. hillii* by the presence of a bold margin around the leaf and distinct nodal glands. The bold margin in *P. strictifolius* appears similar to the more prominent leaf veins.

Haynes (1974) indicated the variability which may occur in the morphology of the leaf tips. While the bristle-tipped leaves are common, occasionally blunt-tipped or apiculate leaf tips are observed. These leaves appear to occur both on plants early in the growing season and during the latter portion of the season, especially on the winter buds.

Fernald (1932) stated that winter buds are not known for *Potamogeton hillii.* Haynes (1974) indicated he had observed winter buds on a few sheets of *P. hillii.* During October 1982, I observed in Vermont many plants of *P. hillii* with numerous winter buds; in many cases only the winter buds were present. These winter buds often had the central portion partially hardened, similar to those of *P. obtusifolius* Mert. & Koch, and *P. pusillus* var. *tenuissimus.*

Potamogeton hillii is occasionally seen with up to 5 veins, not 7 as previously reported by Hellquist (1977). When the venation is more than 5, *P. ogdenii* Hellquist & Hilton, a closely related but much rarer taxon, should be suspected.

Potamogeton hillii is known from nine states and provinces in the United States and Canada with a total of 108 locations having been reported (Fig. 1). The number of reported sites by states and provinces, (known verified locations in parentheses), are: Massachusetts 35(32), Vermont 24(19), Michigan 15(11), Ontario 12(10), New York 11(6), Pennsylvania 6(0), Ohio 3(1), and Connecticut 2(1). Currently *P. hillii* is known to be extant in all states except Pennsylvania. Seventy-five percent of all known localities for *P. hillii* have been found since 1970. As more field work is conducted in the proper habitats within the alkaline regions, more populations will surely be located.

Potamogeton hillii is locally abundant at most of its locations. The numerous winter buds and fruits produced apparently guarantee survival and facilitate spread of this species. *Potamogeton hillii* should no longer be considered for federal protection under the Endangered Species Act of 1973, and should likewise be dropped from consideration by the states of Massachusetts, Vermont, and Michigan. In these states it is well established and not in danger of extirpation.

The following list includes site information for all populations of *Potamogeton hillii* documented by herbarium specimens. In instances where many different collections were made at the same site only the earliest, or the earliest and latest, records are recorded.

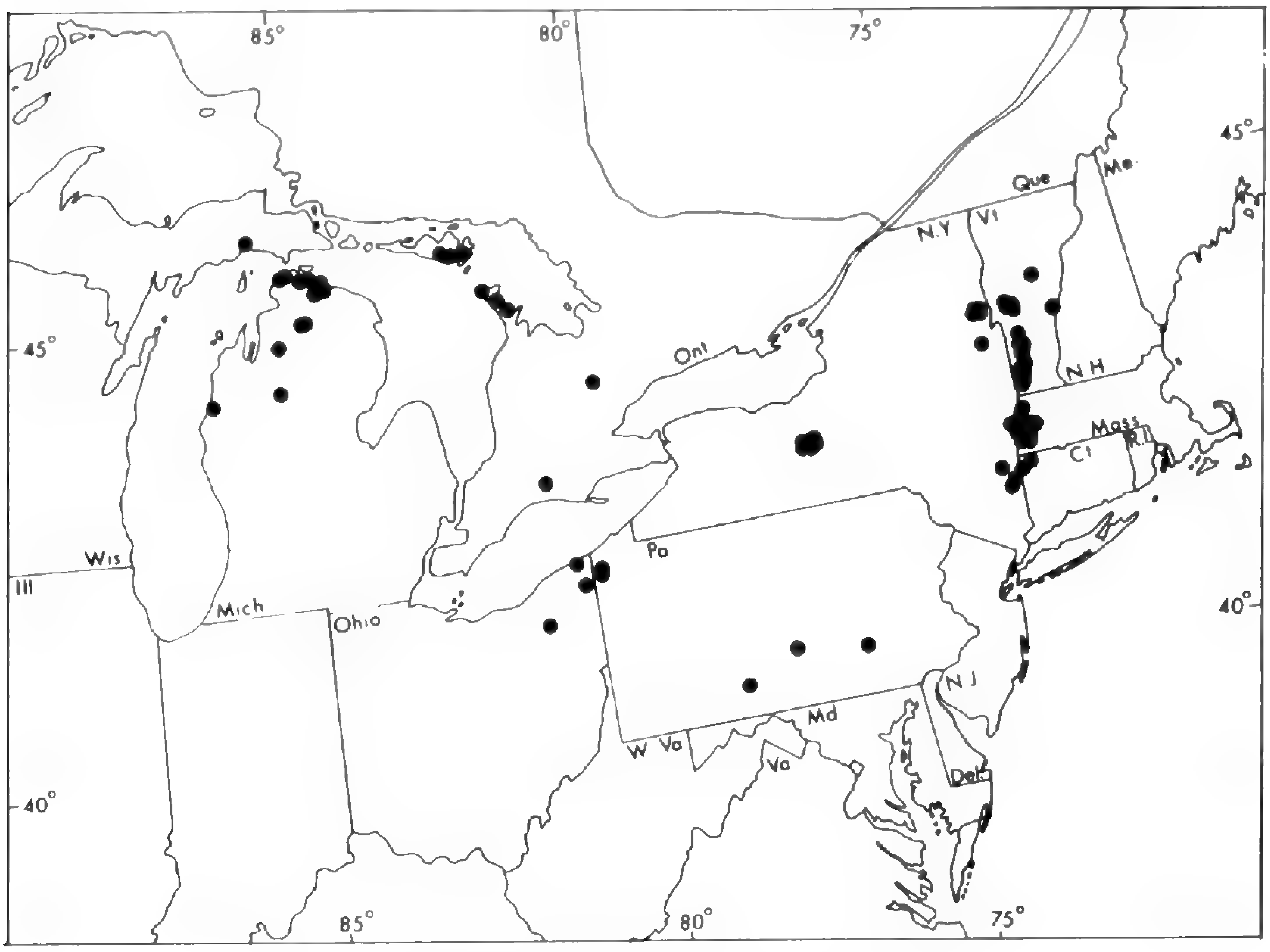

Figure 1. Distribution of *Potamogeton hillii.*

VERMONT: Bennington Co., Arlington, stream in cow pasture immediately east of Battenkill River on south side of Rt. 313, *Hellquist 15139* (NASC, NEBC); Arlington, small pond on the west side of Old Depot Rd. ca. 1/2 mile south of Rt. 7A, *Hellquist 15166* (MSU, NASC, NEBC, NYS, OS, UNA, VT); Arlington, marshy pond along Warm Brook on the east side of Old Depot Rd. south of Rt. 7A, *Hellquist 15165* (F, MO, MSU, NASC, NEBC, PH, US, VT, WAT); Arlington, in clear cool water among sedges in small pond on west side of Old Depot Rd. ca. 3/4 mile south of Rt. 7A, *Hellquist 15169* (CM, CU, DAO, NASC, NEBC, PAC, PH, VT, WAT); Arlington, small pond SW of town at Howell's Campground in shallow clear water, *Hellquist 15167* (NASC, PAC, VT); Arlington, small stream ca. 1/4 mile east of Rt. 7A along connection to new Rt. 7, East Arlington, *Hellquist 15175* (MICH, NASC, NEBC, NHA, VT); Dorset, in shallow water of Otter Creek, 1 Aug. 1934, *Eames s.n.* (GH, YALE); Dorset, Prentiss Pond west of town, *Hellquist 15175* (NASC, NEBC, VT); Dorset, East Dorset, 28 Aug. 1857, *Aames s.n.* (GH); Dorset, abundant in small pool east of railroad north of Village Rd. and immediately south of stream under railroad, East Dorset, *Hellquist 15423* (DAO, NASC, NEBC, NY, OS, VT, WAT); Manchester, among *Equisetum fluviatile* along shore of Battenkill River at old fishing access site of "Dufresne Pd.", *Hellquist 15172* (MICH, MO, MSU, NASC, NEBC, UNA, VT); Manchester, small pond near Rt. 7 in Dellwood Cemetery south of Manchester, *Hellquist 15196* (NASC, NEBC, OS, VT, WAT); Pownal, South Stream at fishing access, 30 July 1973, *Hellquist various numbers* (MASS, MICH, NASC, NEBC, NHA, OS, NLU, UCSB, VT). Orange Co., Washington, bog with *Rhamnus alnifolia, Seymour 29679* (VT). Rutland Co., Danby, common on east side of Rt. 7 in small pasture stream ca. 1.5 miles south of Danby-Wallingford town line, *Hellquist 15195* (NASC, NEBC, VT, US); Danby, common on west side of Rt. 7 in small pasture stream ca. 1.6 miles of Danby-Wallingford town line, *Hellquist 15405* (NASC, NEBC, NHA, US, VT); Hubbardton, uncommon in Giddings Brook along north side of Hill Rd. just west of Parsons School, *Hellquist 15422* (MO, NASC, NEBC, VT); Hubbardton, abundant in Giddings Brook south of Hill Rd. at jct. with Ganson Hill Rd., *Hellquist 15424* (CAN, DAO, NASC, NEBC, NY, NYS, UNA, US, VT); Mt. Tabor, shallow water, Otter Creek, *Eames 11643* (YALE); Mt. Tabor, common in small pond on east side of Rt. 7, 0.8 mile south of Danby, *Hellquist 15193* (NASC, NEBC, VT), Mt. Tabor, east side of Rt. 7, 0.8 mile south of Danby, *Hellquist 15193* (NASC, NEBC, VT); Mt. Tabor, east side of stream that crosses Rt. 7, 0.7 mile south of Danby, *Hellquist 15194* (DAO, MO, NASC, NEBC, NYS, VT); Pittsford, abundant along east shore of Smith Pd., Florence, *Hellquist 15403* (F, NASC, NEBC, NY, UNA, VT, WAT); Pittsford, small stream ca. 1/2 mile SW of Florence on road to Butler Pd., *Hellquist 15404* (MICH, MO, NASC, NEBC, OS, PH, US, VT). Windsor Co., Windsor, Evart's Pd. Aug. 1886, *Dudley s.n.* (GH, NY); Windsor, Evart's Pd., in deep water, 27 Aug. 1933, *Weatherby & Griscom s.n.* (NEBC).

MASSACHUSETTS: Berkshire Co., Alford, small pond on west side of West St. off Tom Ball Bk., 2 Aug. 1974, *Hellquist various numbers* (CUSC, MO, NASC, NEBC, NLU); Alford, marsh west of small pond on west side of West St. off Tom Ball Bk., 2 Aug. 1944, *Hellquist various numbers* (ALU, MASS, MO, NASC); Great Barrington, Muddy Bk, at Blue Hill Rd., 2 Aug. 1974, *Hellquist various numbers* (NASC); Great Barrington, Muddy Bk. at Stoney Bk. Rd., *Hellquist 10916* (ALU, NASC, NEBC, NLU); Great Barrington, flooded portion of Muddy Bk. north of Stoney Bk. Rd., *Hellquist 14050* (CM, NASC); Hancock, edge of pool, *Hunnewell 16997;* Hancock, small stream east of Rt. 43 ca. 1/2 mile north of Whitman Rd. on land owned by Eugene Reese, *Hellquist 14388* (NASC); Hancock, pond along Kinderhook Ck. east of Rt. 43 and north of Whitman Rd., *Hellquist 14389* (NASC); Lenox, pond in bird sanctuary, *Githens 208* (NASC, PH); Lenox, eighth pond in series of beaver ponds west of Rt. 7 along Yokun Bk., *Hellquist 13653* (NASC, NEBC); Lenox, East Branch, Yokun Bk., *Hellquist 13663* (NASC, NEBC); Lenox, beaver pd. along Yokun Bk., *Hellquist 13674* (CM, MICH, NASC, NEBC); Lenox, pond west of first beaver dam, west of Rts. 7 & 20, immediately behind the Yankee Motor Lodge ca. 1/2 mile south of Pittsfield line, *Hellquist 14403* (NASC); Lenox, pond west of second beaver dam, west of Rts. 7 & 20 behind the Yankee Motor Lodge, ca. 1/2 mile south of Pittsfield line, *Hellquist 14385* (NASC); Pittsfield, south end of Mud Lake at outlet, *Hellquist 15220B* (NASC); Pittsfield, beaver pond along west side of Tamarack Rd. ca. 1/4 mile south of South Mountain Rd., *Hellquist 15214* (NASC, NEBC, US); Pittsfield, beaver marsh on north side of Tamarack Rd. ca. 1/4 mile west of Bousquet Ski area, *Hellquist 15217* (CONN, CU, KANU, NASC, NEBC, NY, NYS, PH, SDC, US, VT); Pittsfield, pond south of dam at conservation park NE of Pittsfield airport, *Hellquist 15216* (NASC); Richmond, Cone Bk. at Lenox Rd. 6 Sept. 1972, *Hellquist various numbers* (ALU, CM, MICH, NASC, NEBC, NHA); Richmond, Miller's Pd., east of jct. of Rossiter Rd. and West Rd., *Hellquist 11837* (ALU, C, DS, MO, NASC); Richmond, Fairfield Pd., *Hellquist 11838* (ALU, C, DS, NASC); Richmond, Sherrill Pd. at jct. of Rossiter Rd. and Rt. 41, *Hellquist 13019* (CM, NASC, NEBC); Richmond, Crystal Lake on the west side of Swamp Rd. ca. 1/2 mile south of Lenox Rd., *Hellquist 13676* (CM, MICH, NASC, NEBC); Richmond, pond on the north side of Summit Rd., *Hellquist 13681* (NASC, NEBC); Richmond, small pond on south side of Summit Rd., *Hellquist 13684* (CM, MICH, NASC, NEBC); Richmond, small pond along Fairfield Bk. on the north side of Sleepy Hollow Rd. ca. 1/2 mile east of Rt. 41, *Hellquist 14382* (NASC); Richmond, small farm pond on the west side of Rt. 41 ca. 3/4 mile south of the Pittsfield line, 1/2 mile south of North Cemetery, *Hellquist 14394* (CM, MICH, NASC); Richmond, small pond on south side of Canaan Rd., 0.7 mile east of the New York border, *Hellquist 15191* (MICH, NASC, NEBC, NYS, US); South Egremont, in 3 feet of quiet water of the inlet to the pond fed by Karner Bk., *Weber 1626* (BH, CAN, CU, F, GH, MICH, MO, NHA, NY, US); South Egremont, common in stream along the north side of Mt. Washington Rd. ca. 1/4 mile from jct. of Rt. 41 at SW corner of the Mill Pd., *Hellquist 15199* (F, MSU, NASC, NEBC, NYS, OS, PAC, PH, US); Stockbridge, swamp along the south branch of Lily Bk. at Bean Hill Rd., *Hellquist 11147* (NASC); Stockbridge, Kampoosa Bk. on west side of Rt. 7, ca. 1.0 mile north of Rt. 182, *Hellquist 15391* (CAN, NASC, NEBC, US); West Stockbridge, pond south of Wilson Rd. ca. 1/2 mile west of West Center Rd., West Stockbridge Center, *Hellquist 15389* (CAN, CM, CONN, CU, DAO, F, KANU, MICH, MO, MSU, NASC, NEBC, NHA, NY, NYS, OS, PAC, PH, SDC, UNA, US, VT, WAT).

CONNECTICUT: Litchfield Co., abundant in Flat Bk. at jct. of Rts. 126 & 63, *Hellquist 15200* (CAN, CONN, DAO, MICH, MO, NASC, NEBC, NYS, OS, PH, UNA, US, VT); Sharon, Indian Pd., 9 Sept. 1909, *Bissell s.n.* (NCBS, NASC).

NEW YORK: Columbia Co., Canaan, Beebe Pd. south of Beebe Pd. Rd., *Hellquist 9651* (MASS, NASC, NLU). Dutchess Co., Amenia, in deep mud and 0.7–2.0 m water of Amenia Lake, scarcely reaching surface, usually in large clumps to near 1.0 m diameter at top, *Eames 11794* (NASC, NYS); Amenia, marsh on west side of Rt. 22 ca. 1.5 miles south of Amenia, *Hellquist & Dean 15409* (CAN, CU, GH, MICH, MO, NASC, NY, NYS, OS, UNA, VT); Pine Plains, *Hoystadt s.n.* (NY). Thompkins Co., Dryden, Red Mills Pd., July 1895, *Dudley s.n.* (CU) [includes those distributed by Morong as collected by Dudley from Cayuga Lake, 1 Aug. 1886, *Dudley s.n., see:* Fernald, 1933, (CAN, F, GH, MICH, MO, US)]; Malloryville, near Malloryville, July 1886, *Dudley s.n.* (NYS). Washington Co., Putnam, abundant in small pool along Rt. 22 on west side near culvert, muddy bottom, ca. 2.0 miles north of Dresden Station Rd., *Haynes 3342* (GH, MICH, OS); Putnam, stream east of Road B at jct. with Rt. 22, north of Dresden line, *Hellquist 15189A* (CAN, CM, CU, DAO, MO, NASC, PH); Putnam, ditch in marsh on west side of Rt. 22 across from Road B ca. 0.1 mile north of Dresden town line, *Hellquist 15401* (CU, GH, KANU, NASC, NY); Putnam, Mill Creek ca. 0.5 mile south of Rt. 22 and south of Putnam Cemetery, *Hellquist 15190* (CAN, CM, CU, F, MICH, NASC, PH, WAT); Kingsbury, east of Vaughan's, South Beaver Creek, 17 July 1900, *Burnham s.n.* (CU, GH).

PENNSYLVANIA: Bedford Co., Woodbury, densely filling large Mill Pd. south of Woodbury, *Hotchkiss 6003* (GH, US); Woodbury, edge of dam, alt. 1210 ft., 1.0 mile SSW of Woodbury, 10 Aug. 1941, *Berheimer s.n.* (CM, PH). Crawford Co., Conneaut Lake, 14 Aug. 1869, *Porter s.n.* (PH); Harmonburg, 1889, *Whiteside s.n.* (GH). Lancaster Co., Lancaster, cold riverlets near Lancaster, 5 Oct. 1860, *Porter s.n.* (P, MO, NY, PH), [Type for *Potamogeton porteri* Fernald]. Mifflin Co., Newton-Hamilton, in Beaverdam Run at Brush Run School, 2 miles NE of Newton-Hamilton, Westerfield *16619* (NYS, PAC, PH).

ONTARIO: Bruce Co., Albermarle Twp., Hope Bay, Albermarle Bk. by road south of Hope Bay, Bruce Peninsula, in sluggish brook, 24 Aug. 1977, *Morton & Venn s.n.* (CAN, MICH, WAT); Lindsay Twp., partially dried-up ditch on east side of Brickman's Corner-Cape Chin Rd., 0.1 mile north of Miller Lake East Rd. *Hellquist & Hellquist 15385* (CAN, DAO, MICH, NASC, PH, UNA, US, WAT); St. Edmunds Twp., ditch connecting into Willow Ck. on north side of Rt. 6, 1.5 miles north of radio tower and 2.7 miles north of Hidden River Rd., *Hellquist & Hellquist 15384* (CAN, CU, DAO, GH, MICH, MSU, NASC, NY, OS, US, WAT). Elgin Co., St. Thomas, shallow water, entirely submerged except for tips with fruit, 12 June 1951, *James s.n.* (DAO). Manitoulin Co., Carnarvan Twp., Mindemoya, Manitoulin Island, road south Mindemoya ca. 1.0 mile north of jct. with Providence Bay Rd., in sluggish stream flowing out of swamp, *Morton 80* (WAT); Carnarvan Twp., Mindemoya, west side of stream on large open marsh ca. 1.8 km south of Mindemoya, *Hellquist & Hellquist 15380* (NASC); Tehkummah Twp., South Baymouth, in swamp at head of small boat docking area, *Morton & Venn NA14834* (WAT); Tehkummah Twp., South Baymouth, Manitoulin Island, the Slash at the head of Leason Bay, in ditch by side of road, *Morton & Venn 10095* (WAT); Tehkummah Twp., South Bay, Manitoulin Island, the Slash, NE of Leason Bay, west side of bridge in stream, *Hellquist & Hellquist 15368* (CAN, DAO, GH, MICH, MO, NASC, US); Tehkummah Twp., Black Creek on east side of Side Road 15 ca. 0.4 km north of Providence Bay Rd., *Hellquist & Hellquist 15379* (CAN, DAO, MICH, NASC, US, WAT). Peel Co., Caledon Twp., Green Lake between 1st and 2nd lines, east side of Hwy. 24, Grid Ref. 795544, abundant in water 5 ft. deep, *Webber & Gregory 12120* (CAN, DAO, MICH, UNA); Caledon Twp., man-made ponds on north and south side of Rt. 24, ca. 0.1 mile east of 2nd Line Rd., *Hellquist & Hellquist 15387* (NASC).

OHIO: Ashtabula Co., Ashtabula, pools, 17 July 1877, *Hill s.n.* (F); Wayne Twp., open, impounded mud bottom ponds on west tributary to Pymatuning Ck. upstream from beaver dams just SE of intersection between Conrail tracks and Woodworth Rd., NE corner of Wayne Twp., occasional, forming dense mats along shoreline, *Bissell & Peskin 30* (MICH, OS). Portage Co., Garrettsville, Silver Ck., *Webb 1272* (F).

MICHIGAN: Cheboygan Co., locally frequent in ca. 1 ft. of water of ditch in boggy ground a few yards east of Elliot Ck. near center E1/2 Sec. 35, T38N, R1W, ca. 4 miles east of Cheboygan, *Voss 12735* (MICH, MSU, UMBS); Grant Twp., in 1–2 ft. of water near the southern shore of the more northerly of the Twin Lakes, Sec. 34, T37N, R1E, 2 Aug. 1951, *Wood s.n.* (GH, UMBS); Grant Twp, north shore of Twin Lakes ca. 5.0 miles east of Alverno, Sec. 24, T37N, R1E, *Hellquist & Haynes 10667* (MASS, NASC, NLU); Grant Twp., southern-most of the two streams flowing into the northern bay of Twin Lakes, ca. 5.0 miles east of Alverno, Sec. 34, T37N, R1E, *Hellquist & Haynes 10670* (NASC). Emmet Co., Wawatam Twp., locally common in ca. 1.5 ft. water, marsh in Cecil Bay between mouths of French Farm Creek, Sec. 28, ca. 4 miles SW of Mackinaw City, *Voss 14061* (CAN, MICH, MSC, NASC, NY, UMBS); Wawatam Twp., French Farm Creek east of Wilderness State Park Rd. at Cecil Bay, Lake Michigan, Sec. 28, T39N, R4W, *Hellquist & Haynes 10484* (NASC); Bliss Twp. Big Sucker Ck., Wilderness State Park, 24 July 1950, *Sparrow s.n.* (MICH); Big Sucker Ck. at eastern bridge of Sturgeon Bay Trail, Wilderness State Park, Sec. 34, T39N, R5W, *Hellquist & Hellquist 15300* (F, MO, MSU, NASC, NHA, PAC, UMBS, US). Kalkaska Co., Little Blue Lake, *Ashley 92* (MICH). Mackinac Co., Engadine, abundant at intersection of M-117 & U.S. 2; small stream which runs under M-117 ca. 1 mile south of Engadine, Sec. 20, T43N, R10W, *Haynes 4002* (OS). Manistee Co., Manistee, 5 Aug. 1880, *Hill s.n.* (F, PH, MICH, Type specimens), Manistee, pool on Garfield's farm near Manistee, 14 Aug. 1882, *Morong s.n.* (NY). Missaukee Co., West Branch Twp., ditch, west side of Nelson Rd. just north of Haymarsh Ck., 3.5 miles north by road of Star City, Sec. 1, T23N, R6W, *Pringle 646* (MICH); West Branch Twp., Haymarsh Creek, Nelson Road, 3.5 miles north of Star City, Sec. 1, T23N, R6W, *Hellquist & Hellquist 15293A* (GH, MO, NASC, NY, UNA). Otsego Co., locally common in muddy shallow water along west edge of road at outlet of Grass Lake, center of eastern edge of Sec. 5, T32N, R1W, *Stuckey & Nunan 1300* (GH, MICH, NY, NYS, OS, UMBS, US); southeastern corner of Grass lake ca. 12 miles northeast of Gaylord, Sec. 3, T32N, R1W, *Hellquist & Haynes 10467* (NASC). Presque Isle Co., Bearinger Twp. local in shallow water of Black Mallard River near mouth, NE 1/4, Sec. 25, T35N, R2E ca. 1.0 mile south of Grace, *Stuckey 3182* (OS); Ocqueoc Twp, east side of Little Ocqueoc River south of Rt. M-68, 4½ miles west of Moltke, north side Sec. 25, T35N, R3E, *Hellquist, Hellquist, & Crow 15317* (CAN, F, MICH, MSU, NASC, NY, OS, UMBS, UNA, US).

ACKNOWLEDGMENTS

I wish to thank Garrett E. Crow for his suggestions and manuscript review. Thanks are also extended to the curators of the following herbaria for the loan of plant specimens: CAN, CM, CU, DAO, F, GH, MICH, MO, MSU, NASC, NEBC, NY, NYS, OS, PAC, PH, US, VT, WAT.

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NEW ENGLAND NOTES

GERANIUM NEPALENSE VAR. *THUNBERGII* AND *G. SIBIRICUM* NATURALIZED IN WESTERN MASSACHUSETTS

C. John Burk

Geranium nepalense Sweet var. *Thunbergii* (Siebold and Zucc.) Kudo, a Japanese variety of a species widely distributed in Asia, was first reported in North America as an aggressive garden weed in Wellesley, Norfolk Co., Massachusetts (Hunnewell, 1945). A second Massachusetts population of this variety with white rather than the usual violet petals was later found in Newburyport, Essex Co. (Bean, 1953). Although Fernald (1950) described *G. nepalense* var. *Thunbergii* as locally abundant in Middlesex Co., Seymour (1969) cited only the Wellesley and Newburyport collections for New England.

Geranium nepalense var. *Thunbergii* is now well established as a weed on the Smith College campus in Northampton, Hampshire Co. The largest campus population extends intermittently for a distance of approximately 80 m along both sides of a recently reconstructed gravel path leading into floodplain forest on the northwest side of Paradise Pond. The plants, which were not observed prior to September, 1983, have set fruit abundantly and are spreading aggressively by rhizomes, even invading the coarse gravel surface of the path. Individual shoots and smaller colonies occur sporadically elsewhere on the campus. The petals of all plants seen flowering in 1983 were white.

The only New England report of the Eurasian *Geranium sibiricum* L. is based on a specimen collected on a wasteheap in Cambridge, Middlesex Co., MA in 1885 (Knowlton and Deane, 1919). Fernald (1950) described this species as locally abundant from New York and Pennsylvania to Illinois. In 1972, the late Harry E. Ahles collected *G. sibiricum* in a woodland border on the campus of Mount Holyoke College, South Hadley, Hampshire Co., (*Ahles 75801,* Aug. 5, 1972, *Ahles 76187,* Oct. 12, 1972 in MASS, duplicates sent to NEBC). At present, *G. sibiricum* thrives on the Mount Holyoke College campus with a large population beginning north of the dam which impounds Upper Pond and continuing approximately 100 m southwest along a fence and road edge. These plants were fruiting densely in September, 1983.

The western Massachusetts populations of these two geraniums are similar in both aspect and habitat and the taxa might potentially be confused. For example, specimens of *Geranium sibiricum* key out to *G. nepalense* var. *Thunbergii* in Seymour (1969), while in Gleason and Cronquist (1963), specimens of *G. nepalense* var. *Thunbergii* key out to *G. sibiricum,* with the text then differentiating *G. nepalense* var. *Thunbergii* on the basis of the number of flowers produced per peduncle. The two taxa are readily distinguished, nonetheless. *Geranium nepalense* var. *Thunbergii* perennates and increases by vigorous rhizomes which produce upright to decumbent shoots while *G. sibiricum* is nonrhizomatous and may be annual or perennial in duration. *Geranium nepalense* var. *Thunbergii* usually produces two flowers per axillary peduncle, each on a separate pedicel, while *G. sibiricum* usually produces a single flower on a solitary peduncle. In addition, in the western Massachusetts populations, the fruits of *G. nepalense* var. *Thunbergii* are more robust and range from 1.5–2.0 cm in length, as opposed to 1.0–1.5 cm in *G. sibiricum.*

Specimens have been deposited in SCHN, MASS, and the herbarium of Mount Holyoke College. I thank David A. Haskell, Marian Rohman at the University of Massachusetts and Leslie Lovett Doust at Mount Holyoke College for their generous assistance with this project.

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ARISTOLOCHIA TOMENTOSA SIMS ESTABLISHED AT TWO WESTERN MASSACHUSETTS SITES

C. John Burk

The pipe-vine or Dutchman's pipe-vine, *Aristolochia tomentosa* Sims, is a high-twining shrubby liana native to stream edge habitats of the southeastern and south central United States (Pfeifer, 1966). The similar *A. macrophylla* Lam. occurs in forests of the southeastern Appalachians. Pfeifer (1966) noted that the natural ranges of these species are separate, with "neither sympatry nor hybridization" where they border in the Smoky Mountains. Both species are widely planted northward as fast-growing covers for trellises, fences and verandas. *Aristolochia tomentosa* has not been reported outside cultivation in New England, although it is naturalized locally in western New York (Fernald, 1950). *Aristolochia macrophylla,* more frequently cultivated, has become naturalized at some New England stations (Fernald, 1950). Pfeiffer (1966) reported this species from Connecticut, Massachusetts, and Vermont, and Seymour (1969) cited Connecticut and Vermont specimens.

In June, 1982, Constance A. Parks and I found a small colony of *Aristolochia tomentosa* in the Mt. Tom State Reservation, Hampden Co., near the Hampshire Co. line. The vines occur on the north side of Christopher Clark Road approximately 30 m southwest of the Mt. Nonotuck overlook at an elevation of about 210 m. Several stems ascend a distance of 6 m or more to the top of a northern catalpa (*Catalpa speciosa* Warder) while others scramble into a nearby staghorn sumac (*Rhus typhina* L.). Smaller pipe-vines, apparently seedlings, occur among herbaceous vegetation near the base of the older vines. The large vines were flowering on June 22, 1982, and on the same date in 1983, but did not set fruit either year.

A second, much larger colony of *Aristolochia tomentosa* occurs near the west bank of the Connecticut River in Deerfield, Franklin Co. *Aristolochia tomentosa* was first observed at this site by Roberta Poland on August 29, 1957 (personal communication). The vines occur in the vicinity of old cellar holes on the east side of McClellan Farm road, approximately 1.9 km from the southern intersection of McClellan Farm Road with River Road and opposite the East Deerfield railroad yards. On July 4, 1967, Mrs. Poland visited the site with the late Harry E. Ahles. Specimens collected in 1967 are now on file in the University of Massachusetts Herbarium and in Mrs. Poland's personal herbarium. By summer, 1983, *A. tomentosa* had spread roughly 40 m along McClellan Farm Road, extending from the road edge eastward 15 m or more past the cellar holes and into a ravine which approaches the Connecticut River. Individual pipe-vines range in size from seedlings of the current year to very large plants which climb 12 m or more into various support trees, including staghorn sumac and northern catalpa. Several of these trees, especially the sumacs, are dead or dying and the aspect of the colony resembles that of sites farther south where kudzu [*Pueraria lobata* (Willd.) Ohwi.] or Japanese honeysuckle (*Lonicera japonica* Thunb.) have overrun woody vegetation.

The Deerfield colony of *Aristolochia tomentosa* almost certainly originated from a plant or plants persistent after cultivation, along with lilacs (*Syringa vulgaris* L.) and summer phlox (*Phlox paniculata* L.), which are also common in the immediate vicinity. The origin of the Mt. Tom pipe-vines is unknown. Given the widely differing habitats in which the two western Massachusetts colonies are established and the vigor which both *A. tomentosa* and *A. macrophylla* show in cultivation, these species might be expected to be spreading elsewhere in the region.

I am grateful to Roberta Poland for showing me the Deerfield colony of *A. tomentosa* and sharing her knowledge of the site and to Marian Rohman for assistance again with this project. Specimens from both sites are in MASS and SCHN.

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NANTUCKET FIELD TRIP OF THE NEW ENGLAND BOTANICAL CLUB

RAY ANGELO & BRUCE A. SORRIE

The New England Botanical Club held a field trip to Nantucket, Massachusetts on September 9–11, 1983. A diversity of habitats on this offshore island was visited.

Some of the more interesting species seen in the barrens were *Aster concolor* L. (in bloom and in Massachusetts known currently only on Nantucket), *Liatris borealis* Nutt., *Amelanchier nantucketensis* Bickn. (in good quantity though not known from the mainland), and *Hypericum adpressum* Bart. (at the Wigwam kettle ponds). Along Barnard Valley Rd. acres of *Corema conradii* Torr. were admired. Closer to the ocean (south of Bartlett Farm) the party searched unsuccessfully for *Agalinis (Gerardia) acuta* Pennell which had been collected in the vicinity at one time (now known from only three sites in its range). However, at this site were found *Linum intercursum* Bickn. (a few blossoms lingering), *Helianthemum dumosum* (Bickn.) Fern. (a few blossoms lingering), *Aletris farinosa* L. (in fruit), and *Prenanthes serpentaria* Pursh. These open sand plains (or "moors") remain one of New England's most intriguing plant communities but are threatened by continued advance of *Quercus ilicifolia* Wang.

Unusual examples of *Quercus velutina* Lam. and *Acer rubrum* L. with tortuous, spreading limbs were examined in low, moist woods in company with *Nyssa sylvatica* Marsh. and *Sassafras albidum* (Nutt.) Nees. This locality was near Pocomo Road. About 1½ miles south of this site the party was led to locally rare stations of *Actaea rubra* (Ait.) Willd. and *Mitchella repens* L. in the vicinity of the Windswept Bogs owned by the Nantucket Conservation Foundation. A particularly large specimen of *Ilex opaca* Ait. was growing nearby. In a thicket beside the dirt road that provided access to this area, one of the party found a new record for the island—*Pyrus sieboldii* Reg., a species that is naturalizing in eastern Massachusetts.

The disturbed site of the old Siasconset dump provided an interesting array of species including *Rhynchospora torreyana* Gray (one of two known stations in the state), *Solidago elliottii* T. & G. (in bloom), *Lycopodium inundatum* L., *Aletris farinosa* L., *Drosera* *filiformis* Raf., *Platanthera blephariglottis* (Willd.) Lindl. (essentially past flowering), *Pogonia ophioglossoides* (L.) Ker and *Spiranthes cernua* (L.) Richard var. *ochroleuca* (Ryd.) Ames (in bloom).

A side trip to Low Beach along the southern shore of the island made by one member of the group turned up *Polygonum glaucum* Nutt. in great quantity.

In the immediate vicinity of the Nantucket Field Station (University of Massachusetts) *Baccharis halimifolia* L. (in bloom) and *Rubus bifrons* Vest flourished. This is one of the very few sites in New England where this latter alien species is known to be established.

Faunal rarities that highlighted the field trip were *Egretta gularis* (Western Reef Heron), a vagrant from West Africa, and *Speyeria idalia* (Regal Fritillary) which is now rare in eastern United States. Both were seen in the general vicinity of the Field Station.

All the new records for vascular plants found on the island during this trip are adventive species. These are *Buddleia davidi* Franch., *Clematis dioscoreifolia* Levl. & Vaniot, and *Pyrus sieboldii* Reg. Voucher specimens have been deposited with the New England Botanical Club herbarium (NEBC).

The Club is very grateful for the hospitality and generous assistance of Dr. Wesley N. Tiffney Jr., Director of the Nantucket Field Station. Thanks also go to Dr. Robert Zaremba for sharing his knowledge of ecologically interesting sites on the island.

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ERRATUM, OCTOBER 1983 ISSUE (VOL. 85, NO. 844)

"Relationships of two isolated groups of sugar maples (Acer saccharum Marshall ssp. saccharum) in west central Oklahoma to eastern and western species" by Thomas C. Dent and Robert P. Adams.

Figures 3 and 4 are transposed from respective captions.

ANNOUNCEMENT

The annual Joint Field Meeting of the Northeastern Section of the Botanical Society of America, the Torrey Botanical Club, and the Philadelphia Botanical Club will be held on June 17 to 20, 1984, in Salisbury, MD. Accommodations will be at Salisbury State College. There will be guided field trips to dunes, forests, swamps, and marshes at various sites on the Delmarva Peninsula in Maryland, Virginia, and Delaware. Space is limited and prior registration is required. Full details will be available after February 1, 1984, by writing the Chairman, Dr. Larry H. Klotz, Dept. of Biology, Shippensburg University, Shippensburg, PA 17257 (717-532-1401).

Vol. 85, No. 843, including pages 274–396, was issued August 11, 1983.

Vol. 85, No. 844, including pages 397–473, was issued December 31, 1983.

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Rhodora

JOURNAL OF THE NEW ENGLAND BOTANICAL CLUB

Vol. 86 April 1984 No. 846

The New England Botanical Club, Inc.

Botanical Museum, Oxford Street, Cambridge, Massachusetts 02138

Conducted and published for the Club, by
NORTON H. NICKERSON, Editor-in-Chief

RHODORA.—Published four times a year, in January, April, July, and October. A quarterly journal of botany, devoted primarily to the flora of North America. Price $20.00 per year, net, postpaid, in funds payable at par in the United States currency at Boston. Some back volumes and single copies are available. Information and prices will be furnished upon request. Subscriptions and orders for back issues (making all remittances payable to RHODORA) should be sent to RHODORA, Botanical Museum, Oxford Street, Cambridge, Mass. 02138. In order to receive the next number of RHODORA, changes of address must be received prior to the first day of January, April, July or October.

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PRINTED BY
THE LEXINGTON PRESS, INC.
LEXINGTON, MASSACHUSETTS

Cover illustration

Ledum groenlandicum Oeder, Labrador tea, reaches its southeastern distributional limit in Concord, Mass. It was first collected by Thoreau in 1858, subsequently regarded as extirpated by Richard Eaton in 1974, and rediscovered by Ray Angelo in 1978. Angelo has since found it in two more Concord locations.

Original artwork by Josephine Ewing.

Rhodora

(ISSN 0035-4902)

JOURNAL OF THE

NEW ENGLAND BOTANICAL CLUB

Vol. 86 | **April 1984** | **No. 846**

A NEW SPECIES OF *PHYLLANTHUS* (EUPHORBIACEAE) FROM THE CAYMAN ISLANDS

GRADY L. WEBSTER AND GEORGE R. PROCTOR

ABSTRACT

Phyllanthus caymanensis Webster & Proctor is described from specimens collected in the Cayman Islands. This species resembles Mesoamerican species such as *P. mcvaughii* and *P. mocinianus* rather than any of the West Indian taxa of sect. *Nothoclema*. It is the first endemic species of sect. *Nothoclema* recorded from the West Indies.

Key Words: Euphorbiaceae, *Phyllanthus*, West Indies

In the revision of the West Indian species of *Phyllanthus*, Webster (1957) recorded only 2 species of sect. *Nothoclema*: the widespread *P. acuminatus* Vahl, and *P. subglomeratus* Poir. in the Lesser Antilles. It was therefore a distinct surprise when the junior author discovered a third species in the Cayman Islands. Although it is very similar in aspect to the Mesoamerican *P. mocinianus* Baillon, the Cayman plant clearly represents a previously undescribed species.

Phyllanthus caymanensis Webster & Proctor, *sp. nov.*, ab aliis speciebus sect. *Nothoclemae* differt ramulis glabris simpliciter pinnatiformibus, foliis ovatis subacutis conspicue venosis, antheris compressis subacutis, pollinis grana striato-reticulata.

Glabrous shrub c. 2.5 m high; twigs terete, 1–2.5 mm thick, greyish. Cataphylls ± scarious, indurate, subpersistent; stipules triangular-ovate, c. 1.2–1.5 mm long and 1.2 mm broad; blade lanceolate, c. 1–1.2 mm long, narrower. Deciduous branchlets all simple (pinnatiform), 3–7 cm long, with 6–10 nodes; axes greenish, angled, slender (less than 1 mm thick). Leaves with stipules

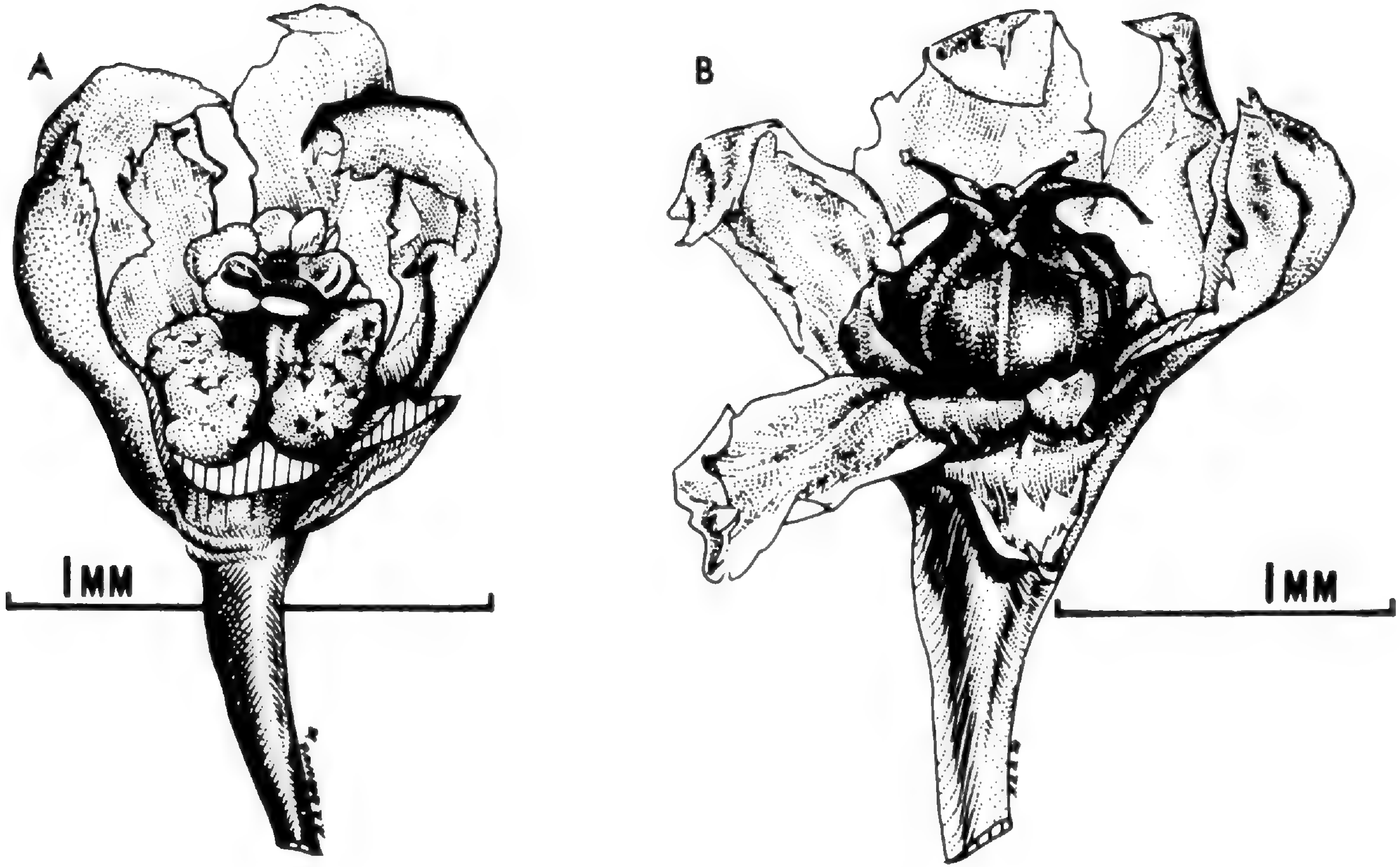

Figure 1. Flowers of *Phyllanthus caymanensis*. A. Staminate flower. B. Pistillate flower.

lanceolate, acuminate, becoming scarious and subpersistent, 0.8–1 mm long; petioles 1–2 mm long; blades chartaceous, ovate, obtusely to acutely pointed at tip, obtusely rounded to slightly subcordate at base, mostly 1.5–2.7 cm long, 1.2–2.1 cm broad, above olive green (paler beneath), with midrib, major lateral veins (c. 5–7 on a side) and veinlet reticulum distinctly prominulous (on both faces); margins plane.

Monoecious; cymules axillary on branchlets, bisexual, with one central ♀ and several lateral ♂ flowers. Staminate flowers: pedicel slender, 5–10 mm long; calyx-lobes 6, biseriate, erect, elliptic to obovate, obtuse, with paler margins, 1.3–1.7 mm long, 0.7–1.2 mm broad; disk segments 3, massive, bilobed, pitted, c. 0.6–0.8 mm across; stamens 3, filaments completely connate into a column 0.3–0.5 mm high; anthers triangular-ovate, acute or subacute, flattened, c. 0.4 mm long and 0.5 mm broad, fused by the connectives, dehiscing horizontally; pollen grains subglobose, c. 18–22 μm in diameter, 3-colporate, not syncolpate, colpi distinctly marginate, exine with even and relatively fine vermiculate ornamentation pattern. Pistillate flowers; pedicel slender (not dilated distally), becoming 8–12 mm long in fruit; calyx-lobes 6, biseriate, triangular-lanceolate, acute, 1.4–1.7 mm long; disk 3-lobed, lobes c. 0.7–0.8 mm across; ovary smooth, of 3 carpels; styles free, spreading, c. 0.4 mm long, bifid, branches slender. Capsules oblate, prominently veiny, greenish, 4–4.5 mm across; seeds 1.9–2 mm long, distinctly angled, light brownish, nearly smooth.

Type: Cayman Islands, Cayman Brac, Foster Land Distr., rocky woodland c. 0.7 mi NW of Pollard Bay, alt. c. 100 ft, 7 Aug. 1975, *G. R. Proctor 35151* (JAM, Holotype). Additional collection examined: Cayman Islands, Little Cayman, sandy woodland just N of W end of the air strip, 7 Aug. 1975, *G. R. Proctor 35145* (JAM).

This species represents an exciting novelty because it is the first endemic species of sect. *Nothoclema* to be discovered in the West Indies. In appearance, the specimen suggests a small-leaved form of the Mexican species *P. mocinianus* Baillon. However, in most floral characters (Fig. 1), especially the anther shape, it is closer to *P. mcvaughii* Webster of Chiapas and northern Central America. It differs from that species, though, in its glabrous conspicuously veined leaves, slender pistillate pedicel, and smaller seeds. Curiously, the pollen of the Cayman plant, as seen in scanning micrographs (Fig. 2), is much closer to *P. mocinianus* in its relatively fine

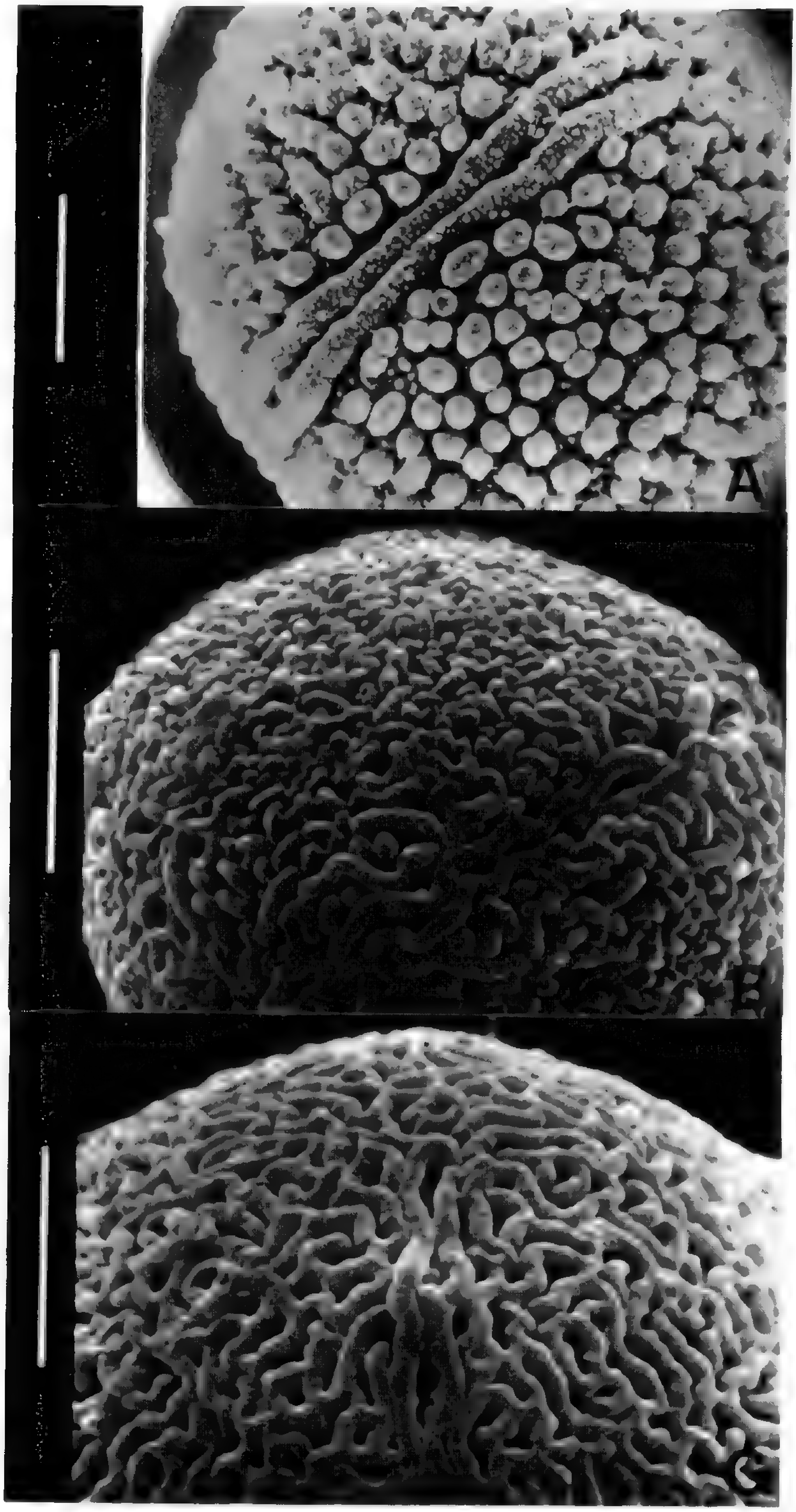

Figure 2. Pollen grains of some species of *Phyllanthus* sect. *Nothoclema*. A. *Phyllanthus mcvaughii*. B. *Phyllanthus mocinianus*. C. *Phyllanthus caymanensis*. Scale bar = 4 μm.

vermiculate sculpturing than it is to the coarser, more irregular ornamentation of *P. mcvaughii* (see also figures in Webster, 1967).

Overall, *P. caymanensis* thus shares some characters with both *P. mcvaughii* and *P. mocinianus*, but is clearly distinct from either of them. It remains an intriguing phytogeographical puzzle that sect. *Nothoclema* should be represented by an endemic Antillean species only on the Cayman Islands.

ACKNOWLEDGMENTS

We wish to thank the Institute of Jamaica for loan of specimens, Dr. Steven Lynch and the Botany Department of the Smithsonian Institution for the SEM pictures of pollen, and Mr. Norman Geesing for preparing the illustrations.

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AN AWARD FOR THE SUPPORT OF BOTANICAL RESEARCH IN NEW ENGLAND, U.S.A.

The New England Botanical Club is offering an award of $1,000 in support of botanical research to be conducted in the New England region during 1985. It is being made to stimulate and encourage botanical research on the New England flora and to make possible visits to the New England region by those who would not otherwise be able to do so. The award will be given to the graduate student submitting the best research proposals dealing with field studies in systematic botany and plant ecology, but proposals for research in other areas of botany will also be considered. This award is not limited to graduate students at New England institutions. The NEBC's support must be acknowledged in any publications resulting from this study. It is encouraged that papers based on this research be submitted to RHODORA, the Club's journal, for possible publication—subject to standard review processes. The New England Botanical Club hopes to be able to make this award on an annual basis.

Applicants should submit a proposal of no more than three double spaced pages, including a budget (the budget will not affect the amount of the award), and their *Curriculum Vitae.* Two letters, one from the student's major professor, in support of the proposed research are also required. Proposals and supporting letters should be sent before 28 February 1985 to: Awards Committee, The New England Botanical Club, 22 Divinity Avenue, Cambridge, MA 02138. The recipient of the award will be notified by 30 April 1985.

A NEW, WIDESPREAD SPECIES OF *CHAPTALIA* (ASTERACEAE: MUTISIEAE) FROM MEXICO

Guy L. Nesom

ABSTRACT

Chaptalia transiliens Nesom, a new species from Mexico, is described and assigned to *Chaptalia* sect. *Leria;* notes on its distribution and phenology are given.

Key Words: Asteraceae (Mutisieae), *Chaptalia transiliens,* Mexico, Guatemalan disjunct

In order that it may properly be dealt with in Rzedowski's forthcoming treatment of Compositae from the Valley of Mexico, I propose the following new species in advance of a revisionary treatment of all 13 species from North America, Mexico, and continental Central America (Nesom, in prep.). Burkart's revision of *Chaptalia* (1944) cited none of the collections listed below; most of them have been made since the completion of his study.

Chaptalia transiliens Nesom, *sp. nov.*

Chaptaliae nutanti (L.) Polak. affinis, a qua imprimis differt foliis crassis spathulatis petiolis distincte et anguste alatis, phyllariis interioribus marginibus latis, ligulis erectis angustatis involutis ad maturitatem purpureis initio albis supra, floribus pistillatis interioribus paucioribus ligulis prominentibus, ramis stylorum florum pistillatorum aliquantum complanatis, acheniis rostris brevioribus.

Plants from a simple caudex or a slender, horizontal to ascending rhizome up to 4 cm long. Leaves thick, sometimes slightly coriaceous, spatulate, the blade elliptic to ovate-elliptic, sometimes sublyrate with several shallow lobes at the base, 6–28 cm long, petiole 1/2–2/3 as long as the leaf, winged, blade 9–55 mm wide, densely tawny-gray pubescent below, quickly glabrescent above, glabrous and often somewhat shiny by flowering, margins with numerous apiculae, not revolute. Stems 12–56 cm tall at anthesis, elongating slightly in fruit, tawny webby-pubescent, glabrescent, ebracteate or with a linear bract within 5 mm of the head. Heads 1–2 per plant, nodding in bud; involucre campanulate to hemispheric, 9–19 mm wide (pressed); phyllaries in 3–4 imbricated series, linear-lanceolate with acute apices, sparsely to densely tawny-villous except for margins and narrow midregion, inner 14–20 mm long at anthesis, not elongating in fruit, 1.3–1.8 mm wide, sometimes purple margined, developing wide (0.2–0.5 mm), flange-like, scarious margins below the upper third and often becoming involute, margins of outer 1–3 series usually minutely stipitate-glandular, outermost 1/4–1/2 as long as the inner; receptacle flat, weakly foveolate. Flowers trimorphic in 3 concentric zones, all fertile; outer pistillate flowers 11–21 (32) in 1 series, erect, corolla 11–17 mm long, bilabiate, the inner lip microscopic (0.5 mm long) to 2.5 mm long and equalling the style in length, ligule white above, reddish-purple below, usually maturing purplish above, 0.8–1 mm wide, 3–5 veined, usually involute and often enclosing the style, apex truncate to shallowly lobed or notched, tubular portion 5–7 mm long, style 9.2–11 mm long with somewhat flattened branches 1–2 mm long, often purple; inner pistillate flowers rare to nearly as numerous as the outer ones, ligulate with ligules shorter than those of the outer but sometimes longer then the style, red to cream, bilabiate with an inner lip up to 1 mm long; hermaphroditic (disc) corollas in center of head, yellowish, narrowly oblanceolate in outline, 9–11 mm long, bilabiate, longest lobes 2.2–3.5 mm long, erect to spreading, anthers with thecae 1.5–2.3 mm long, apical appendages 0.8–1.2 mm long, style branches narrowly obovate, 0.8–0.9 mm long. Achenes 7.5–11 mm long at maturity, the body fusiform, slightly flattened, tan to brown, 5–6 mm long, 0.9–1.3 mm wide, 5–6 ribbed, moderately pubescent with prominently attenuate-apiculate papillae, beak light-colored, (0.6) 0.9–1 times as long as the body, upper part minutely stipitate-glandular; carpopodium narrow; pappus tawny-white, bristles weakly barbellate, 9.5–12 mm long, longer than the disc corollas.

DISTRIBUTION AND PHENOLOGY. Scattered localities in southcentral Nuevo León, Guanajuato, Hidalgo, México, and Puebla, apparently disjunct to Chiapas and Guatemala; usually on steep, moist, shaded, often rocky slopes, with pine, oak, pine-oak, or pine-oak-juniper, in Nuevo León on "open, dry slopes among thorny shrubs"; 1600–2550 m; flowering (January) April through October (November).

TYPE: MEXICO. NUEVO LEÓN: NW slope of Cerro Peña Nevada on road to pass, ca. 1.5 km directly NW of summit, ca. 35 km ENE of Doctor Arroyo, steep slope, oak-pine-juniper with

Agave; common but scattered, in shade, deep soil, usually under oaks, 31 Jul 1983, *Guy Nesom 4759* (HOLOTYPE: US; ISOTYPES: [to be distributed] ANSM, CAS, ENCB, GH, K, MEXU, MICH, MO, NY, OS, SMU, TEX, UC).

ADDITIONAL COLLECTIONS EXAMINED: GUATEMALA: Chimaltenango, San Martín Chile Verde, 1 Aug 1941, *Johnston 1765* (F); along Aguacatán road E of Huehuetenango, at KM 15, 2 Jan 1941, *Standley 81939* (F); canyon above Chiantla, Sierra de las Cuchumatanes, 9 Aug 1942, *Steyermark 50351* (F). MEXICO. Chiapas: mpio. Tenejapa, W of Tenejapa Center along trail to Paraiso, 5 Aug 1964, *Breedlove 6870* (DS); mpio. La Independencia, 6–10 km NNE of La Soledad along logging road from Las Margaritas to Campo Alegré, 24 Oct 1976, *Breedlove 41026* (DS); 6–10 km NNE of La Soledad, 26 Nov 1980, *Breedlove & Almeda 47775* (CAS); mpio. San Cristóbal las Casas, Cerro San Cristóbal in San Cristóbal, 23 Apr 1966, *Laughlin 740* (DS, MICH); Mt. Malé, Porvenir, 6–12 Jul 1941, *Matuda 4686* (MEXU, MO, NY); Amatenango de Valle, 12 Jun 1945, *Matuda 18243* (MEXU). Guanajuato: camino a San Miguel pasando frontera con Qro., 12 Apr 1981, *Argüelles 1574* (MEXU); ca. 8 km NE of Santa Rosa [Hwy. 110], 10 Nov 1970 (past flower), *Mcvaugh 24173* (NY). Hidalgo: ca. 0.4 km N of Minas Viejas, 3.2 km NE of Durango on Hwy. 85, ca. 32 km S of Jacala, 8 Aug 1981, *Nesom 4377* (LL, MEXU, US). México: 4 km N de Atizapan, 21 Jul 1968, *Rzedowski 26002* (ENCB). Nuevo León: 0.8 km NE of Dulces Nombres, near Tamaulipas border, 18 Jun 1948, *Meyer & Rogers 2575* (MO, US); Lower San Francisco Canyon, ca. 24 km SW of Pueblo Galeana, 18 May 1934, *Mueller & Mueller 437* (GH, MICH, TEX, US). Puebla: mpio. Tecamachalco, El Ocotál, 11 Jul 1972, *Ventura A. 5719* (ENCB, MICH); 8.5 km SW of San Salvador el Seco, 13 Jul 1960, *Beaman 3620* (MSC); Boca del Monte, Tehuacan, Jun 1907, *Purpus s.n.* (UC).

Chaptalia transiliens possesses ebracteate scapes, nodding buds, narrow ligules without a definite midstripe, relatively long and narrow pistillate style branches, and fertile disc achenes; these characters identify it as a member of *Chaptalia* sect. *Leria* and a member of the species group that includes the widespread and well-known *C. nutans* (L.) Polak., with which it has usually been confused. It is not clear at present, however, which species within sect. *Leria C. transiliens* is most closely related to. Tentative identifications of the new species can be made on the basis of the relatively thick or slightly coriaceous, spatulate leaves with narrow, winged petioles. Other distinctive features of this species are: 1) long phyllaries, the outer with stipitate-glandular margins, inner with wide, scarious, sometimes flange-like margins; 2) long, narrow, involute ligules, white above and reddish-purple below at early anthesis, completely purplish at maturity; 3) inner pistillate flowers with short but prominent ligules; 4) somewhat flattened pistillate style branches; and 5) achenes with a narrow beak about as long as the body, pubescent with prominently attenuate-apiculate papillae.

The epithet "transiliens" refers to the "leap" shown by the new species in geographic distribution from Mexico and Puebla southeastward to Chiapas and Guatemala.

ACKNOWLEDGMENTS

For their assistance I thank the curators of the following herbaria from which specimens were borrowed: CAS, DS, ENCB, F, GH, MEXU, MICH, MO, MSC, NY, TEX, UC, and US. Dr. G. J. Gastony provided editorial assistance with the Latin diagnosis.

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NOTES ON *CROOMIA PAUCIFLORA* (STEMONACEAE)[1]

R. David Whetstone

ABSTRACT

Croomia pauciflora (Nuttall) Torrey is an endemic to the southeastern United States. Documented distribution includes the following states and physiographic regions: Ridge & Valley, Cumberland Plateau, Piedmont Plateau, and Gulf Coastal Plain of Alabama; Piedmont Plateau, and Gulf and Atlantic Coastal Plain of Georgia; and the Gulf Coastal Plain of Florida and Louisiana. *Croomia pauciflora* is a rare element of the southeastern flora and is considered an "endangered" or "threatened" species in portions of its range. A neotype is designated due to the apparent loss of the single specimen cited in the original description.

Key Words: *Croomia pauciflora,* Stemonaceae, neotype, endemic, disjunct, endangered species, threatened species, rare species.

The Stemonaceae is comprised of four genera with 30–35 species (Hutchinson, 1973; Willis, 1973; van Steenis, 1982). The genus *Croomia* is highly celebrated as being disjunct from the southeastern United States to southeastern Asia. Three species are currently recognized with one in the United States, *Croomia pauciflora* (Nuttall) Torrey, and two in Japan, *C. heterosepala* (Bak.) Okuyama and *C. japonica* Miq. (Ohwi, 1965). Rogers (1982) reported the range of the latter to extend to eastern China.

Hardy Bryan Croom first discovered Croomia across the Apalachicola River from his home. Specimens were sent to Thomas Nuttall who named the new plant *Cissampelos pauciflora* (Nuttall, 1834). Apparently unaware of Mr. Nuttall's publication of the new name, but cognizant that Nuttall referred the plant to the Menispermaceae, Croom (1835) provided a description and duly noted the new taxon should be classified elsewhere. John Torrey, friend and correspondent, recognized the distinction of the herb and

[1]These Notes were developed while preparing a treatment of the Stemonaceae for the *Vascular flora of the southeastern United States* (Radford, in prep.). Specimens consulted during this study are housed in the following herbaria: AUA, BH, CU, DUKE, FSU, GA, GH, JSU (Jacksonville State University Herbarium), LSU, MO, NCU, NY, PH, SMU, TENN, TEX, UNA, US, USF, VDB, and the University of South Alabama. Acronyms are from Holmgren *et al.* (1981), unless otherwise specified. Exsiccata are not further cited because of the rarity of this species. A list of specimens examined is deposited in libraries at A/GH and MO.

established the genus *Croomia* in honor of the discoverer (Torrey and Gray, 1840). However, Torrey placed *Croomia* within the Berberidaceae.

Nuttall (1834) mentioned a single collection made by Croom and Loomis. No specimens labeled thus were located at the Academy of Natural Sciences (pers. comm., Dr. A. E. Schuyler, 1983) or at the British Museum (pers. comm., John Lewis, 1979). It should be noted the title of the article specifically states the specimens are at PH. Torrey (Torrey and Gray, 1840) cited two collections, "Mr. Croom!" and "Dr. Chapman!". Two sheets labeled "Croom" are at the New York Botanical Garden, one with flowers and one with buds. In the type collection at New York, a manuscript copy of the original description of *Croomia* and the ensuing *comb. nov.* reveals the following within the habitats section: "Under the shade of *Torreya taxifolia* Arn., at Aspalaga on the Apalachicola, Florida, H. B. Croom, Esq.—Flowers in April." Several "Herb. Chapman" exsiccata at NY and GH may be materials cited by Torrey. One sheet examined by this author is labeled "Torr. and Gr. Fl. N. Amer." Quite possibly, this specimen represents material sent to Dr. Torrey by Hardy Croom in 1830 (*fide* a letter addressed to Dr. Torrey in the archives collection at PH). Torrey acknowledged receipt of specimens from Mr. Croom in the subsequent publication. Since no specimen exists at PH or at BM which is indisputably the single specimen cited by Nuttall (1834), it becomes necessary to designate a neotype. In the letter (mentioned above), Croom notes he collected some specimens from along the Apalachicola River at Aspalaga. I have chosen a collection made by Dr. Godfrey from Torreya State Park which is ca. 8 km south of Aspalaga. The neotype is labeled as follows: "FLORIDA, LIBERTY COUNTY. Wooded bluffs along the Apalachicola River at Torreya State Park, 16 March 1961, R. K. Godfrey 60614, FSU 63997" (Figure 1). Replicates of this collection which were examined are at BH (*s.n.*); DUKE (147433); GA (63218 & 106380); NCU (216705); SMU (*s.n.*); TENN (2 sheets, *s.n.*); and US (238915).

Familial placement has likewise had a rather colorful history ranging from the Menispermaceae (Magnoliopsida) to the Croomiaceae (Liliopsida). Recent phylogenists (Cronquist, 1981; Hutchinson, 1973; Takhtajan, 1980) place the genus in the Stemonaceae (Roxburghiaceae) although evidence (Ayensu, 1968) suggests that this group remains rather heterogenous.

Figure 1. Neotype of *Croomia pauciflora*.

Most of the known localities for *Croomia pauciflora* are along watercourses that have headwaters in the southern Appalachian Mountains and flow southward to the Gulf of Mexico. Two collections deviate from this pattern. A specimen at NY was collected by Pond along the Savannah River which debouches into the Atlantic Ocean. More noteworthy is a collection by Featherman in 1870 (LSU 34679). Label data indicate "Brashear City" which is in St. Mary Parish, Louisiana. This parish is located west of the Mississippi River. The primary drainage, the Red River, has headwaters in the Ozarks and eastern Texas although there is a confluence with the Mississippi River (some western Appalachian drainage) near Torras. Quite possibly other localities exist in the highlands west of the Mississippi River, perhaps in east Texas or Arkansas.

The greatest diversity of physiographic distribution occurs in Alabama where *Croomia* has been located in the Cumberland Plateau, Valley and Ridge, and Piedmont Plateau sections of the Appalachian Highlands Province and in the Gulf Coastal Plain Province. Georgia localities include Gulf and Atlantic slopes of the Coastal Plain Province. Populations in Florida and Louisiana are within the Gulf Slope of the Coastal Plain Province. See Figure 2 for the documented county distribution.

Croomia is known from a variety of substrates but is found chiefly in rich, sandy or rocky soils of wooded slopes and bottoms. Most frequently, the slope is sheltered (e.g., ravines) or north-facing. Soils are ostensibly circumneutral although not necessarily calcareous (*vide* discussion in Harper, 1922). All habitats described on labels and those visited by this author are mixed deciduous forests which are mesic.

Presumably, *Croomia pauciflora* is an epibiotic, an endemic considerably restricted from a former, much broader range. Presently the taxon is very much disjunct in isolated localities in the warmer temperate portions of the southeastern United States. From personal observations, populations appear to be largely clonal. Also, current distribution is possibly a result of a constriction of much broader distribution owing to colder Pleistocene temperatures and limited habitat availability south of the Appalachian Highlands Province.

Despite the number of populations (some historical and perhaps extirpated) throughout the range, *Croomia* is a rare element of the

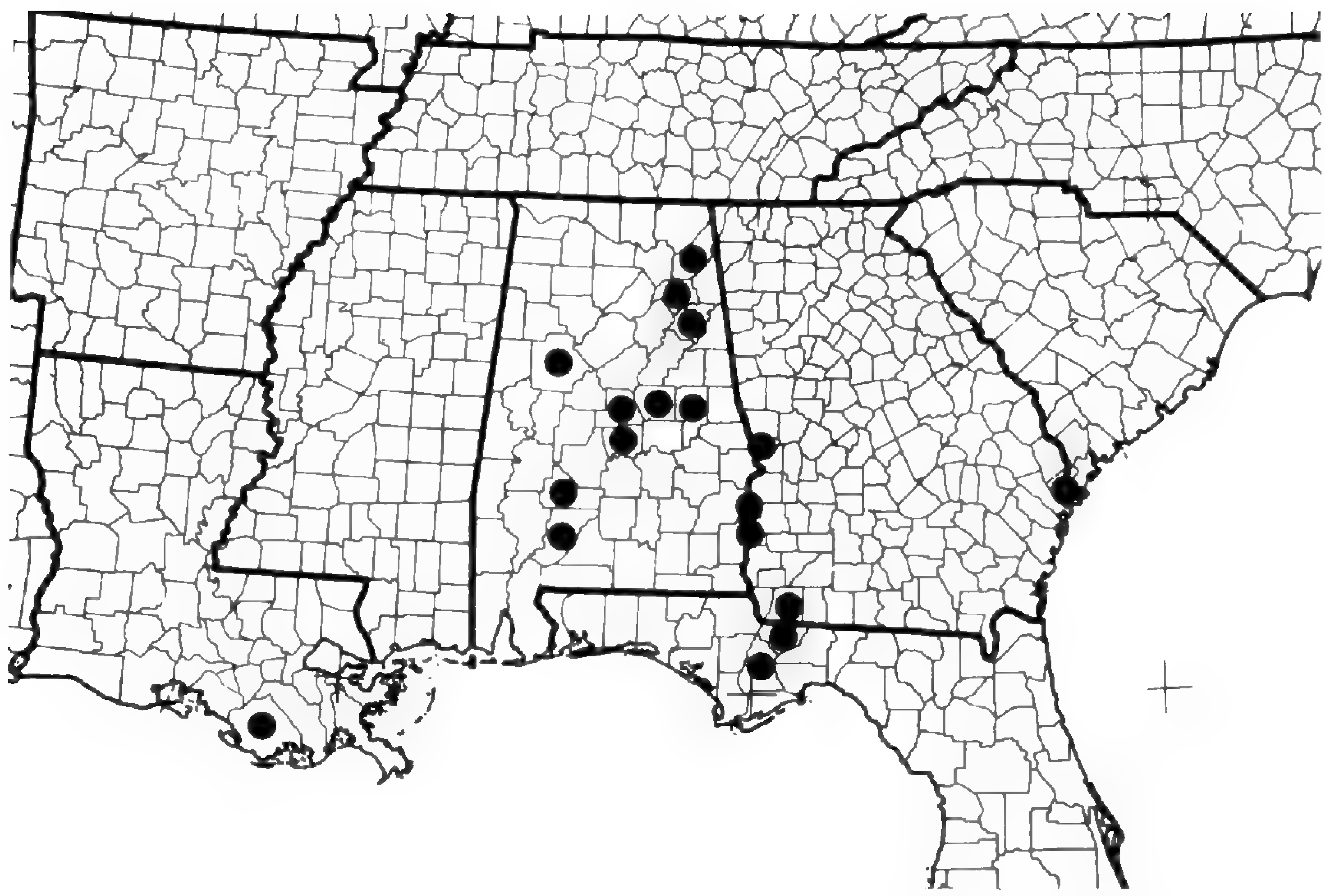

Figure 2. Documented county distribution of *Croomia pauciflora*.

southeastern flora. *Croomia* is considered "threatened" in Alabama (Freeman *et al.*, 1979), "endangered" in Florida (Godfrey & Ward, 1979) and "threatened" in Georgia (McCollum & Ettman, 1977). The "endangered" status in Florida is because of damage inflicted on populations by feral pigs. Godfrey and Ward (1979) stressed the importance of controlling the animals to prevent destruction of the populations along the Apalachicola River bluffs. Much more difficult would be the assessment of damages to populations that were directly or indirectly affected by the impoundments created along the numerous watercourses in Alabama, Florida, and Georgia.

ACKNOWLEDGMENTS

I am indebted to the curators of the herbaria cited herein for the consultation of materials under their purview. I also appreciate the search of the manuscript collection of the Academy of Natural Sciences by Carol M. Spawn, the type collection at PH by A. E. Schuyler, the type collection at NY by P. K. Holmgren, and the collections of the British Museum by John Lewis. T. A. Atkinson and J. R. Massey provided assistance with the processing of materials as well as interesting discussions of facets of this work. In addition, D. E. Boufford provided sound advice and bibliographic assistance. Melanie G. Bussey very patiently and carefully typed the manuscript. Mr. Opal R. Lovett photographed the neotype. All conclusions and facts contained herein reflect the observations and opinions of the author. Portions of this research were performed while the author held a Coker Fellowship in the Department of Botany at the University of North Carolina at Chapel Hill. I am indeed grateful for the financial support.

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DISTRIBUTION AND ECOLOGICAL CHARACTERISTICS OF IRONWOOD, *OSTRYA VIRGINIANA* (MILLER) K. KOCH, IN NORTHEASTERN NOVA SCOTIA

K. N. H. Greenidge

ABSTRACT

Ironwood, *Ostrya virginiana* (Miller) K. Koch, an Alleghanian species, reaches the northeastern limit of its range in northern Nova Scotia. The species is in a vigorous condition and widely distributed in the region, but normally reflects low density of stocking. Notable silvical characteristics of ironwood in northern Nova Scotia include high tolerance, wide ecological amplitude, vitality and aggressiveness.

Key Words: Ironwood, Nova Scotia, range limit, ecological amplitude, density

Ironwood, *Ostrya virginiana* (Miller) K. Koch, is one of a number of tree species, mainly of Canadian or Alleghanian affinity, which reach the northeastern limit of their ranges in northern Nova Scotia. Other taxa reflecting this pattern of distribution include *Populus grandidentata*[1], *Quercus rubra* var. *borealis, Acer saccharum, Fraxinus americana* and *Tsuga canadensis* (Little, 1971; Scoggan, 1978.)

Available information suggests the possiblity of considerable differences in local distribution, abundance and habitat-selection in northern Nova Scotia among elements of the foregoing complex of species (Roland and Smith, 1969). Accordingly, studies were initiated with the object of gaining detailed information on the occurrence, importance and ecological relations of Canadian-Alleghanian species in the region. Observations on *Acer saccharum* have been published previously (Greenidge, 1977). The purpose of the present paper is to describe and discuss the local distribution and silvical characteristics of ironwood over a broad range of sites in the northeastern region of the Province.

METHODS

Field work was concentrated in topographically-diverse areas of Nova Scotia bordering the southern reaches of the Gulf of St.

[1]Nomenclature follows Fernald (1950)

Lawrence (Figure 1). This region suffered extensive Pleistocene glaciation (Prest and Grant, 1969). However, the possibility of the existence in late-Wisconsin time of upland and coastal refugia has been recognized by Grant (1977).

Extensive new collections of ironwood were made to increase knowledge of its distribution in northen and northeastern Nova Scotia[2]. Reconnaissance and intensive surveys, transects, line (strip)-cruises and sample plots were used to investigate the occurrence, density, morphological characteristics, habitat preferences, crown-class relations, tolerance, associated species, vigor, successional tendencies and reproductive potential of ironwood over a wide spectrum of sites.

Observations were made both in forested and partially-forested areas of the region, with emphasis on conditions in the closed forest. Transects utilized to investigate the occurrence and field-relations of the species on topographically well-defined sites were oriented at right angles to the contours on hill-slopes, and along the axes of spurs, stream-hollows and valley-heads. Surveys and searches were employed for the same purpose on sites of limited topographic variability, including upland-surfaces, terraces and bottom-lands. Quantitative data on density (trees per acre), dominance (basal area per acre) and stand-composition were accumulated with the aid of strip-cruises and sample plots.

RESULTS

DISTRIBUTION. Figure 2 illustrates the pattern of distribution of ironwood in Nova Scotia. This map incorporates information on collections housed in several herbaria: ACAD, DAL, NSPM, NSAC, UNB, GH, CAN, and DAO. Also included in Figure 2 are the results of the author's collection of ironwood in the Gulf of St. Lawrence-Cabot Strait area of Nova Scotia.

With specific reference to northeastern Nova Scotia, a study of available collections suggests that the species becomes less frequent northeastward. Thus far, ironwood apparently has not been collected north of the Cheticamp River watershed, and no collections of the species from Victoria and Richmond Counties are

[2]These materials have been deposited in NSPM.

Figure 1. Map of the Gulf of St. Lawrence—Atlantic Provinces Area of Eastern North America.

known to the author. However, a report by Bulmer and Hawboldt (1958) treating the forest resources of Nova Scotia noted the occurrence of ironwood in both of the above-mentioned counties.

OCCURRENCE AND HABITAT PREFERENCES. In areas of discontinuous or partial forest-cover in northern Nova Scotia, ironwood occurs as scattered individuals or in small concentrations in riparian stands and thickets, along roadsides and the edges of fields, and in cut-over areas, power-line clearings and similar types of disturbed sites.

In forested areas of northern mainland Nova Scotia, the species exploits a broad range of sites, and reflects modest, occasionally considerable, abundance in light soils on the variable topography immediately south of the Gulf of St. Lawrence. Scattered indi-

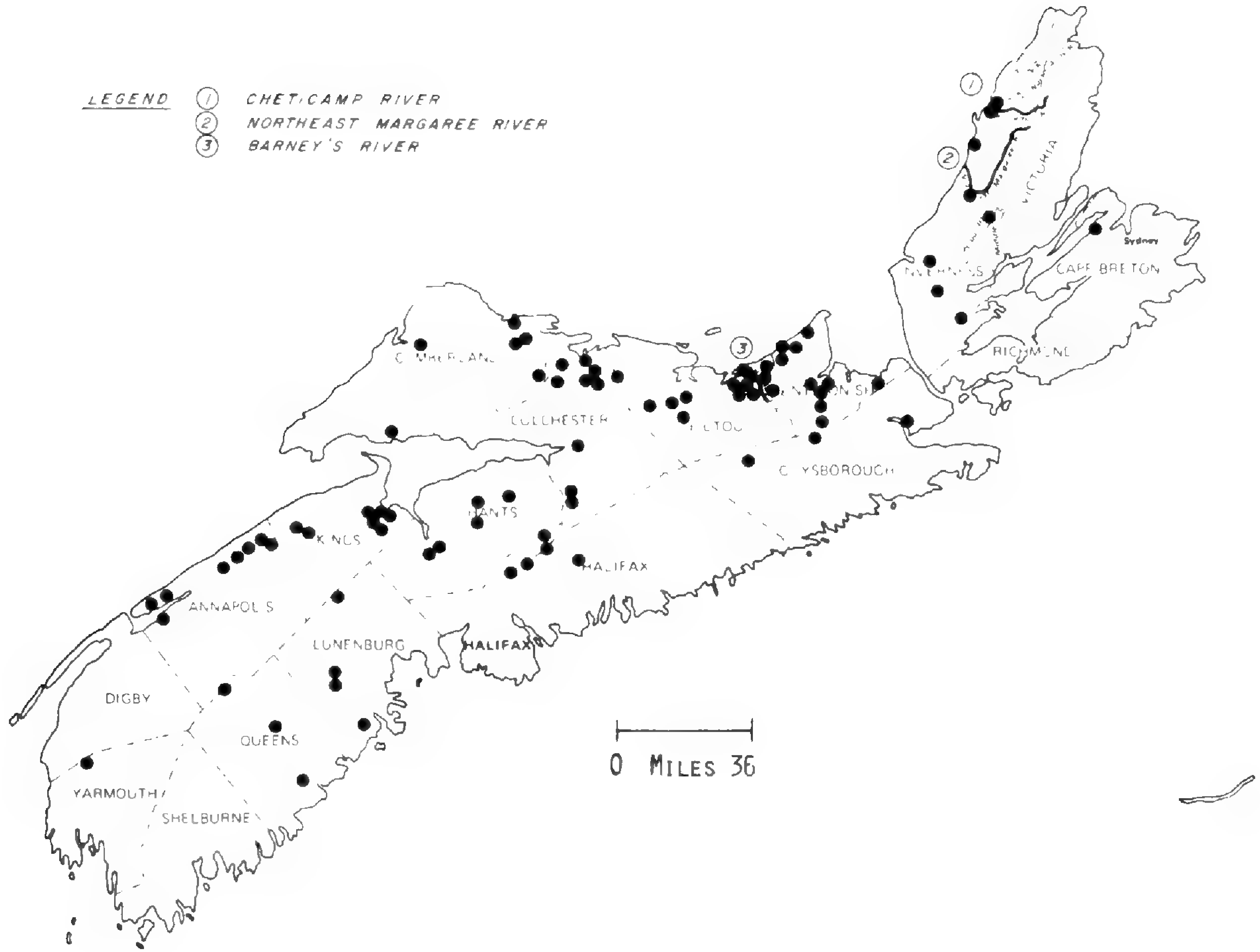

Figure 2. Distribution of *Ostrya virginiana* in Nova Scotia.

viduals or occasional small concentrations of the species occur on saddles and upland-surfaces to elevations of approximately 750 feet. The species also occurs on the flanks, axes and toes of spurs, on valley-side slopes of all exposures, on flood-plains, on outwash and alluvial-terraces, and on low, protected, off-shore islands in the lower Barney's River region of Pictou County.

The species is uncommon on lowland sites in the region marked by the presence of heavy, fine-textured soils.

To the northeastward, on the approaches to the limit of its range in Cape Breton Island (Figure 2), ironwood continues to demonstrate modest ecological amplitude. The species is scattered and infrequent in the topographically-varied, forested landscape of the lower Cheticamp River, occurring on flood-plains, alluvial-terraces, spurs, and saddles, and on east, southeast, south, southwest and west-facing slopes. South of the Cheticamp River, in the Margaree watershed, the species has been collected on forested alluvial-terraces and in meadow thickets.

DENSITY AND STAND RELATIONS. Ironwood generally constitutes a secondary species in contemporary forests of northern and northeastern Nova Scotia. The species is found very rarely in old-growth forests, infrequently in disturbed or deteriorating older stands, and more commonly in young, disturbed or undisturbed, hardwood and mixedwood forests. Density commonly is low, with somewhat higher levels of stocking evident in upland areas of northern Pictou and northernmost Antigonish Counties, and north-central Colchester County.

Occasionally, however, ironwood reflects considerable abundance over limited areas in northern Nova Scotia, and achieves locally the status of a primary species. Illustrations of this tendency toward greater densities are presented in Tables 1 and 2. These tables summarize results obtained from sample-plots established in northern Pictou County for the purpose of documenting high densities of stocking in ironwood and to indicate its ecological tolerance. Attention is invited to the occurrence and abundance of ironwood on the alluvial-terrace in association with relatively intolerant pioneer species, and to its considerable presence on the upland-surface in combination with long-lived, tolerant species.

MORPHOLOGICAL FEATURES. In the closed forests of northern Nova Scotia individual ironwood trees may reach diameters at breast

Table 1. Composition, density and basal area (BA) relations in a 0.1 acre plot established on an alluvial-terrace on the lower reaches of Barney's River, Pictou County, Nova Scotia.

Species	Ironwood		W. birch		W. ash		W. spruce		Grey birch		Service berry		T. aspen		Totals	
	No.	BA(ft.^{2})	No.	BA(ft.^{2})	No.	BA(ft.^{2})	No.	BA(ft.^{2})	No.	BA(ft.^{2})	No.	BA(ft.^{2})	No.	BA(ft.^{2})	No.	BA(ft.^{2})
DBH (in.)																
4	3	0.26	1	0.09	1	0.09	3	0.26	4	0.35	2	0.17	1	0.09	15	1.31
5	7	0.95	2	0.27			2	0.27							11	1.50
6	7	1.37	1	0.20	1	0.20									9	1.77
7	4	1.07			2	0.53									6	1.60
8					1	0.35									1	0.35
9	2	0.88	1	0.44											3	1.33
10																
11							2	1.32							2	1.32
12																
Totals	23	4.53	5	1.00	5	1.17	7	1.85	4	0.35	2	0.17	1	0.09	47	9.18
Percentages	49	49	11	11	11	13	15	20	9	4	4	2	2	1	–	–

Ironwood: *Ostrya virginiana*
White birch: *Betula papyrifera*
White ash: *Fraxinus americana*
Grey birch: *Betula populifolia*
Service berry: *Amelanchier* sp.
Trembling aspen: *Populus tremuloides*
White spruce: *Picea glauca*

Table 2. Composition, density and basal area (BA) relations in a 0.1 acre plot established on an upland-surface, Barney's River watershed, Pictou County, Nova Scotia.

Species	Ironwood No.	Ironwood BA($ft.^2$)	Sugar maple No.	Sugar maple BA($ft.^2$)	White ash No.	White ash BA($ft.^2$)	Beech No.	Beech BA($ft.^2$)	Totals No.	Totals BA($ft.^2$)
DBH (in.)										
4	3	0.26	9	0.79					12	1.05
5	6	0.82	4	0.55			2	0.27	12	1.64
6	8	1.57	5	0.98	5	0.98	2	0.39	20	3.92
7	5	1.34	5	1.34	1	0.27	1	0.27	12	3.22
8	1	0.35	1	0.35	7	2.44			9	3.14
9			1	0.44	3	1.33			4	1.77
10					1	0.55			1	0.55
11	1	0.66	1	0.66					2	1.32
12										
Totals	24	5.00	26	5.11	17	5.57	5	0.93	72	16.61
Percentages	33	30	36	31	24	34	7	6	–	–

Ironwood: *Ostrya virginiana*
Sugar maple: *Acer saccharum*
White ash: *Fraxinus americana*
Beech: *Fagus grandifolia*

height of 14 inches (36 cm) and heights of 55 feet (17 m). Poorly-formed, much-branched, damaged individuals of still greater diameter occasionally are encountered. Vigorous, co-dominant trees on good sites attain ages of approximately 95 years.

Tree-form in mature, forest-grown material ranges from moderately good to poor. Lean and crook in varying amounts typify many stems, although a few trees develop clear, straight boles. Individual trees may be single or multi-stemmed, often with long, round-topped crowns of varying width. Growth-habit is excurrent at the outset, commonly with numerous laterals, subsequently becoming deliquescent, but with considerable variation in branching relations from tree to tree. Branches range in size from slender to stout and in orientation from ascending to orthogonal, with the lowermost branches living or dead. Epicormic branching is very common.

ASSOCIATE SPECIES. On flood-plains, alluvial-terraces and foot-slopes ironwood occurs in association with conifers such as *Abies balsamea, Tsuga canadensis* and *Picea glauca.* Common dicotyledonous associates of ironwood in valley-bottoms and coves include *Betula papyrifera, Betula lutea, Fagus grandifolia, Ulmus americana, Acer saccharum, Acer rubrum, Acer pensylvanicum* and *Fraxinus americana. Populus balsamifera* and *Quercus rubra* var. *borealis* are infrequent bottom-land associates of ironwood.

On mid-slopes and crest-slopes the complex of species associated with ironwood is very similar to that characteristic of bottom-lands. Two minor variations involve *Ulmus americana,* which is very uncommon on valley sides, and *Picea rubens,* somewhat uncommon on bottom-lands but found more frequently with ironwood on both mid-slopes and crest-slopes. A major variant, noted only once, involves the occurrence of ironwood with *Pinus strobus* in combination with *Quercus rubra* var. *borealis* and *Tsuga canadensis* on an open, south-facing crest-slope in northeast Pictou County.

Ironwood occasionally forms local concentrations on mainland upland-surfaces at elevations below approximately 800 ft. Under these circumstances the associated species commonly are few in number and include *Fagus grandifolia, Acer saccharum* and *Fraxinus americana.* More commonly ironwood occurs as a scattered tree on mainland upland sites, in varying mixtures with *Picea glauca, Picea rubens, Tsuga canadensis, Abies balsamea, Betula lutea, Betula papyrifera, Fagus grandifolia, Fraxinus americana, Acer saccharum, Acer rubrum* and *Acer pensylvanicum.*

CROWN-CLASS AND REPRODUCTIVE RELATIONS. Ironwood occurs both as a canopy and as an understory element in the closed forests of northern Nova Scotia. In old-growth and older second-growth stands the species is rare, but has been noted in openings as well as in stands reflecting disturbance or deterioration. Under the latter circumstances the crown-class of individual ironwood stems ranges from suppressed to intermediate or isolated. In second-growth stands ironwood may be present in the canopy as co-dominant and intermediate crown-class trees, and below the canopy as suppressed, i.e. overtopped trees.

Ironwood reproduction was noted in 59 percent of the observing stations established in this study, the species occurring either in advance-growth or seedling stages, and often in both phases.

DISCUSSION

Ironwood, although apparently absent from Newfoundland (Rouleau, 1956, 1978) and Prince Edward Island (Scoggan, 1978), is widely distributed in northeastern Nova Scotia. Density commonly is low, the species occurring usually as scattered, single or multi-stemmed trees. Infrequently, considerably higher than normal densities of ironwood may be observed in north-central Nova Scotia, the species then constituting a primary element over small areas in young, second-growth, mixedwood and hardwood forests in this region.

A feature of the distribution and ecology of ironwood in the closed forests of northern Nova Scotia is its occurrence over a broad spectrum of sites in association with a large number of broad-leaved and coniferous elements. The species occurs both in the overstory and understory of young, second-growth forests in the region, and demonstrates the capacity for establishment and development under both continuous and discontinuous canopies. This distribution-occurrence-behaviour pattern is indicative of a tolerant species of substantial ecological amplitude characterized by considerable vitality.

In partially-forested areas of the region, ironwood frequently becomes established on disturbed sites. The species may be found in young, developing forests, and in thickets, hedge-rows and similar vegetation types. This capacity for establishment and continued development on disturbed sites suggests an aggressive, vigorous species adapted to a wide range of environments. The near absence of ironwood from closed, old-growth forests may be a reflection of a modest life-span, whereas its presence in decadent or disturbed older stands suggests the capacity to invade and develop in gaps and openings.

The species appears to be in a sound condition throughout its area of occurrence in northern Nova Scotia. Flowering and fruiting materials have been observed and collected at numerous stations in the region, including several on the lower Cheticamp River watershed where the species appears to approach the northeastern limit of its range. Regeneration in both seedling and advance-growth phases is common in northern Nova Scotia; mature trees attain heights and diameters approaching those reached by individual stems in the northeastern United States (Gleason, 1952; Hough, 1907; Hui-lin Li, 1972).

ACKNOWLEDGMENTS

The author gratefully acknowledges the financial aid and logistic assistance provided by J. L. Martin and A. A. Wilson of the Nova Scotia Museum in support of the field work on which this paper is based.

My grateful thanks are extended also to W. H. Drury, D. A. Livingstone and I. C. M. Place who read an earlier version of the manuscript, and made helpful and useful suggestions for its improvement.

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ANNOTATED LIST OF MINNESOTA CARICES, WITH PHYTOGEOGRAPHICAL AND ECOLOGICAL NOTES

Gerald A. Wheeler and Gerald B. Ownbey

ABSTRACT

One hundred forty-two species of *Carex* are recorded for Minnesota, 4 of which have not been previously reported. Because four floristic provinces converge in Minnesota, certain groups of carices tend to be associated with specific geographic areas of the state. A map is presented that divides Minnesota into 9 areas of *Carex* affiliation, each of which is briefly discussed. Our carices also display other, more subtle and local, distributional patterns, and we demonstrate, through various examples, that many carices are greatly affected by the nature of the substrate in which they grow. Habitat descriptions for the 142 species are given in an annotated list, and for some carices additional taxonomic, phytogeographical and ecological comments are made. Distribution maps are presented, and for the 4 carices new to the state, representative collections are noted. Doubtful and excluded taxa are indicated and discussed.

Key Words: *Carex*, carices, sedges, Minnesota, floristic provinces, floristics, phytogeography, autecology

Since the late 1940's, the Moore and Tryon (1946) checklist of Minnesota plants has probably been the primary source of information used to ascertain what carices occur in the state. Because their *Carex* list is now greatly outdated and unfortunately contains some erroneous reports, we feel it highly desirable to provide an up-to-date account of the Minnesota *Carex* flora, an updating that should prove helpful to the numerous students of this genus both in Minnesota and in surrounding areas. We also comment here on the phytogeographical and ecological status of the genus in the state. Four carices previously unknown from Minnesota, *C. annectens, C. conjuncta, C. festucacea,* and *C. laxiculmis,* are reported for the first time. Further, we suggest here that some carices reported for the state by Mackenzie (1931–1935) and later workers should be excluded.

NUMBERS OF SPECIES

Prior to Mackenzie's monograph of North American *Carex,* well over 100 species of the genus had been reported from Minnesota (Lapham, 1875; Upham, 1884, 1887; Arthur *et al.,* 1887; Bailey, 1892; MacMillan, 1892; Cheney, 1893; Sheldon, 1894, 1895, 1896; Holzinger, 1896; Wheeler, 1900, 1901; Rosendahl, 1903). Mackenzie recognized 116 species of *Carex* native to the state and deleted several previously reported taxa. Carices reported for Minnesota since Mackenzie's monumental work are given in Table 1.

Presently, 142 species of *Carex* are known to occur in Minnesota, and clearly they form the largest genus of vascular plants in the state. Except for *C. lurida,* one or more specimens of each of the species reported here are in the University of Minnesota Herbarium (MIN). A specimen of *C. lurida* (*Sheldon, s.n.,* Milaca, Mille Lacs Co., July, 1892) is at the New York Botanical Garden (NY).

FLORISTICS

Gleason and Cronquist (1964) mapped three major floristic provinces (Grassland, Northern Conifer, Eastern Deciduous) as coming together within Minnesota. In Wisconsin, the Eastern Deciduous Province has been divided into the Northern Hardwoods Province to the north and the Prairie-Forest Province to the southwest (Curtis, 1959), and the boundary between the two, which Curtis (1959) refers to as the tension zone, meets the Minnesota border in northern Washington, Chisago, and southern Pine counties (Minnesota counties are shown in Figure 1). The geographical extension of this boundary zone across Minnesota is presently under study (Wheeler, G. A., E. J. Cushing, E. Gorham, G. B. Ownbey and T. Morley, in preparation). The approximate areas covered by the four floristic provinces in Minnesota are shown in Figure 2: Grassland in the west; Northern Conifer in the far north-central and northeastern portions; Northern Hardwoods in the north-central and east-central parts; and Prairie-Forest in central and southeastern Minnesota.

The diversity of floristic types in Minnesota is reflected in the large number of *Carex* species occurring in the state, especially when compared to the 68 species reported for North Dakota (McGregor *et al.,* 1977; Wheeler, 1983a), 74 for South Dakota (Van Bruggen, 1976), 106 for Iowa (Gilly, 1946; Hartley, 1966; McGregor *et al.,* 1977), and 124 for Manitoba (Scoggan, 1957). Some states and provinces in proximity to Minnesota, however, particularly those to the east, such as Michigan (Voss, 1972b) and Ontario (Scoggan, 1978), have appreciably larger *Carex* floras than ours.

Table 1. *Carex* Species Reported for Minnesota Since Mackenzie's (1931–1935) Monograph of North American Carices[1]

C. deflexa (Lakela, 1941)
C. debilis (Lemon, 1943)
C. crawei (Lakela, 1944)
C. angustior (Moore and Tryon, 1946)
C. capillaris (Moore and Tryon, 1946)
C. cephalantha (Moore and Tryon, 1946)
C. eleocharis (Moore and Tryon, 1946)
C. formosa (Moore and Tryon, 1946)
C. merritt-fernaldii (Moore and Tryon, 1946)
C. molesta (Moore and Tryon, 1946)
C. oligosperma (Moore and Tryon, 1946)
C. xerantica (Fernald, 1950)
C. filifolia (Moore, 1950)
C. obtusata (Moore, 1950)
C. katahdinensis (Lakela, 1952)
C. michauxiana (Butters and Abbe, 1953)
C. praticola (Butters and Abbe, 1953)
C. pallescens (Lakela, 1954)
C. woodii (Hartley, 1966)
C. hallii (McGregor *et al.*, 1977)
C. scirpiformis (McGregor *et al.*, 1977)
C. grayi (Wheeler, 1979)
C. typhina (Wheeler, 1979)
C. bromoides (Wheeler, 1981b)
C. gynandra (Wheeler, 1981b)
C. hitchcockiana (Wheeler, 1981b)
C. oligocarpa (Wheeler, 1981b)
C. garberi (Wheeler, 1983b)
C. annectens (this report)
C. conjuncta (this report)
C. festucacea (this report)
C. laxiculmis (this report)

[1]Only reports substantiated by annotated herbarium specimens are given here.

Because the four floristic provinces mentioned above converge in Minnesota, certain groups of carices tend to be associated with specific geographic areas of the state. Indeed, based on the distribution maps presented near the end of this report, the state can be divided into 9 areas of *Carex* affiliation (Figure 3). Each area is delimited by the presence of certain species restricted to it, or by the fact that widespread-occurring species are absent from it, or by both of these criteria. Some of these areas correspond closely to

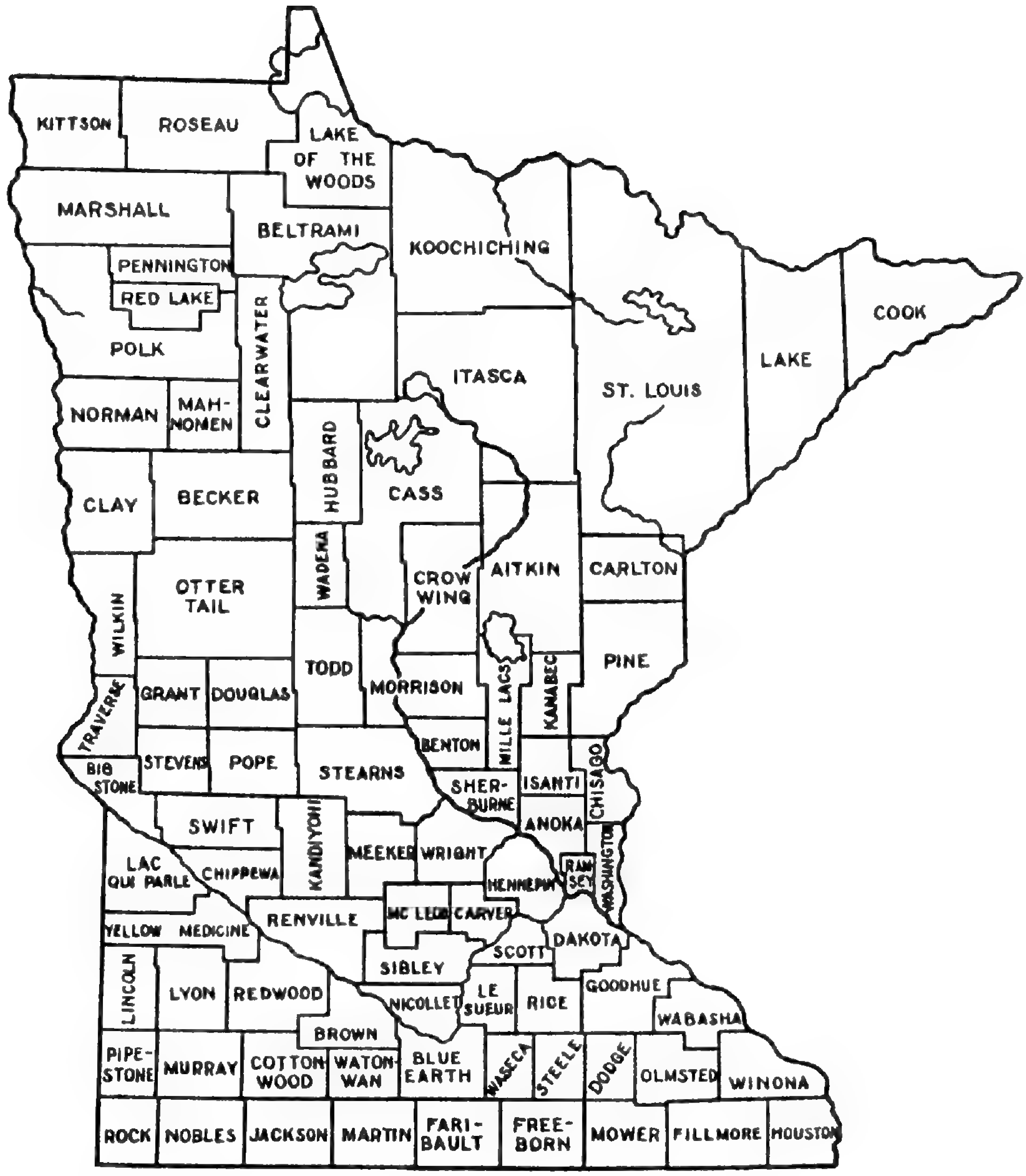


Figure 1. Counties of Minnesota.

landscape regions already defined for the state (Yaeger and Borchert, 1971; Wright, 1972).

Areas 1, 2, and 3 (Figure 3) harbor *Carex* taxa primarily associated with the Northern Conifer (e.g. *C. canescens, C. limosa,* and *C. pauciflora*) and Northern Hardwoods (e.g. *C. arctata, C. leptonervia,* and *C. ormostachya*) floristic provinces; areas 5, 6 and 7 harbor taxa primarily of the Prairie-Forest Province (e.g. *C.*

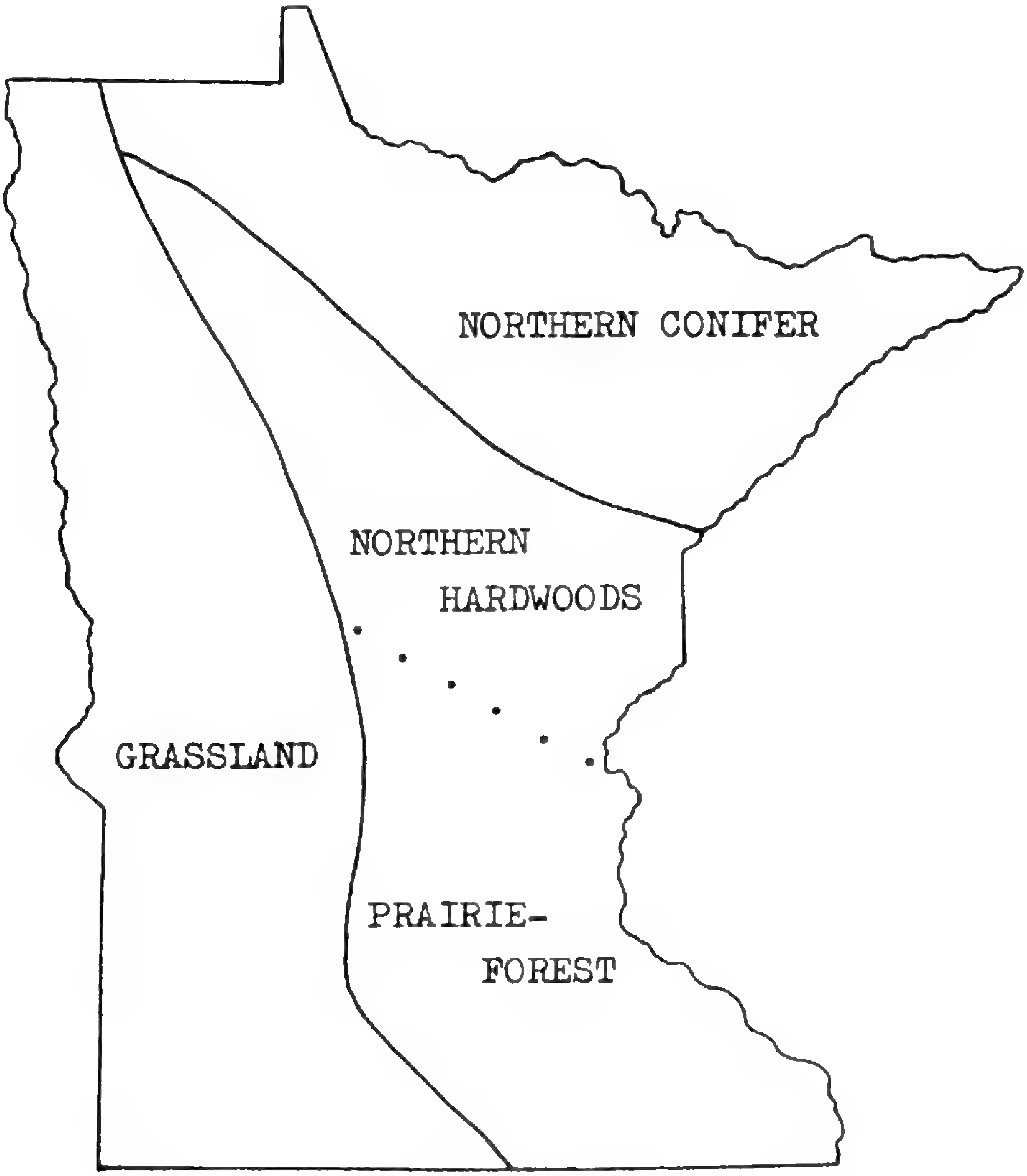


Figure 2. Floristic provinces in Minnesota, after Gleason and Cronquist (1964) and Cushing (1965). Dotted line shows approximate position of the floristic boundary that separates the Northern Hardwoods and Prairie-Forest floristic provinces in Minnesota (Cushing, 1965).

albursina, C. cephaloidea, and *C. sparganioides*); and areas 8 and 9 harbor taxa primarily of the Grassland Province (e.g. *C. eleocharis, C. hallii,* and *C. praegracilis*). Area 4 is characterized by an intermingling of carices from these four floristic provinces. The eastern extremity of area 4 corresponds closely to where the tension zone of Wisconsin (Curtis, 1959) meets the Minnesota border.

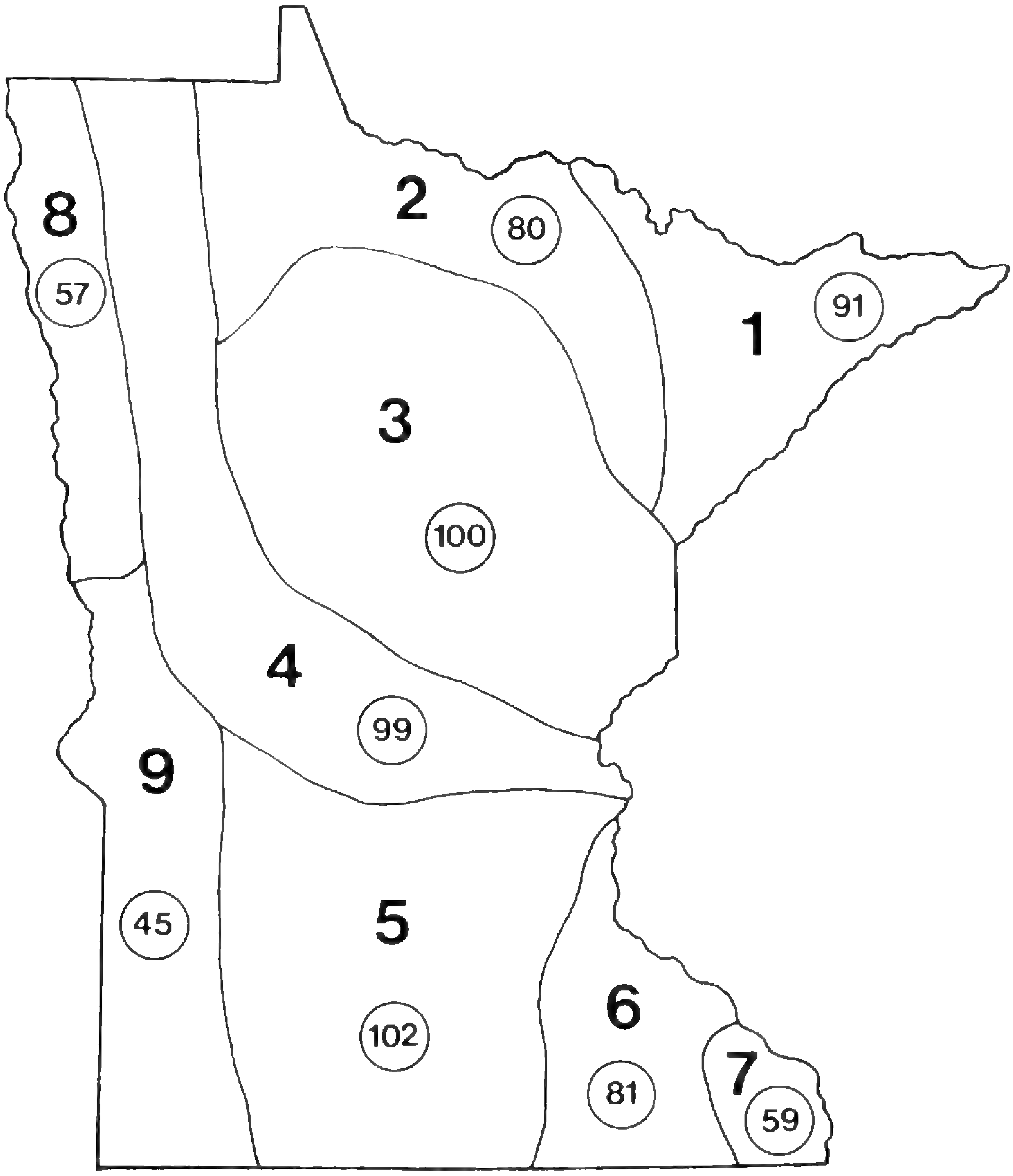


Figure 3. Areas of *Carex* affiliation in Minnesota. The number of carices known to occur within each area is circled.

Although the Northern Conifer and Northern Hardwoods floristic provinces are shown in Figure 2 as occupying geographically separate areas in the northern portion of Minnesota, it is clear that the vegetation of the region, or even a small part of it, cannot be characterized by a single species or group of only coniferous or deciduous species (Cushing, 1965). Instead, one finds here deciduous, pine, and boreal forest elements intermingling to create a mosaic of forest types. In consequence, many *Carex* species of northern affinity have state distributions that are relatively similar, even though particular sets of species grow in clearly dissimilar habitats (Wheeler, 1983b). For instance, the distributions of *C. arctata, C. deflexa,* and *C. aenea* are somewhat similar, but the species frequent different habitats, namely deciduous, boreal, and pine forests, respectively. Owing to this intermingling of different forest types, much of northern Minnesota has been mapped (Küchler, 1964; Cushing, 1965) as mixed conifer-hardwood forest.

Area 1, which approximates the Ice Scoured North Shore region of Yaeger and Borchert (1971), is a land of lakes surrounded by high bluffs, deep gorges cut by swiftly moving streams, and rocky cliffs and shores that border on Lake Superior. This area is notorious for harboring plants of discontinuous range, particularly arctic-alpine species (Butters and Abbe, 1953; Given and Soper, 1981). Of the *Carex* species restricted (or nearly so) to area 1, some, such as *C. supina* and *C. xerantica,* are essentially confined to cliff-talus and bluff-tops bordering lakes near the Minnesota-Ontario border. *C. praticola* is also best known from bluff-tops in the Border Lakes region, but it also occurs, albeit rarely, on rocky sites farther southward. Three other carices with very restricted distributions in area 1 are *C. katahdinensis, C. michauxiana,* and *C. pallescens*; the first is known only from rocky shores of Iron Lake (St. Louis County), the second from swampy verges near Schroeder (Cook County), and the last from moist sites on the Lake Superior terrace near Duluth (St. Louis County). Of the remaining carices restricted to area 1, all of which occur more frequently than those just discussed, *C. lenticularis* and *C. media* are best known from the shores of Lake Superior, and *C. flava* and *C. gynandra* from springy sites and the marshy borders of streams and "bogs" just inland from the lake.

Issued as a caveat in a previous publication (Wheeler *et al.,* 1983), throughout this paper we use bog (the unadorned word) in the sense of true ombrotrophic conditions; we use "bog" (in quotes) in the sense of *Sphagnum*-dominated areas that typically have fen characteristics (e.g. peatland-surrounded kettle-hole lakes). Indeed, in Minnesota most kettle-hole "bogs" are actually poor fens and tamarack "bogs" (better termed swamps) often approach rich-fen conditions (Wheeler *et al.,* 1983). Only in the upland peatland areas in the far northern portion of the state are true ombrotrophic bogs encountered, such as in the large mire complex situated just north of Upper Red Lake.

Area 2, which is somewhat larger than the Big Bog region of Yaeger and Borchert (1971), is primarily an area of gentle slope and poor drainage that contains many upland peatlands. One of these, the Red Lake Peatland (Heinselman, 1963, 1970; Griffin, 1975, 1977; Wheeler and Glaser, 1979, 1982; Glaser *et al.*, 1981; Wheeler *et al.*, 1983), is the largest continuous mire in the contiguous United States. Many circumpolar species of *Carex* (Hultén, 1962), such as *C. canescens, C. chordorrhiza, C. diandra, C. disperma, C. lasiocarpa, C. limosa, C. pauciflora, C. paupercula, C. tenuiflora,* and *C. vaginata,* are widely distributed in northern Minnesota and several of them are most common and abundant in area 2. The latter is certainly true for the North American endemics *C. oligosperma* and *C. trisperma,* both of which commonly occur, and are sometimes dominants, in upland peatland.

Carices with restricted distributions in north-central Minnesota include *C. capillaris, C. exilis, C. garberi,* and *C. livida.* Of these, *C. exilis* and *C. livida* are primarily confined to scattered localities in areas 1 and 2, where they both frequent poor- and rich-fen sites in patterned peatlands (Glaser, 1983; Wheeler, 1983b). Of more restricted distribution, *C. capillaris* occurs only in the western portion of area 2 and small parts of 3 and 4, and *C. garberi* is known only from a single station in St. Louis County. Finally, some northern carices, such as *C. arcta* and *C. crinita,* are widely distributed in areas 1, 3, and 4 but are uncommon or unknown in area 2.

Areas 3, 4, and 5 harbor the greatest number of *Carex* species in the state (Figure 3), with area 4, as mentioned earlier, representing a transition zone. Nevertheless, several carices of northern affinity are known from isolated stations south of area 4, and some species of southern affinity north of it. Likewise, some western species, such as *C. torreyi,* occur at isolated stations east of this transition area. Carices known to be restricted (or nearly so) to one or more of these areas include *C. bromoides, C. debilis, C. festucacea, C. formosa, C. lurida,* and *C. rossii.* The four last-named species are known only from a few stations in Minnesota, and they seldom occur in abundance. *C. bromoides* and *C. debilis,* on the other hand, while being more or less restricted to the extreme east-central portion of the state, are both known from several localities and sometimes occur in great abundance. Indeed, *C. bromoides* often provides the major ground cover in low, swampy woodlands adjacent to rivers.

Wheeler (1981b) reported *C. bromoides* as extending no farther west in Minnesota than wooded lowlands bordering the Kettle River, but the authors have recently discovered several stations for this species along the Snake River (southern Aitkin and northern Kanabec counties), some 20 miles farther westward. Another *Carex* species growing in central Minnesota, *C. sterilis,* until recently had been known from very few localities in the state, but in the last few years several spring-fed, calcareous fens have been discovered in areas 4, 5, and 8 that harbor this apparent calciphile.

The Minnesota River, which flows primarily through the central portions of areas 5 and 9, presently occupies a small part of the huge valley cut out by the ancient River Warren. The river is bordered by bluffs that are not as imposing as those in extreme southeastern Minnesota, but these bluffs do harbor many plants that are uncommon or unknown elsewhere in these areas. *Carex hitchcockiana* and *C. oligocarpa* are best known in the state from these bluffs and, indeed, the latter provide the habitats for the northwesternmost stations for each of these species in North America (Wheeler, 1981b). Another sedge of frequent occurrence on these bluffs, particularly westward, is *C. saximontana.* Although this species is reported by various workers (Mackenzie, 1931–1935; Fernald, 1950; Gleason and Cronquist, 1963) as restricted in the state to "western Minnesota", it does, in fact, extend as far eastward with us as Ramsey County, with the majority of the eastern stations situated on the bluffs of the Minnesota River.

Extreme southeastern Minnesota, the Stream Dissected region of Yaeger and Borchert (1971), is botanically as well as geologically one of the most interesting parts of the state. Area 7 is part of the celebrated Driftless Area (Hartley, 1966) and, like the remaining parts (in southwestern Wisconsin, northeastern Iowa, and northwestern Illinois), has very irregular topography resulting from the action of various natural processes, particularly stream erosion. Like the remainder of the Driftless Area, area 7 is notorious for harboring plants of limited or discontinuous range, such as *Montia chamissoi* (Portulacaceae), *Sullivantia renifolia* (Saxifragaceae), and *Talinum rugospermum* (Portulacaceae).

Several species of *Carex* occurring in southeastern Minnesota are unknown from elsewhere in the state, and include *C. annectens* (area 6), *C. conjuncta* (area 6), *C. crus-corvi* (area 6), *C. laevivaginata* (area 7), and *C. laxiculmis* (area 7). Furthermore, *C.*

davisii, C. grayi, C. muskingumensis, and *C. typhina* are primarily confined to the southeast, where they are characteristic species in floodplain forests, particularly those bordering the Mississippi River. Indeed, with the exception of *C. typhina,* which occurs at a few localities along the St. Croix River in Washington and southern Chisago counties, these species rarely occur north of Goodhue County (Wheeler, 1979). Finally, many *Carex* species occurring in area 5 and in areas farther north do not extend as far southeastward as area 6, and fewer yet extend into area 7 (Figure 3).

It is obvious from Figure 3 that fewer species of *Carex* occur in western Minnesota (areas 8 and 9) than in the eastern portion of the state. Although the genus is clearly less well represented in prairie than in forest, fen, or "bog", individual species, such as *C. brevior* and *C. eleocharis* in dry sites and *C. atherodes* and *C. praegracilis* in wet sites, are sometimes widespread and abundant in undisturbed prairie. Indeed, *C. eleocharis* sometimes forms, along with various grasses, the major ground cover on hillsides and slopes, and *C. atherodes* is often the dominant species in prairie swales. In Minnesota, as well as elsewhere (Hudson, 1977), *C. atherodes* appears to tolerate the drying up of prairie swales, unlike *C. lacustris, C. rostrata,* and *C. aquatilis,* which seem to need more or less persistently wet conditions. Therefore, only at very favored locations within the prairie region of Minnesota are the last three species able to attain dominance. Some prairie carices, including *C. hallii, C. scirpiformis, C. filifolia,* and *C. obtusata,* have very restricted distributions in the western half of the state, and they seldom occur in any great abundance. The first two species seem to be restricted to prairie swales, particularly to the moist outer margins, and the last two taxa grow primarily in dry, sandy sites, such as in sand barrens. A paper discussing all 9 areas in more detail is being prepared.

Although a particular *Carex* species may be common in one region of Minnesota, it may also occur, as indicated above, at isolated stations in other parts of the state. For instance, several carices that have their major occurrence in *Sphagnum*-dominated areas in northern Minnesota, such as *C. canescens, C. leptalea,* and *C. paupercula,* also occur in tamarack "bogs" scattered throughout the central and, less commonly, the southern portions of the state. Furthermore, some calcareous fens in southern and western Minnesota harbor some carices of northern affinity, such as *C. aquatilis, C. lasiocarpa,* and *C. limosa.*

While many species of *Carex* are geographically restricted in the state, others are more widely distributed. A number of the latter, such as *C. hystericina, C. lanuginosa, C. stipata, C. stricta,* and *C. vulpinoidea,* are aquatic plants (Fassett, 1957) that grow along shores and in adjacent wet meadows of the numerous lakes scattered throughout Minnesota. Some woodland species, such as *c. peckii, C. pedunculata, C. pensylvanica,* and *C. rosea,* are also widely distributed. And some carices that grow along the banks of rivers often have wide distributions in the state. However, some riverine carices, such as *c. alopecoidea, C. cristatella,* and *C. emoryi,* are essentially absent from extreme northeastern Minnesota, an area where prolonged level riparian tracts with well-developed meander scrolls and floodplains are mostly lacking because the rivers flow swiftly from the upland down a steep gradient to Lake Superior (Wheeler, 1983b).

As in the above case, the distributions of other sedges in the state are restricted by the lack of suitable habitats. For example, several carices, including *C. atherodes, C. interior, C. praegracilis, C. prairea, C. sartwellii,* and *C. tetanica,* all of which grow primarily in prairie swales and marshlands, have state distributions that approximate that of the calcareous drift deposited by the Mankato Substage of the Wisconsin Stage of glaciation. It appears that a lack of low, wet, strongly calcareous habitats in southeastern Minnesota results in the exclusion (or near exclusion) of these species from this part of the state, an area not invaded by the Des Moines Lobe of the Mankato Substage. Several other vascular species that frequent wet calcareous sites, such as *Juncus balticus* (Juncaceae), *Rumex maritimus* (Polygonaceae), *Iris versicolor* (Iridaceae), and *Habenaria hyperborea* (Orchidaceae), are also essentially absent from the southeast. In Figure 3, this demarcation is illustrated by the line that separates area 5 (covered with Des Moines calcareous drift) and area 6 (not covered with Des Moines calcareous drift).

Because four floristic provinces converge in Minnesota, many species of *Carex* reach the limits of their ranges in the state (Wheeler, 1981a). Some of these carices, such as *C. brunnescens* (Northern Conifer Province), *C. leptonervia* (Northern Hardwoods Province), *C. hirtifolia* (Prairie-Forest Province), and *C. filifolia* (Grassland Province), display more or less continuous ranges as they approach and enter Minnesota. Other carices, however, are represented by only a few local populations in the Midwest. As an example of the latter, *C. exilis* is primarily a plant of the Atlantic coastal plain that has only limited local populations west of New York (Reznicek and Ball, 1980). In Minnesota, it is known only from a few patterned peatlands in the northeastern and north-central portions of the state (Glaser, 1983; Wheeler, 1983b), with the Red Lake Peatland harboring the westernmost stations in North America (Wheeler and Glaser, 1979; Wheeler *et al.,* 1983).

Lastly, a few *Carex* taxa, such as *C. supina,* represented in the state by disjunct populations, may be relicts. However, their migration to favorable habitats after glaciation cannot be ruled out. The relict hypothesis is generally favored to explain the wide discontinuities in range of arctic-alpine taxa in the Lake Superior region (Butters and Abbe, 1953; Soper and Maycock, 1963; Given and Soper, 1981) and is supported by some palynological data (Cushing, 1965). The nunatak hypothesis of Fernald (1935) is no longer considered tenable (Cushing, 1965). Probable *Carex* relicts occurring in Minnesota are indicated and discussed in the listing of species given near the end of this report.

Besides the distributions discernible for Minnesota *Carex* species resulting from the convergence of the four floristic provinces within the state, our carices display still other more subtle and local distributional patterns. Many carices are greatly affected by the nature of the water in which they grow (Wheeler *et al.,* 1983), which in turn is influenced by the physical nature of the water source. That some peatland *Carex* species are profoundly acidophilous or basiphilous is well known (e.g. Sjörs, 1961, 1963), and this fact has been demonstrated for some carices occurring in kettle-hole "bogs" and upland peatland areas in northern Minnesota (Glaser *et al.,* 1981; Wheeler *et al.,* 1983).

Carex species primarily confined to *Sphagnum*-dominated areas in Minnesota have state distributions that are somewhat similar, but some differences are apparent. For example, *C. oligosperma* and *C. pauciflora* are occasional to common in peatlands and "bogs" throughout the northeastern, north-central, and east-central portions of the state, but they are essentially absent from such habitats in the central, west-central, and northwestern parts of Minnesota. In contrast, many other "bog-loving" carices, such as *C. lasiocarpa, C. leptalea,* and *C. limosa,* are present in these habitats throughout the entire northern half of the state and, as indicated earlier, some of them extend even farther southward and westward, growing in fens and tamarack swamps. Significantly, other vascular "bog-loving" species display similar distributional patterns: *Eriophorum spissum* (Cyperaceae), *E. virginicum*, and *Kalmia polifolia* (Ericaceae) have distributions in the state similar to those of *C. oligosperma* and *C. pauciflora*, whereas many other species, such as *Betula pumila* (Betulaceae), *Equisetum fluviatile* (Equisetaceae), and *Menyanthes trifoliata* (Gentianaceae), have state distributions similar to *C. lasiocarpa*, *C. leptalea*, and *C. limosa*. Because some oligotrophic species, particularly obligate oligotrophs, are probably unable to achieve ecesis in highly nutrient-rich conditions, the moderately to highly minerotrophic nature of the fens and "bogs" in western and southern Minnesota may well impede the growth of such species. Indeed, *C. oligosperma* and *C. pauciflora*, as well as the other three vascular plants mentioned above with restricted distributions in Minnesota, are essentially confined to oligotrophic sites in the Red Lake Peatland (Wheeler *et al.*, 1983), and they are more or less restricted to kettle-hole "bogs" in the state that are "acidic" (pH usually less than 6.5).

In the Red Lake Peatland, which is situated just north of Upper Red Lake in north-central Minnesota, *Carex* species account for approximately 15% of the vascular flora (Wheeler *et al.*, 1983). In this mire, ombrotrophic bogs, areas of weak minerotrophy (poor fens), and patterned rich fens can be distinguished on the basis of acidity and other chemical properties of the peat and surface-waters and by species richness. Only four *Carex* species (*C. oligosperma*, *C. pauciflora*, *C. paupercula*, and *C. trisperma*) are known from ombrotrophic sites in the mire, whereas twenty-nine carices frequent minerotrophic sites. Some species, such as *C. chordorrhiza* and *C. livida*, are excellent indicators of minerotrophy, inasmuch as they separate areas of weak minerotrophy from true ombrotrophic sites. Still other species, such as *C. leptalea* and *C. pseudocyperus*, are obligate rich-fen indicators. However, in the Red Lake Peatland, as in other mires (e.g. Malmer, 1962; Sjörs, 1963), there are no vascular taxa, including *Carex*, that are indicators of ombrotrophy.

In upland peatlands, variations in environmental parameters such as in water chemistry, hydrology and shading greatly influence whether a particular species will be present or absent from a particular site. Figures 4 and 5 illustrate for four *Carex* species common to the Red Lake Peatland the relationship between the principal components axes, which are based on variations in the frequency with which species occur, and environmental factors

(Brush, 1982). These figures show that whereas *C. oligosperma* displays a narrow range of tolerance for all environmental parameters considered, each of the other three species displays a relatively wide range of tolerance for one or more of these parameters. Although Figures 4 and 5 were constructed from data gathered from one mire complex, the results (for these four species) seem to hold in other upland peatlands investigated in the state.

Although *C. oligosperma* dominates large areas in the Red Lake Peatland, it is more or less restricted to open bogs and bog drains, and to meadow-like, open poor-fen areas where bog drains coalesce. In contrast, *C. lasiocarpa* grows over a wide range of pH and calcium values, and it is often the dominant species in wet, open rich-fen sites, such as flarks of patterned fens. With regard to the other two peatland species referred to in Figures 4 and 5, *C. trisperma* is restricted to wooded bogs, wooded poor-fen islands, and hummock-tops in the wooded rich-fen islands. *C. leptalea,* on the other hand, is an obligate rich-fen indicator that grows most abundantly on wooded rich-fen islands but also occurs in flarks and in partially-shaded depressions between string hummocks in patterned fens. A more detailed discussion of the distribution of *Carex* species along various environmental gradients in the Red Lake Peatland is given by Wheeler *et al.* (1983).

Another example of species of *Carex* being affected by differences in water chemistry can be demonstrated from kettle-hole "bogs". In east-central, north-central, and northeastern Minnesota, *Carex oligosperma* is almost invariably the most important species in the formation of pioneer mats surrounding "acid" kettle-hole lakes (actually most such lakes are weakly acid, with a pH usually less than 6.5), as well as being the dominant vascular plant in adjacent moss-heath zones. It is replaced by *C. lasiocarpa,* however, in kettle-hole "bogs" surrounding "alkaline" lakes (pH mostly greater than 6.5). Indeed, throughout these areas the two species seldom grow together on the same floating mats or in the same "bogs," but *C. lasiocarpa* sometimes frequents the nutrient-rich laggs of *C. oligosperma*-dominated peatlands. Some species of *Carex* are common to both types of *Sphagnum*-dominated peatlands, whereas others are restricted to one type or the other. Species commonly found on mats and "bogs" dominated by *C. oligosperma* are *C. pauciflora, C. paupercula, C. limosa, C. canescens,* and *C.*

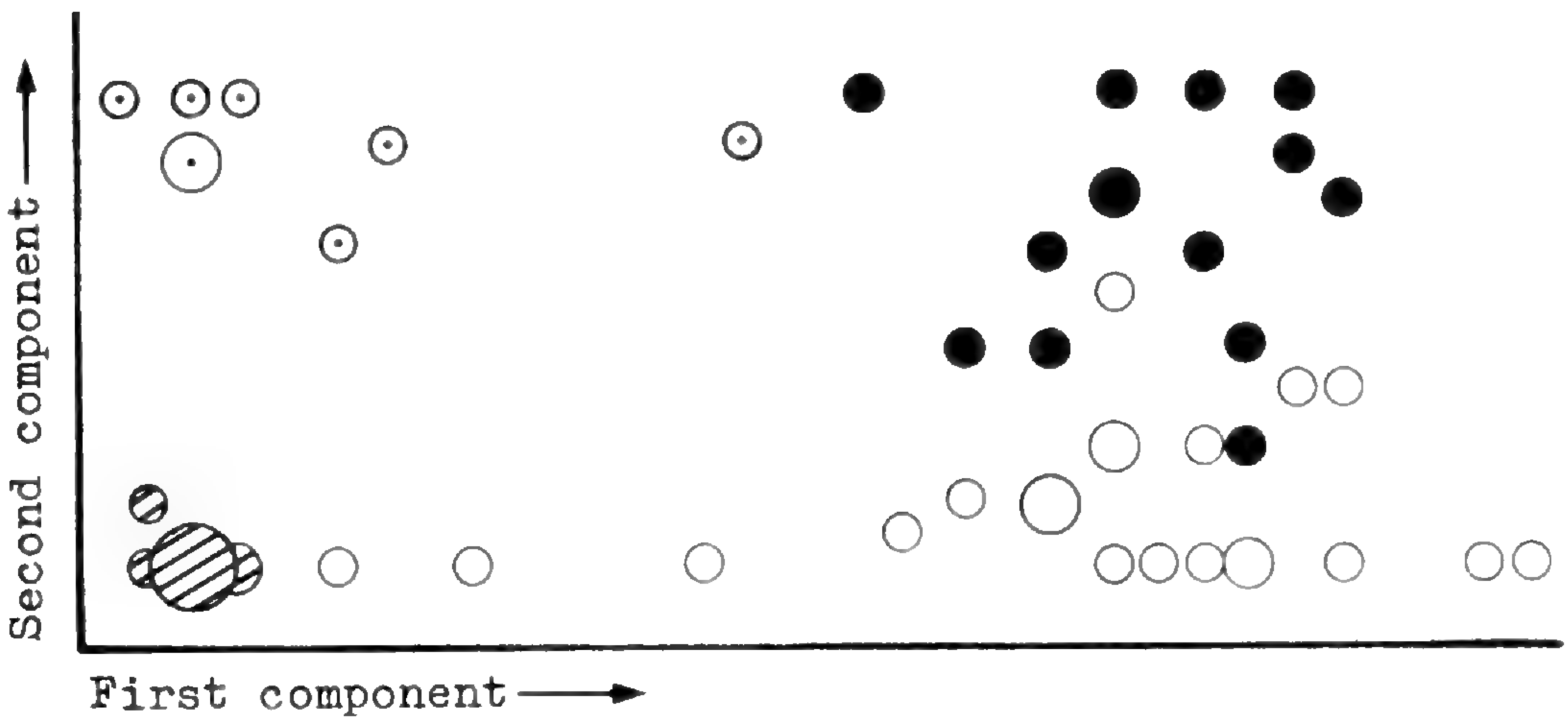


Figure 4. Local environmental interactions on distribution of 4 *Carex* species. The first component shows a distribution ranging from "acid" species at the left to "circumneutral" species at the right; pH values range from 3.8 to 7. The second component reflects tolerance to shading, with sciaphytes appearing on the top of the axis and heliophytes on the bottom. The sizes of the circles are proportional to the number of occurrences of a particular species in 45 relevés (Wheeler *et al.*, 1983); the largest circle represents 4 occurrences and the smallest circle a single occurrence. The circles with diagonal lines represent *C. oligosperma;* dotted circles *C. trisperma;* open circles *C. lasiocarpa;* and closed circles *C. leptalea.*

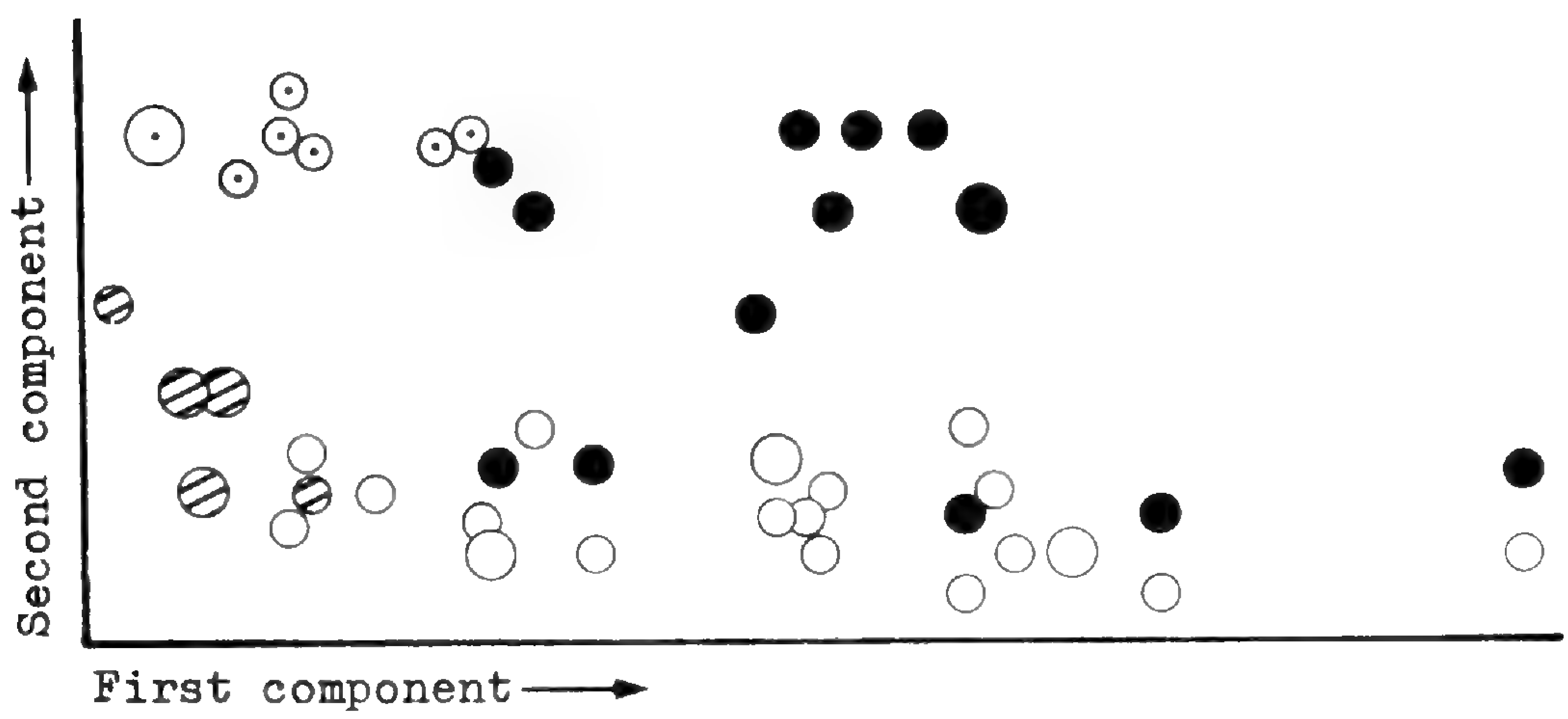


Figure 5. Local environmental interactions on 4 *Carex* species. The first component shows a distribution ranging from calciphobic species (left on the axis) to calciphilic species (right on the axis); calcium values range from 0.5 mg/l to 19.6 mg/l. The second component reflects tolerance to dry sites, with "dry" species appearing on the top of the axis and "wet" species on the bottom. See Figure 4 for explanation of symbols and circle sizes.

chordorrhiza; species occurring most often on mats and in "bogs" dominated by *C. lasiocarpa* are *C. aquatilis, C. diandra, C. limosa, C. canescens, C. chordorrhiza* and, more rarely, *C. paupercula.* Likewise, in northern Michigan (Vitt and Slack, 1975), the *Carex* species of peatlands surrounding acid kettle-hole lakes are mostly different from those in peatlands surrounding alkaline lakes.

Several instances are known from Minnesota where a particular terrestrial species of *Carex* is restricted to a specific soil type and is absent from others. For example, *C. backii* grows in sandy, acid soils whereas *C. albursina, C. hitchcockiana, C. laxiculmis,* and *C. oligocarpa* grow in calcareous sites. The four last-named species, all of which are confined to the southern half of the state, are well known from sugar maple-basswood forests that are situated on steep, north- and east-facing slopes characterized by rich loamy soils. These calciphiles or near-calciphiles (Mackenzie, 1931–1935; Hermann, 1940; Fernald, 1950; Wheeler, 1981b) are absent from neighboring dry hardwood forests and the more locally occurring woodlands dominated by white pine, both of which are developed on better-drained, more acid, sandy soils. In contrast, the acidophilous species *C. backii,* although best known from pine forests in northern Minnesota, is of occasional occurrence in the aforementioned white pine-dominated woodlands but is rare or absent from the neighboring, much more common, sugar maple-basswood forests. Other examples of distributional patterns exhibited by *Carex* species in Minnesota are given by Wheeler (1981a).

Quite often the same combination of carices grow in a particular habitat even though the localities are miles apart, and at least in some habitats, if not in most, certain species are associated with specific microhabitats. For example, in a recent study of 17 tamarack swamps in seven counties in west-central and northwestern Minnesota, of the 15 carices found growing in these swamps, 10 species (*C. aurea, C. paupercula, C. retrorsa, C. stipata, C. deweyana, C. disperma, C. hystericina, C. interior, C. leptalea,* and *C. pedunculata*) were present in at least 75% of the swamps investigated; and the 6 last-named species were present in over 85%. Of the remaining species, 4 of them, *C. brunnescens, C. gynocrates, C. rosea,* and *C. tenuiflora,* occurred in more than one swamp, and *C. vaginata* was limited to a single swamp in Mahnomen County. Furthermore, one or more *Carex* species, such as *C. atherodes, C. lacustris, C. stricta* or, less commonly, *C. lasiocarpa, C. prairea,* and

C. rostrata, invariably grow along the margins of these swamps and sometimes in the swamp interiors.

Within these tamarack swamps, *C. disperma, C. leptalea,* and *C. deweyana* are primarily associated with the sides and tops of hummocks, whereas *C. aurea, C. interior,* and *C. paupercula* generally grow in wet depressions between hummocks. *C. pedunculata* is mostly confined to the bases of trees and windthrow mounds, and *C. hystericina, C. retrorsa,* and *C. stipata* are most abundant and grow best in low, level areas. *C. lacustris* often dominates the outer edges of the swamps, sometimes growing in nearly pure stands, and is often a common constituent in the interiors, particularly in and around the margins of small pools and other wet depressions.

Some *Carex* species have clearly expanded their ranges within rather recent times through man's intervention. In Minnesota, probably the most obvious example is *C. praegracilis* which, although native in western and south-central Minnesota, is now adventive in the north-central, northeastern, and extreme east-central portions of the state, particularly along highway verges (Wheeler, 1983b). This species has, in fact, become adventive well eastward of its native range (Mackenzie, 1931–1935; Hermann, 1974; Reznicek *et al.,* 1976), presumably through dispersal of achenes and rhizomes along major highways and because of its apparent high resistance to extreme conditions of road verges, such as summer drought and high sodium levels owing to "de-icing" salt (Reznicek *et al.,* 1976).

Another example of area expansion of *Carex* species within the state can be demonstrated from the Red Lake Peatland. Although twenty-nine carices are known from this mire, nine of them are clearly restricted to disturbed sites. It is assumed that these species have only recently entered the mire, most likely following the construction of the major highway that transects the area and the several drainage ditches that penetrate into the peatland interior. Although these species are most likely recent arrivals, they presently form an integral part of the peatland flora and no doubt will continue to spread to future disturbed areas (Wheeler *et al.,* 1983).

Hybridization is known to occur in *Carex* (Wahl, 1940; Drury, 1956), and several hybrids and suggested hybrids have been reported from the eastern United States and Canada (Fernald, 1950; Scoggan, 1978). Although little is known about the hybridization of

Carex in Minnesota, observations in the field and some herbarium specimens suggest that crossing does take place between particular species in the state. Specimens have been seen from southeastern Minnesota (Houston and Winona counties) that appear to be hybrids of *C. tenera* and *C. normalis*. Hybridization between these two members of the *Ovales* group is not indicated by Fernald (1950) or Scoggan (1978), but it has been reported by Zimmerman (1976) as possibly occurring in Wisconsin.

Specimens which display characteristics intermediate between *Carex bebbii* and *C. cristatella* (both members of the *Ovales* group) are also known from the state; these specimens come from northern Minnesota (Lake of the Woods, Itasca, and St. Louis counties). Hybridization between *C. bebbii* and *C. cristatella* has been reported as possibly occurring in Michigan (Voss, 1972b), Wisconsin (Zimmerman, 1976), and Saskatchewan (Hudson, 1977), but it was not indicated by Fernald (1950) or Scoggan (1978).

A plant which closely resembles *Carex castanea*, but which is more glabrous, is known from widely scattered localities in the United States and Canada (Arthur *et al.*, 1887; Bill, 1930; Mackenzie, 1931–1935; Fernald, 1950; Scoggan, 1978), and it is considered by some workers (Fernald, 1950; Scoggan, 1978) to be a hybrid between *C. castanea* and *C. arctata* (both members of the *Sylvaticae* group). In Minnesota, this suspected hybrid (*C.* ×*knieskernii* Dew.) is known only from St. Louis County. Specimens of suspected hybrids have not been mapped for this study.

The species listed below are arranged alphabetically, and for the most part the treatment here follows that of Mackenzie (1931–1935), except where a departure has been forced (or at least suggested) by certain available evidence. Section or group (see Voss, 1966, 1972a, 1972b) relationships are indicated, and synonyms correlating this treatment with those in current manuals are noted. Although group names are without formal taxonomic standing, the group that includes the type species of the genus, *C. hirta*, is here called *Carex* in accord with the spirit of the Code of Nomenclature.

Data gathered from field observations and specimens contained in various herbaria (DUL, GH, IA, ISC, MANK, MICH, MIN, NDA, NY, SCL, US, UWL, WIS; abbreviations after Holmgren *et al.*, 1981) were used to develop habitat descriptions. The areas illustrated in Figure 3 are referred to when they are useful in characterizing distribution patterns and when reporting the frequency of occurrence of a species within a particular area.

On the distribution maps, which were prepared from the herbarium specimens examined, each solid circle represents a collection of known locality; an open circle represents a collection without specific location within a county.

Following the annotated list are remarks on some doubtful and excluded taxa.

ANNOTATED LIST OF MINNESOTA CARICES

C. abdita Bickn. *Montanae*

Cliffs and bluffs, rocky slopes and shores, rock outcrops and, more rarely, dry prairies; infrequent to occasional in the eastern half of the state, uncommon in the western half. Some authors (e.g. Gleason and Cronquist, 1963) combine *C. abdita, C. tonsa,* and *C. umbellata* under the epithet *umbellata,* but in Minnesota the first-named entity is well-marked and easily distinguished from the other two: beak of perigynium is short and the tips of the pistillate scales are acute. In contrast, the other two entities have long beaks and acuminate scales. Furthermore, whereas *C. tonsa* and *C. umbellata* generally grow in sand barrens and in other sandy sites, some of which are highly disturbed, *C. abdita* rarely grows in pure sand, and particularly not in disturbed places; instead, it seems to be invariably associated with rocky slopes, rock outcrops, and cliffs and bluffs. For those (e.g. Mackenzie, 1931–1935, 1940; Voss, 1972b) who consider *C. rugosperma* Mack. to be the true *C. umbellata* Schkuhr *ex* Willd., then this entity becomes *C. umbellata* Willd. See comments under *C. tonsa* and *C. umbellata.*

C. adusta Boott *Ovales*

Rock outcrops, cliffs and bluffs, margins of pine forests, sandy and rocky slopes, and sandy disturbed sites (sand and gravel pits, roadside shoulders and embankments, clear-cut and burned-over areas); frequent in area 1, infrequent to occasional in 2, 3.

C. aenea Fern. *Ovales*

Sandy and rocky slopes, margins of pine forests and pioneer hardwood stands, cliffs and bluffs, and sandy disturbed sites (sand and gravel pits, roadside shoulders and embankments, clear-cut and burned-over areas); frequent to common in area 1, occasional in 2, 3.

C. albursina Sheldon *Laxiflorae*

Steep hardwood-covered slopes, moist wooded ravines and, less commonly, flat deciduous woodlands; occasional to frequent in area 7, infrequent to occasional in 5, 6. The type of this species was collected near White Bear Lake (Washington County) in east-central Minnesota by E. P. Sheldon in 1892. Some workers (e.g. Gleason and Cronquist, 1963) treat it as *C. laxiflora* Lam. var. *latifolia* Boott.

C. alopecoidea Tuckerm. *Vulpinae*

Floodplain forests, abandoned river channels and ox-bows, woodland swales and pond margins, wooded river banks, ditches, and moist to wet meadows adjacent to rivers and creeks; occasional throughout the state, except in area 1, where it is unknown.

C. amphibola Steud. *Griseae*

Floodplain forests, mesic hardwood stands (especially in swales and along the margins of creeks and ponds), wooded river banks, and disturbed sites (trails and paths); frequent to common in areas 5, 6, 7, occasional in the eastern half of 4, infrequent in 9, uncommon in 3. Our material may be referred to var. **turgida** Fern. [*C. grisea* Wahlenb.; *C. turgida* (Fern.) J. W. Moore].

C. angustior Mack. *Stellulatae*

Wet sandy shores of lakes, margins of alder swamps, wet edges of trails, and "bog" borders; occasional in area 1, infrequent in 2, 3. *C. angustior* and *C. cephalantha* are fairly distinctive in Minnesota and, as such, they are treated here as separate species. It must be noted, however, that Reznicek and Ball (1980), in their recent treatment of the *Stellulatae* group, place both of these entities under *C. echinata* Murr. Previously, some workers (e.g. Gleason and Cronquist, 1963) treated *C. angustior* and *C. cephalantha* as varieties of *C. muricata* L., as var. *angustata* Carey and var. *cephalantha* Baily, respectively. In Minnesota, *C. cephalantha* grows in "bogs" and in upland peatlands whereas *C. angustior* grows primarily in wet depressions along the edges of swamps and trails as well as along the wet shores of lakes. In the Red Lake Peatland, *C. cephalantha* is a frequently-occurring plant on strings of patterned fens, but *C. angustior* is absent from this large mire complex. A similar situation, as regards the presence of *C. cephalantha* and absence of *C. angustior,* seems to exist in the other upland peatlands that have been recently investigated in the state. *C. cephalantha,* on the other hand, seems to be invariably absent from those habitats given for *C. angustior.* For the majority of our material, the morphological differences usually given to separate these two entities (e.g. Fernald, 1950) seem to hold quite well.

C. **annectens** (Bickn.) Bickn. *Multiflorae*

Two stations are known for this species in Minnesota. It was first collected on sand barrens at the Weaver Dunes (Wabasha County), where it was primarily associated with *C. muhlenbergii.* Only a few clumps were observed, all growing in proximity to one another. Somewhat later, the species was collected on a mesic prairie strip in Mower County. While the latter material is var. *xanthocarpa* (Bickn.) Wieg., the former material is probably best treated as var. *annectens.* This note represents the first report of this species from Minnesota; it appears to be very rare in the state.

Mower Co.: 3 mi. NW of LeRoy on Rte. 56, mesic prairie strip, T101N, R14W, Sec. 19, *Smith 4348* (MIN). Wabasha Co.: 5 mi. SE of Kellogg on Rte. 84, sand dune area, T109N, R9W, Sec. 5, *Wheeler 2700* (MIN).

C. **aquatilis** Wahlenb. *Acutae*

Most Minnesota material is var. **altior** (Rydb.) Fern., which frequents marshy lake shores, floating peat mats surrounding alkaline kettle-hole lakes, "bog" borders, swales that are persistently wet, ditches, and the margins of streams; occasional to frequent in the northern half of the state, infrequent in the southern half. The var. **aquatilis,** which was reported for Minnesota by Butters and Abbe (1953), is known only from the extreme northeast corner of the state, where it is uncommon. These two taxa have not been mapped separately.

C. **arcta** Boott *Heleonastes*

Floodplain forests, abandoned river channels and ox-bows, woodland swales and pond margins, mixed conifer-hardwood swamps, and "bog" borders; occasional in areas 1, 3.

C. **arctata** Boott *Sylvaticae*

Mesic to dry forests (deciduous, mixed conifer-hardwood and, less commonly, coniferous), thickets, clearings, and wooded river banks; frequent to common in areas 1, 2, 3, infrequent in 4, uncommon in 5.

C. assiniboinensis W. Boott *Sylvaticae*

Floodplain forests, abandoned river channels and ox-bows and, less commonly, mixed conifer-hardwood forests and mesic hardwood stands; occasional to frequent throughout the state, except in the northeast and southeast corners, where it is rare or unknown. The plants often bear numerous, long-arching sterile culms or stolons, the tips of which upon reaching the ground form new plants; at some localities these sterile culms form the major cover of the field layer. Various workers (Tolstead, 1946; Stevens, 1950; Bernard, 1959; Hudson, 1977; Wheeler, 1981a, 1983b) have discussed or alluded to vegetative reproduction in this species.

C. atherodes Spreng. *Paludosae*

Prairie swales, wet meadows, ditches, and the marshy borders of lakes, rivers, and ponds; frequent throughout the state, except in the northeast and southeast corners, where it is rare or unknown. The plants often form dense, nearly pure stands in swales and other wet depressions, even those that dry up during the summer. Easily recognized by the pubescence on the sheaths and underside of the leaves, but plants growing in standing water sometimes lack this pubescence.

C. aurea Nutt. *Bicolores*

Moist to wet meadows, damp sandy shores, ditches, swampy woods, marshy borders of lakes and springy banks of streams, and disturbed sites that are artificially watered (e.g. taconite tailings ponds); frequent in the northern half of the state, infrequent to occasional in the southern half. The perigynia are brightly colored (golden-yellow or brownish-orange) and fleshy at maturity, and in all probability attract birds. See comments under *C. garberi.*

C. backii Boott *Phyllostachyeae*

Wooded slopes, cliffs and bluffs, ravines, and sandy ridges in pine stands; occasional in the eastern half of the state, infrequent in the western half. See comments under *C. saximontana.*

C. bebbii (Bailey) Fern. *Ovales*

Moist meadows, swales, ditches, clearings, and the marshy margins of lakes, rivers, and ponds; occasional to frequent throughout the state, except in the southwest, where it is uncommon. This species rarely occurs in woodlands, and it has been suggested (Hudson, 1977) that its rarity in prairies is because of an intolerance to soluble salts.

C. bicknellii Britt. *Ovales*

Prairies, sandy hillsides, railroad and highway embankments (especially prairie strips), sand barrens, rock outcrops, and, less commonly, the borders of lakes and ponds; occasional to frequent in the southern half of the state, infrequent in the northern half.

C. blanda Dew. *Laxiflorae*

Deciduous woodlands of all types and disturbed sites (e.g. clearings, paths and trails, roadway embankments); common in areas 5, 6, 7, occasional to frequent in 4, 8, 9, infrequent in 3. One of the most commonly-occurring carices in deciduous woodlands in the southern half of the state. Some workers (e.g. Gleason and Cronquist, 1963) treat it as *C. laxiflora* Lam. var. *blanda* (Dew.) Boott. See comments under *C. leptonervia.*

C. brevior (Dew.) Mack. *Ovales*

Prairies, sandy hillsides, railroad and highway embankments (especially prairie strips), sand barrens, rock outcrops, sandy disturbed sites and, less commonly, cliffs and bluffs, river banks, and open woodlands; frequent to common in the western and southern portions of the state, infrequent in the north-central and northeastern portions. One of the most commonly-occurring carices in dry, open sites in southern and western Minnesota.

C. bromoides Willd. *Deweyanae*

Floodplain forests, abandoned river channels and ox-bows, woodland swales and pond margins, mixed conifer-hardwood swamps, and the springy banks of streams; restricted to east-central Minnesota, where it is locally abundant. Best known from low, swampy woodlands along the Kettle (Wheeler, 1981b) and Snake rivers.

C. brunnescens (Pers.) Poir. *Heleonastes*

Coniferous and mixed conifer-hardwood forests and swamps, alder swamps, clearings, and "bog" borders; frequent to common in areas 1, 2, 3, occasional in 4, uncommon in 5, 8. Our material may be referred to var. **sphaerostachya** (Tuckerm.) Kükenth.

C. buxbaumii Wahlenb. *Atratae*

Moist meadows, prairie swales, fens (usually confined to flarks in patterned fens), rocky shores of lakes, and wet ditches; occasional to frequent in the northern half of the state, infrequent to occasional in the southern half (except in the southwest, where it is unknown). In the Red Lake Peatland, it is infrequent in flarks of patterned fens and in disturbed sites (Wheeler *et al.,* 1983).

C. canescens L. *Heleonastes*

Open and wooded oligotrophic and mesotrophic "bogs", floating peat mats surrounding acid and alkaline kettle-hole lakes, fens (usually associated with strings in patterned fens) and, somewhat less commonly, conifer and mixed conifer-hardwood swamps, and alder swamps; frequent in areas 1, 2, 3, occasional in 4, uncommon in 5. In areas 4 and 5, it is mostly restricted to tamarack swamps. In the Red Lake Peatland, it grows in wet hollows on the poor- and rich-fen wooded islands, along the margins of string hummocks in patterned fens, and in disturbed sites (Wheeler *et al.,* 1983). Most of our material may be referred to var. **disjuncta** Fern., but var. **subloliacea** (Laest.) Hartman also occurs occasionally. Furthermore, some material from the extreme northeast is best referred to typical var. **canescens.** But because intergrades are so frequent, particularly between the first two taxa, these three entities have not been mapped separately.

C. capillaris L. *Capillares*

Moist shaded lake shores and, less commonly, thickets, wooded beach ridges, and "bog" and swamp borders; infrequent to occasional in the western portions of areas 2, 3, uncommon in 4. Best known from the environs of Lake Itasca (Clearwater County). Our material may be referred to var. **major** Drej. [*C. capillaris* var. *elongata* Olney; *C. capillaris* ssp. *chlorostachys* (Stev.) Löve, Löve, & Raymond].

C. castanea Wahlenb. *Sylvaticae*

Mesic meadows, abandoned fields, "bog" and swamp borders, lake shores, roadside embankments, and ditches; occasional in areas 1, 2, 3.

C. cephalantha (Bailey) Bickn. *Stellulatae*

Open mesotrophic "bogs", fens (usually associated with strings in patterned fens), openings in conifer swamps, and "bog" borders;

occasional in areas 1, 2, 3, infrequent in 4 and the northern half of 5. In areas 4 and 5, it is mostly restricted to tamarack swamps. In the Red Lake Peatland, it grows on strings of patterned fens and in disturbed sites (Wheeler *et al.*, 1983). As treated here, our material includes *C. laricina* Mack. [*C. muricata* L. var. *laricina* (Mack.) Gl.]. See comments under *C. angustior.*

C. cephaloidea (Dew.) Dew. *Bracteosae*

Deciduous woodlands (wet to dry) and thickets; occasional to frequent in areas 5, 6, 7, infrequent in 9 and the southern portion of 4. It often grows in thickets, particularly under *Zanthoxylum,* where it sometimes occurs in abundance. Some workers (e.g. Gleason and Cronquist, 1963) treat it as *C. sparganioides* Muhl. var. *cephaloidea* (Dew.) Carey.

C. cephalophora Willd. *Bracteosae*

Dry deciduous woodlands and thickets, sandy hillsides, exposed ravines, and the margins of mesic hardwood stands; occasional in areas 5, 6, 7.

C. chordorrhiza L. f. *Chordorrhizeae*

Open oligotrophic and mesotrophic "bogs", floating peat mats surrounding acid and alkaline kettle-hole lakes, openings and edges of conifer swamps, and fens; occasional to frequent in areas 1, 2, 3, infrequent in 4 and the northern portions of 5, 6. In areas 4, 5, and 6, it is mostly confined to openings in tamarack swamps. In the Red Lake Peatland, it grows in poor and rich-fen sites and serves as an indicator of minerotrophy in ecotones between ombrotrophic and minerotrophic areas (Glaser *et al.*, 1981; Wheeler and Glaser, 1982; Wheeler *et al.*, 1983). The plant seems to require at least moderate light for best growth, and it has a most unusual and well-marked habit of growth, where old prostrate culms of the previous year give rise to new plants from the nodes.

C. communis Bailey *Montanae*

Rocky ledges in woodlands, cliffs and bluffs and, less commonly, on rocky shores; infrequent to occasional in the eastern half of the state. Best known from rocky ledges along the shores of Lake Superior. According to Handel (1978a), this species is a myrmecochore, with the perigynia having elaiosomes that attract ants to carry diaspores to their nests. He claims that when the fruits become mature, the culms bend, thus placing the perigynia at ground level.

C. comosa Boott *Pseudocypereae*

Marshes, floating peat mats of alkaline kettle-hole lakes, wet ditches, and the borders of lakes, "bogs", and swamps; frequent in areas 3, 4, 5, infrequent to occasional in 1, 6, 7.

C. conjuncta Boott *Vulpinae*

A single station is known in Minnesota. It was collected from a lowland forest bordering the Cannon River (Rice County), where several clumps were observed just where the floodplain gives way to higher ground. Of some interest, two other uncommon Minnesota carices, *C. davisii* and *C. grayi,* were also observed in this lowland forest, both of which were present in some abundance. Although *C. conjuncta* somewhat resembles *C. alopecoidea,* the sheaths of the former are conspicuously cross-puckered whereas those of the latter are smooth. *C. conjuncta* is well known to the south and southeast of us, such as in northern Missouri (Steyermark, 1963), Illinois (Mohlenbrock and Ladd, 1978), and the southern half of Iowa (Gilly, 1946), but it is uncommon or rare in northern Iowa (Gilly, 1946) and Wisconsin (Zimmerman, personal communication). It appears to be very rare in Minnesota. This note represents the first report of this species from the state.

Rice Co.: Cannon River Wilderness Area, floodplain forest, T111N, R20W, Sec. 34, *Wheeler 5297* (MIN).

C. conoidea Willd. *Griseae*

Moist meadows, low prairies and, more rarely, thinly-wooded areas; known only from a few sites scattered throughout the state. Well known from the environs of the Twin Cities Army Arsenal (Ramsey County), where it grows along the margins of Marsden Marsh and also, albeit rarely, on partially-shaded wooded banks overlooking the marsh. See comments under *C. katahdinensis.*

C. convoluta Mack. *Bracteosae*

Deciduous woodlands (mesic to dry) and thickets; frequent to common in areas 5, 6, 7, occasional in 4, infrequent in 9, uncommon in 3. Although some workers (e.g. Gleason and Cronquist, 1963) do not treat this entity as distinct from *C. rosea,* in Minnesota these two taxa are well-marked and easily distinguished, both morphologically and in geographic distribution. Regarding the latter, *C. convoluta* is restricted to the central and southern portions of Minnesota whereas *C. rosea* occurs throughout most of the state.

Where the ranges of the two species overlap, *C. rosea* clearly grows over a much wider range of soil types, with *C. convoluta* more or less confined to rich sites.

C. crawei Dew. *Granulares*

Low prairies, moist meadows, swales, ditches, and marly shores of lakes and, less commonly, railroad and highway embankments (especially prairie strips); occasional to frequent in areas 4, 8, infrequent in 2, 9, uncommon in 1, 5.

C. crawfordii Fern. *Ovales*

Moist, open sites (e.g. meadows, ditches, clearings, roadside embankments, borders of lakes and ponds, sandy shores and, less commonly, the borders of "bogs" and swamps); frequent to common in areas 1, 2, 3, infrequent to occasional in 4 and the northern portions of 5, 6.

C. crinita Lam. *Cryptocarpae*

Mixed conifer-hardwood and alder swamps, woodland swales and pond margins, wooded river banks and, less commonly, wet ditches; occasional to frequent in areas 1, 3, infrequent in 2 and the eastern half of 4, uncommon in the northern portions of 5, 6. In Minnesota, only *C. crinita, C. gynandra,* and *C. tuckermanii* have achenes that are consistently deeply invaginated on one side. See comments under *C. gynandra.*

C. cristatella Britt. *Ovales*

Floodplain forests, abandoned river channels and ox-bows, moist meadows, wet ditches, and the marshy margins of ponds, lakes, and streams; occasional to frequent throughout the state, except in area 1, where it is uncommon. The plants often produce numerous nonflowering pseudoculms along with the fertile culms.

C. crus-corvi Kunze *Vulpinae*

Two stations are known for this species in Minnesota: marshy edge of the Mississippi River near Weaver, Wabasha County [*Fassett and Hotchkiss 3087* (GH)]; wet site near Red Wing in Goodhue County [Sandberg in 1885 (MIN)]. Fernald (1937) also mapped it as occurring in east-central and extreme south-central Minnesota, but specimens from these areas have not been seen. This species has not been collected in the state for some fifty years, and recent efforts to recollect it have failed. It appears to be very rare in Minnesota (if not already extirpated from the state).

C. **cryptolepis** Mack. *Extensae*

Moist to wet places, such as meadows, "bog" and swamp borders, and the marshy margins of lakes; occasional in areas 1, 3, infrequent in 2, 4 and the northern portion of 5. Some workers (e.g. Fernald, 1950) treat it as *C. flava* L. var. *fertilis* Peck.

C. **davisii** Schwein. & Torr. *Gracillimae*

Floodplain forests of large rivers in southeastern Minnesota; local in areas 6, 7. It appears to be rare in the state. Probably best known from the Cannon River Wilderness Area (Rice County), where it grows in lowland forest (see comments under *C. conjuncta*). Erroneously reported (Stevens, 1972; McGregor *et al.,* 1977) for North Dakota; see comments under *C. formosa* and also Wheeler, 1983a.

C. **debilis** Michx. *Sylvaticae*

Wet acid woods, wooded ridges bordering "bogs" and swamps and, less commonly, sandy roadside embankments; infrequent to occasional in the eastern portions of areas 3, 4, 5. Best known from Anoka (Lemon, 1943) and Pine counties. Our material may be referred to var. **rudgei** Bailey.

C. **deflexa** Hornem. *Montanae*

Mixed conifer-hardwood forests and swamps, rocky woods, pine forests, cliffs and bluffs, and "bog" borders; occasional in area 1, infrequent in 2, 3.

C. **deweyana** Schwein. *Deweyanae*

Deciduous woodlands (wet to dry), mixed conifer-hardwood forests and swamps, conifer and alder swamps, clearings, and rocky woods and bluffs; common in the northern half of the state, occasional to frequent in the southern half (except in the west, where it is uncommon).

C. **diandra** Schrank *Paniculatae*

Wet meadows, fens (usually associated with flarks in patterned fens), floating peat mats surrounding alkaline kettle-hole lakes, wet ditches, and "bog" and swamp borders; frequent in area 2, occasional in 1, 3, 4, 5, uncommon in 6. In the Red Lake Peatland, it occurs in flarks of patterned fens and on wooded islands as well as in disturbed sites (Wheeler and Glaser, 1982; Wheeler *et al.,* 1983).

C. disperma Dew. *Heleonastes*

Conifer and mixed conifer-hardwood swamps, alder swamps, "bog" borders, and the mossy shaded banks of streams; frequent to common in areas 1, 2, 3, occasional in 4 and the northern half of 5. In the Red Lake Peatland, it is mostly confined to the sides and tops of hummocks on the rich-fen wooded islands (Wheeler *et al.,* 1983).

C. eburnea Boott *Albae*

Steep wooded ridges and partially-shaded limestone and sandstone bluffs; occasional to frequent in areas 5, 6, 7, infrequent in 4, 8, 9, uncommon in 3. Best known from bluffs bordering the Minnesota and Mississippi rivers and their tributaries, where it often grows in dense mats under *Juniperus.* This species retains its fruits for a long time after maturity (Hermann, 1940) and, indeed, it is not unusual to find plants displaying perigynia produced from two consecutive years.

C. eleocharis Bailey *Divisae*

Prairies, dry hillsides, railroad and highway embankments (especially prairie strips), rock outcrops, and sand barrens; occasional to frequent in the western half of the state, infrequent in the eastern half. A strongly rhizomatous species sometimes occurring in great abundance on dry hillsides and slopes in western Minnesota. Some workers (e.g. Fernald, 1950) treat it as *C. stenophylla* Wahlenb. var. *enervis* (C. A. Mey.) Kükenth.

C. emoryi Dew. *Acutae*

Along river banks, where it often forms large beds of nearly pure stands; it also frequents, though less commonly, floodplain forests, wet ditches, prairie swales, and the margins of ponds and lakes. Frequent to common throughout the state, except in area 1, where it is uncommon. Clearly the most commonly-occurring and abundant sedge along the rivers of our state. Some workers (e.g. Gleason and Cronquist, 1963) treat is as *C. stricta* Lam. var. *elongata* (Boeckl.) Gl.

C. exilis Dew. *Stellulatae*

Best known from the Red Lake Peatland (Wheeler and Glaser, 1979, 1982; Glaser *et al.,* 1981; Wheeler *et al.,* 1983), where it is locally abundant in narrow strips of open poor-fen ecotone that separate ombrotrophic bogs from minerotrophic fens; it also occurs, though less commonly, in flarks and on strings. Outside the Red Lake area, the species is known only from a few patterned fens (primarily in flarks) in the north-central and northeastern portions of the state (Glaser, 1983; Wheeler, 1983b).

C. festucacea Willd. *Ovales*

A single station is known in Minnesota. It was collected from a lowland woods bordering the Des Moines River, where a few clumps were observed growing on slightly raised banks. The species is distinguished from other Minnesota members of the *Ovales* by the following combination of characters: spikelets with conspicuous clavate staminate bases; inflorescence more or less straight, not nodding; body of perigynium suborbicular and rather abruptly narrowed to the beak. This species is well known to the south and southeast of us, such as in Missouri (Steyermark, 1963), Illinois (Mohlenbrock and Ladd, 1978), and the southern half of Iowa (Gilly, 1946), but it is very uncommon or rare in North Dakota (McGregor *et al.,* 1977) and Michigan (Voss, 1972b). It appears to be very rare in Minnesota. This note represents the first report of this species from the state.

Jackson Co.: Kilen Woods State Park, low woods, T103N, R35W, Sec. 17, *Wheeler 5828* (MIN).

C. filifolia Nutt. *Filifoliae*

Prairies, dry hillsides and eroded slopes, and sand barrens; occasional in areas 8, 9, infrequent in the western portions of 4, 5. This species grows in dense tufts that often appear to form rings, apparently through some dying out of older plants at the center (Hudson, 1977); the old sheaths are almost invariably broken off evenly about 2 cm above ground level. In Minnesota, only *C. filifolia* and *C. obtusata* consistently have a well-developed rachilla within the perigynium. See comments under *C. obtusata.*

C. flava L. *Extensae*

Moist meadows, springy places in forests, and "bog" borders; local in area 1. It appears to be rare in the state.

C. foenea Willd. *Arenariae*

Dry, open sites. In the north, the plant frequents the margins of jack pine forests and pioneer hardwood stands, sandy ridges and clearings, and sandy disturbed sites (roadside shoulders and embankments, sand and gravel pits). In the southeast, it frequents sand barrens, dry hillsides, railroad and highway embankments (especially prairie strips), and sandy disturbed sites. Occasional to frequent in the northern half of Minnesota, infrequent to occasional in the east-central and southeastern portions of the state. A rhizomatous species often abundant in dry, sandy soil. Some workers (e.g. Gleason and Cronquist, 1963) still refer to this entity as *C. siccata* Dew.

C. formosa Dew. *Gracillimae*

Known only from dry deciduous woodlands in Ramsey County, where it is very local. It appears to be very rare in the state. Although this species is reported by Fernald (1950) as extending no farther west than Minnesota, it is also known from Richland County, North Dakota (see comments under *C. davisii* and also Wheeler, 1983a).

C. garberi Fern. *Bicolores*

One station is known for this species in Minnesota: a marshy roadside near Cotton in St. Louis County (Wheeler, 1983b). Although *C. garberi* is sometimes difficult to distinguish from *C. aurea,* the Minnesota material has all the characteristics of the former: perigynia densely crowded, strongly overlapping, granular, whitish; pistillate scales rounded at the summits, not short-pointed. In contrast, the pistillate scales of *C. aurea* are almost invariably short-pointed and the perigynia are generally not crowded or overlapping and the latter, when dry, are usually pale brown or beige and not very granular. Unfortunately, a recent effort to recollect the species near Cotton was unsuccessful. It appears to be very rare in the state.

C. gracillima Schwein. *Gracillimae*

Deciduous forests (mesic to wet), alder swamps, mixed conifer-hardwood forests and swamps, wooded banks of rivers and, less commonly, moist meadows and highway embankments; common in areas 1, 2, 3, 4, frequent in 5, occasional in 6, 7.

C. granularis Willd. *Granulares*

Moist meadows and clearings, fens, prairie swales, borders of wet woods and, less commonly, wooded bluffs; occasional throughout the state, except in the northeast, where it is unknown. Our material may be referred to var. **haleana** (Olney) Porter.

C. **gravida** Bailey *Bracteosae*

Dry hillsides, pastures and abandoned fields, railroad and highway embankments (especially prairie strips), river banks, woodland margins, prairies, and rock outcrops; frequent in the southern half of the state, infrequent in the northern half.

C. **grayi** Carey *Lupulinae*

Floodplain forests of large rivers (especially the Mississippi River); infrequent in areas 6, 7, rare in 4. Most Minnesota material is var. **grayi** (with glabrous perigynia), but var. **hispidula** Bailey (with hispidulous perigynia) is known from a floodplain woods near Reads Landing in Wabasha County (Wheeler, 1979). Some workers (e.g. Gleason and Cronquist, 1963; Reznicek and Ball, 1974) do not recognize var. *hispidula,* and thus regard the presence or absence of perigynium pubescence as part of the normal variation of the species. These two taxa have not been mapped separately. See comments under *C. conjuncta.*

C. **gynandra** Schwein. *Cryptocarpae*

Wet sites in northeastern Minnesota, especially near Lake Superior (Wheeler, 1983b). It most often frequents the margins of conifer swamps, wet meadows, and the banks of streams; infrequent in area 1, uncommon in the eastern portion of 3. This entity is sometimes treated (e.g. Fernald, 1950; Gleason and Cronquist, 1963) as a variety of *C. crinita,* as var. *gynandra* (Schwein.) Schwein. & Torr., but these two taxa are well-marked and easily distinguished in Minnesota and Wisconsin (Wheeler, 1983b) as well as elsewhere (Voss, 1972b; Standley, 1983). Standley (1983) recently found the two taxa to be distinct on the basis of morphological differences and reproductive isolation. See comments under *C. crinita.*

C. **gynocrates** Drej. *Dioicae*

Conifer swamps, wooded mesotrophic "bogs" and, less commonly, alder swamps; occasional in areas 2, 3, infrequent in 1, 4, uncommon in 5. In areas 4 and 5, it is confined to tamarack swamps. A small, usually dioecious species that is easily overlooked, particularly the staminate plants (however, the latter sometimes bear one or two perigynia at the bottom of the spike).

C. hallii Olney *Atratae*
Prairie swales; local in area 8. It is a polymorphic species that appears to be rare in the state.

C. haydenii Dew. *Acutae*
Wet sandy swales and moist meadows; occasional in the eastern half of the state, infrequent in the western half. It is sometimes a dominant species in wet sandy swales, where it often associates with *C. buxbaumii.* In richer soils it is usually replaced by such species as *C. lacustris* and *C. atherodes.*

C. heliophila Mack. *Montanae*
Prairies, dry hillsides, bluffs and cliffs, sand barrens, and railroad and highway embankments (especially prairie strips); occasional to frequent in areas 4, 5, 6, 7, 8, 9. Some workers (e.g. Fernald, 1950) treat it as *C. pensylvanica* Lam. var. *digyna* Boeckl.

C. hirtifolia Mack. *Triquetrae*
Mesic deciduous forests; occasional to frequent in areas 5, 6, 7, infrequent in 4. Best known from the southeast, where the plant (all parts of which are pubescent) sometimes occurs in abundance in rich woodlands.

C. hitchcockiana Dew. *Oligocarpae*
Steep hardwood-covered slopes, wooded ravines and, less commonly, flat deciduous woodlands; occasional in area 5, infrequent in 6, 7. Best known from wooded bluffs of the Minnesota River (Wheeler, 1981b).

C. houghtoniana Dew. *Carex*
Margins of pine stands, wet sandy shores, and sandy disturbed sites (e.g. sand and gravel pits, railroad tracks, roadside shoulders and embankments, clear-cut and burned-over areas); occasional to frequent in areas 1, 2, 3, infrequent in 4, uncommon in 5, 6. According to Hudson (1977), the rhizomes of this species grow vigorously in response to disturbance.

C. hystericina Willd. *Pseudocypereae*
Conifer and mixed conifer-hardwood swamps, alder swamps, shrub-carrs, wet meadows and ditches, marshy margins of lakes and streams, and "bog" and swamp borders; frequent to common throughout the state.

C. interior Bailey *Stellulatae*

Conifer and mixed conifer-hardwood swamps, alder swamps, fens, prairie swales, wet meadows and, less commonly, ditches, pastures, and "bog" and swamp borders; occasional to frequent throughout Minnesota, except in the southeast corner, where it is very uncommon. In the southern half of the state, this species primarily grows in tamarack swamps and in spring-fed, calcareous fens. In the Red Lake Peatland, it grows in flarks of patterned fens, in wet depressions on the wooded rich-fen islands, and in disturbed sites (Wheeler *et al.*, 1983). In Minnesota, this species grows on richer sites than the closely related species *C. cephalantha* and *C. angustior*; this observation has also been reported from elsewhere (Damman, 1964).

C. intumescens Rudge *Lupulinae*

Deciduous woodlands (mesic to wet), mixed conifer-hardwood forests and swamps, alder swamps, and wooded river banks; common in areas 1, 2, 3, occasional to frequent in 4, 5, infrequent in 6. Our material may be referred to var. **fernaldii** Bailey.

C. katahdinensis Fern. *Griseae*

Known only from the environs of Iron Lake in northern St. Louis County, where it grows on sandy beaches and amongst shore rocks (Lakela, 1952; Wheeler, 1983b). Because in Minnesota *C. katahdinensis* and *C. conoidea* are well-marked and easily distinguished both morphologically and ecologically (Wheeler, 1983b), they are treated here as separate species. However, some workers (Ball and White, 1982) claim that the northern populations of *C. conoidea* consist of dwarf individuals with a crowded inflorescence whereas the more southerly populations consist of tall individuals with a lax inflorsecence. Boivin (1967) treats this entity as a form of *C. conoidea* Willd., as forma *katahdinensis* (Fern.) Boivin.

C. lacustris Willd. *Paludosae*

Marshes, prairie swales, woodland ponds, ditches, wooded swamps, and the borders of lakes, rivers, "bogs", and swamps; common throughout the state, except for the southeast and southwest corners, where it is uncommon or unknown. It is often the dominant plant in and around the margins of woodland ponds, and it is one of the most common sedges bordering tamarack swamps. However, in prairie swales it is often replaced by *C.*

atherodes. In the Red Lake Peatland proper it is infrequent in the environs of ditches, but along creeks bordering the mire and in laggs it is widespread and common (Wheeler *et al.*, 1983).

C. laeviconica Dew. *Paludosae*

River banks, abandoned river channels and ox-bows and, less commonly, prairie swales, wet ditches, and the marshy borders of lakes and ponds; occasional to frequent in the southern half of the state and in the Red River Valley.

C. laevivaginata (Kükenth.) Mack. *Vulpinae*

One station is known for this species in Minnesota: a wet site near Spring Grove in Houston County [*Rosendahl 456* (MIN)]. This species appears to be very rare in the state, and it has not been collected in Minnesota since 1902.

C. lanuginosa Michx. *Carex*

Meadows, marshes, swales, wet prairies, ditches, pastures and abandoned fields, and the borders of lakes and ponds; frequent to common throughout the state. One of the most commonly-occurring carices in wet, open sites. Some workers (e.g. Gleason and Cronquist, 1963) treat it as *C. lasiocarpa* Ehrh. var. *latifolia* (Boeckl) Gilly.

C. lasiocarpa Ehrh. *Carex*

Open mesotrophic "bogs", floating peat mats surrounding alkaline kettle-hole lakes, fens, and "bog" and swamp borders; common in areas 1, 2, 3, occasional to frequent in 4 and the northern portion of 5, infrequent in 6, 8. Clearly the most common and abundant sedge in rich fen in the northern half of the state. In the Red Lake Peatland, it occurs in poor- and rich-fen sites and is the dominant species in flarks of patterned fens (Glaser *et al.*, 1981; Wheeler and Glaser, 1982; Wheeler *et al.*, 1983). Our material may be referred to var. **americana** Fern.

C. laxiculmis Schwein. *Laxiflorae*

This sedge is confined to steep, north- and east-facing wooded slopes of deep stream valleys in area 7, where it is locally abundant. All of our specimens have conspicuously surrulate bract-sheaths and sharply-angled culms, as well as gynaecandrous lateral spikelets. Material possessing these characters is sometimes treated (Hermann, 1940) as var. *copulata* (Bailey) Fern. or even given species rank (Mackenzie, 1931–1935) as *C. copulata* (Bailey) Mack. Fernald (1950), however, treats this entity as a hybrid between *C. laxiculmis* and *C. digitalis,* and Zimmerman (personal communication) considers all of the Wisconsin material of this type to be *C. digitalis.* Still others (e.g. Gleason and Cronquist, 1963) do not treat this entity as distinct from *C. laxiculmis.* Of some interest, Hermann (1940) states that var. *copulata* is a calciphile whereas the var. *laxiculmis* grows best in neutral or only slightly calcareous soils. The distribution of var. *copulata* is given by Hermann (1940) as ranging from New Jersey to Missouri and northward to Michigan. It seems clear that the calcareous bluffs of southeastern Minnesota provide the habitats for the northwesternmost stations for this entity in North America. This note represents the first report of this species from the state.

Houston Co.: 9 mi. SW of Reno, north-facing wooded bluff overlooking Winnebago Creek, 0.25 mi. E of Rte. 5, T101N, R5W, Sec. 15, *Wheeler 4199* (MIN). Beaver Creek Valley State Park, north-facing wooded bluff overlooking Beaver Creek, T102N, R6W, Sec. 5, *Wheeler 4238* (MIN). 3 mi. SE of Caledonia, north-facing wooded bluff overlooking South Fork Crooked Creek, T102N, R5W, Sec. 29, *Wheeler 4804* (MIN). Winona Co.: Whitewater State Park, 3 mi. SW of Alba on Rte. 74, east-facing wooded bluff overlooking Middle Fork Whitewater River, T107N, R10W, Sec. 20, *Wheeler 3646* (MIN).

C. lenticularis Michx. *Acutae*

Rocky shores and sandy lake beaches; occasional to frequent in area 1. Well known from the shores of Lake Superior, where it grows amongst rocks and along the margins of rock pools.

C. leptalea Wahlenb. *Polytrichoideae*

Wooded mesotrophic "bogs", conifer and mixed conifer-hardwood swamps, alder swamps and, more rarely, fens: common in areas 1, 2, 3, frequent in 4, occasional in 5. In areas 4 and 5, this species is mostly confined to tamarack swamps. In the Red Lake Peatland, it occurs in open fens (flarks and string margins) and on wooded islands, and it serves as an obligate rich-fen indicator (Glaser *et al.,* 1981; Wheeler *et al.,* 1983). The plants often grow in dense mats in deeply-shaded places, and it has been suggested (Wheeler *et al.,* 1983) that reduced light greatly favors asexual propagation in the species.

C. leptonervia Fern. *Laxiflorae*

Deciduous forests (mesic to wet), mixed conifer-hardwood forests and swamps, alder swamps and, less commonly, pioneer hardwood stands; occasional to frequent in areas 1, 3 and the eastern portion of 2. Whereas *C. blanda* is the most commonly-occurring member of the *Laxiflorae* in our southern hardwood forests, *C. leptonervia* is the most commonly-occurring member of this group in our northern hardwood and mixed conifer-hardwood forests. The ranges of these two species in the state are more or less exclusive and rarely, if ever, do the two species occur in the same forested area.

C. limosa L. *Limosae*

Open oligotrophic and mesotrophic "bogs", floating peat mats surrounding acid and alkaline kettle-hole lakes, fens, and openings in conifer swamps; frequent in areas 1, 2, 3, occasional in 4, infrequent in 5, 8, uncommon in 6, 9. In areas 4, 5, 6, 8, and 9, this species is mostly confined to spring-fed, calcareous fens and to openings in tamarack swamps. In the Red Lake Peatland, the plant frequents poor- and rich-fen sites, where it grows in flarks and, less commonly, on strings (Wheeler *et al.,* 1983). This species greatly resembles the closely related *C. paupercula* (see comments under this species) and, like it, has roots that are conspicuously covered with numerous yellowish-tinged root hairs.

C. livida (Wahlenb.) Willd. *Paniceae*

Limy meadows and fens and, less commonly, wet ditches and the margins of conifer swamps (Wheeler, 1983b); infrequent to occasional in areas 1, 2, but at some localities occurring in abundance. In the Red Lake Peatland, this species grows in open poor- and rich-fen sites (primarily associated with flarks and the margins of fen-pools), and it is a frequent indicator of minerotrophy between ombrotrophic and minerotrophic areas (Glaser *et al.,* 1981; Wheeler and Glaser, 1982; Wheeler *et al.,* 1983). Our material may be referred to var. **radicaulis** Paine [*C. livida* var. *grayana* (Dew.) Fern.].

C. lupulina Willd. *Lupulinae*

Floodplain forests, woodland swales and pond margins, wooded swamps and, less commonly, wet meadows, ditches, and the marshy borders of lakes and ponds; occasional to frequent in areas 3, 4, 5, 6, 7. Best known from lowland forests bordering the Mississippi and St. Croix rivers.

C. lurida Wahlenb. *Pseudocypereae*

One station is known for this species in Minnesota: wet site near Milaca in Mille Lacs County. Although collected in the state in

1892, recent efforts to recollect it have failed. It appears to be very rare in Minnesota (if not already extirpated from the state). In Wisconsin (Zimmerman, personal communication), *C. lurida* is known from a few sites along the Wisconsin and Black rivers.

C. **meadii** Dew. *Paniceae*
Prairies, sandy hillsides, railroad and highway embankments (especially prairie strips), and the edges of rock outcrops; occasional to frequent in areas 5, 8, 9, occasional in 4, infrequent in 6, 7. See comments under *C. tetanica.*

C. **media** R. Br. *Atratae*
Rocky shores and margins of rock pools, steeply-wooded river banks (especially near waterfalls) and, less commonly, moist meadows, swampy ditches, and "bog" borders; infrequent to occasional in area 1. Best known from the rocky shores of Lake Superior. Some workers (e.g. Gleason and Cronquist, 1963) do not treat this entity as distinct from *C. norvegica* Retz.

C. **merritt-fernaldii** Mack. *Ovales*
Sandy hillsides, gravelly banks, rock outcrops, cliffs and bluffs and, less commonly, edges of pine stands; occasional in areas 1, 2, infrequent in 3, uncommon in 4. Some workers (e.g. Gleason and Cronquist, 1963) do not treat this entity as distinct from *C. brevior* (Dew.) Mack.

C. **michauxiana** Boeckl. *Folliculatae*
Known only from wet ditches near Schroeder in Cook County (Butters and Abbe, 1953; Wheeler, 1983b). It appears to be very rare in the state.

C. **molesta** Bright *Ovales*
River banks, pastures and abandoned fields, prairies, mesic meadows, railroad and roadside embankments and, less commonly, the margins of mesic hardwood stands; occasional in the southern half of the state. Considered by some workers (Gleason and Cronquist, 1963) to be a hybrid between *C. brevior* and *C. normalis.* See Rothrock (1978) for a nomenclatural note.

C. **muhlenbergii** Willd. *Bracteosae*
Sandy hillsides, sand barrens, and dry prairies; occasional in the eastern portions of areas 5, 6, 7. Probably best known from the

Weaver Dunes (Wabasha County) and the sand barrens of the Anoka Sand Plain (e.g., Anoka and Sherburne counties).

C. muskingumensis Schwein. *Ovales*

Floodplain forests of large rivers, particularly the Mississippi River (Wheeler, 1979); infrequent to occasional in areas 6, 7, rare in 5. The plants usually bear numerous, leafy pseudoculms along with the fertile culms, both types of which are characteristically very stiff and erect.

C. normalis Mack. *Ovales*

Deciduous woodlands (mesic to wet) and thickets; occasional to frequent in areas 6, 7, infrequent in 3, 4, 5.

C. obtusata Lilj. *Obtusatae*

Sandy ridges and hillsides, sand barrens, and dry prairies; of local occurrence in area 8 and the northwestern portion of 4. It appears to be rare in the state but is quite abundant at some localities. Probably best known from the Agassiz Dunes Natural Area (Polk County), where it occurs on sand barrens. Of the two Minnesota carices possessing a rachilla (see comments under *C. filifolia*), only *C. obtusata* bears a scale-like appendage at the apex of the structure.

C. oligocarpa Willd. *Oligocarpae*

Steep hardwood-covered slopes, wooded ravines and, more rarely, flat deciduous woodlands; occasional in area 5, infrequent in 6, 7. Best known from wooded bluffs of the Minnesota River (Wheeler, 1981b).

C. oligosperma Michx. *Vesicariae*

Open ombrotrophic bogs, open oligotrophic "bogs", and floating peat mats surrounding acid kettle-hole lakes; frequent in areas 1, 2, 3, infrequent to occasional in the eastern portion of 4 and the northeastern part of 5. It is one of the most commonly-occurring and abundant sedges in open, oligotrophic sites in the northeastern one-third of the state. In the Red Lake Peatland, where it is often a dominant species, this plant frequents open ombrotrophic bogs, bog drains, and open poor-fen areas (Glaser *et al.,* 1981; Wheeler and Glaser, 1982; Wheeler *et al.,* 1983).

C. ormostachya Wieg. *Laxiflorae*
Hardwood and mixed conifer-hardwood forests (particularly along the drier, more thinly-wooded margins), and wooded river banks; known only from a few scattered sites in areas 1, 3, but it is probably more common in the northeast than our present collections suggest. Some workers (e.g. Gleason and Cronquist, 1963) treat is as *C. laxiflora* Lam. var. *ormostachya* (Wieg.) Gl.

C. pallescens L. *Virescentes*
Known only from moist sites on the Lake Superior terrace near Duluth in St. Louis County (Lakela, 1954; Wheeler, 1983b). It appears to be very rare in the state. Our material may be referred to var. **neogaea** Fern.

C. pauciflora Lightf. *Orthocerates*
Open and partially-shaded ombrotrophic bogs, open and partially-shaded oligotrophic "bogs", floating peat mats surrounding acid lakes and, more rarely, conifer swamps; occasional in areas 1, 2, 3, uncommon in 4. In the Red Lake Peatland, this species frequents open and partially-shaded poor-fens and, less commonly, open and partially-shaded ombrotrophic bogs (Glaser *et al.,* 1981; Wheeler and Glaser, 1982; Wheeler *et al.,* 1983). The plant grows best where the water table is at or close to the peat surface, but it is invariably absent from sites having a mud substrate (Wheeler *et al.,* 1983). The long-pointed, slender perigynia that are strongly reflexed and easily detached at maturity are probably readily dispersed by animals (Savile and Calder, 1953; Wheeler *et al.,* 1983).

C. paupercula Michx. *Limosae*
Open and wooded ombrotrophic bogs, open and wooded oligotrophic and mesotrophic "bogs", floating peat mats surrounding acid and, less commonly, alkaline kettle-hole lakes, and conifer and alder swamps; frequent in areas 1, 2, 3, occasional in 4 and the northeastern portion of 5, rare in 7. In areas 4 and 5, this species is mostly restricted to tamarack swamps. In the Red Lake Peatland, it frequents open and wooded ombrotrophic bogs, open poor-fens, and wooded poor- and rich-fen islands (Wheeler and Glaser, 1982; Wheeler *et al.,* 1983). The species seems to be more acid-tolerant than the closely related *C. limosa* (see comments under this species) and, furthermore, it does not seem to frequent such nutrient-rich sites as the latter (Wheeler *et al.,* 1983). Most Minnesota material is

var. **pallens** Fern., but in the northeast var. **irrigua** (Wahlenb.) Fern. is of occasional occurrence. Because intergrades between these two taxa are frequent, they have not been mapped separately.

C. peckii Howe *Montanae*

Deciduous woodlands (mesic to dry), mixed conifer-hardwood forests and swamps, pioneer hardwood stands, wooded river banks and, more rarely, "bog" borders; frequent throughout the state, except in areas 8 and 9, where it is occasional. Some workers (e.g. Gleason and Cronquist, 1963) treat it as *C. nigromarginata* Schwein. var. *elliptica* (Boott) Gl.

C. pedunculata Willd. *Digitatae*

Deciduous woodlands (wet to dry), mixed conifer-hardwood forests and swamps, conifer and alder swamps, and pioneer hardwood stands; occasional to frequent throughout the state, except in areas 8 and 9, where it is very uncommon. The plant is early fruiting (May), and its distribution in woodlands is often clearly non-random, the majority of colonies occurring on rotting logs, windthrow mounds, and near the bases of trees. This species is a known myrmecochore (Handel, 1976, 1978b), and its "seeds", unlike in most species of *Carex,* are known to germinate the same year they are produced (Handel, 1978b).

C. pensylvanica Lam. *Montanae*

Known from many habitats, particularly woodlands of all types; it rarely occurs, however, in prairies or where the soil is extremely wet (e.g. "bogs", marshes, fens). Very common throughout Minnesota, except for the extreme northeast, where it is infrequent. This species is probably the most commonly-occurring and widespread sedge in the state, and it is sometimes very abundant in dry deciduous woodlands.

C. plantaginea Lam. *Laxiflorae*

Steep hardwood-covered slopes and moist wooded ravines; very local in east-central and southeastern Minnesota. It appears to be very rare in the state.

C. praegracilis W. Boott *Divisae*

Low prairies, moist meadows, swales, wet depressions along railroad and highway embankments (especially prairie strips), ditches and, less commonly, moist places around rock outcrops; frequent in western and south-central Minnesota, adventive in the north-central , northeastern, and extreme east-central portions of the state (Wheeler, 1983b).

C. prairea Dew. *Paniculatae*

Low prairies, wet meadows and ditches, swales, marshes, and the borders of lakes and streams; occasional throughout the state, except in the northeast and southeast corners, where it is rare or unknown. This species sometimes dominates wet meadows and margins of lakes; its brightly-colored sheaths (yellow-brown to bronze) are quite conspicuous. Some workers (e.g. Van Bruggen, 1976; McGregor *et al.*, 1977) still refer to this entity as *C. prarisa* Dew.

C. praticola Rydb. *Ovales*

Bluff-tops, cliffs, and sandy and rocky ground; very local in area 1. Best known from bluff-tops bordering lakes of the Rove Slate Formation, near the Minnesota-Ontario border (Cook County). Although *C. praticola* can be easily confused with *C. aenea,* some Minnesota specimens clearly have the characteristics of the former: beak of the perigynium terete at the tip (the latter about 0.4 mm long and white-hyaline or light brown), with the serrulate wing abruptly terminating where the terete portion begins; perigynia less than two-fifths as wide as long, 4.5–6 mm long (average about 5.3 mm); spikelets in a flexuous inflorescence, silver-green or pale brown. This species appears to be very rare in the state.

C. projecta Mack. *Ovales*

Floodplain forests, conifer and mixed conifer-hardwood swamps, alder swamps, woodland swales and pond margins, wet clearings and ditches, and the borders of "bogs", lakes, and rivers; frequent in areas 1, 2, 3, occasional in the eastern half of 4, infrequent in 5, 6. This species often forms dense colonies by developing bud scales at the base of sheaths on old prostrate culms that over-winter and develop into independent plants the following year (Weatherby, 1945).

C. pseudocyperus L. *Pseudocypereae*

Marshy margins of lakes, "bog" borders and, less commonly, wooded swamps, fens, and wet ditches; frequent in areas 2, 3, occasional in 1, 4 and the northern half of 5, uncommon in 8. In the Red Lake Peatland, this species serves as an obligate rich-fen indicator and is best known from wooded rich-fen islands (Wheeler and Glaser, 1982; Wheeler *et al.,* 1983).

C. retrorsa Schwein. *Lupulinae*

Floodplain forests, conifer and mixed conifer-hardwood swamps, alder swamps, shrub-carrs, marshes, wet ditches, and the borders of lakes, rivers, and ponds; frequent to common in the northern half of the state, occasional in the southern half.

C. richardsonii R. Br. *Digitatae*

Pine forests, dry hillsides, prairies, and sandy disturbed sites (e.g. sand and gravel pits, roadside embankments); occasional in the northern half of the state, infrequent in the southern half. Well known from the Grand Rapids area (Itasca County), where it is of rather frequent occurrence along the outer margins of red pine stands.

C. rosea Willd. *Bracteosae*

Deciduous woodlands (wet to dry), thickets, mixed conifer-hardwood forests and swamps, and conifer and alder swamps; common throughout the state, except in the northeast, where it is very infrequent. One of the most common sedges in deciduous and mixed conifer-hardwood forests. Although there was a proposal (Webber and Ball, 1979) to reject the name *C. rosea* (and *C. radiata*), it was opposed by Boivin (1981), and, more recently, it was not accepted by the Committee for Spermatophyta (Taxon 32: 623–624, 1983). See comments under *C. convoluta.*

C. rossii Boott *Montanae*

Two stations are known for this species in Minnesota: rocky soil in Carlton County [*Sandberg* in 1891, exact location unknown (MIN)]; an island in Lake Pokegama [*Sandberg 276* (WIS)], presumably in Pine County and mapped as such. *C. rossii* is a Western Mountain element plant with disjunct populations known from the Black Hills (Van Bruggen, 1976) and the Great Lakes region (Fernald, 1935); the stations in northern Michigan (Keweenaw County) are the easternmost (Fernald, 1935). It is possible that this species was more widespread in Minnesota during the xerothermic period, and that it is a relict of wider eastern distribution during that time. Presently, it appears to be very rare in the state.

C. rostrata Stokes *Vesicariae*

Marshy margins of lakes and rivers, "bog" borders, fens (usually confined to flarks in patterned fens), prairie swales, shrub-carrs, and wet ditches; common in wetlands throughout the state, but usually replaced by *C. atherodes* in depressions that dry up during the summer. In the Red Lake Peatland proper this species is infrequent to occasional in flarks of patterned fens and in the environs of ditches, and it is very common and abundant along creeks bordering the mire and in laggs (Wheeler *et al.,* 1983). Our material may be referred to var. **utriculata** (Boott) Bailey.

C. sartwellii Dew. *Intermediae*

Moist to wet meadows, prairie swales, fens, wet ditches and, less commonly, swamp margins; occasional to frequent in the central and western portions of the state, rare or unknown in the northeast and extreme southeast.

C. saximontana Mack. *Phyllostachyeae*

Steep hardwood-covered slopes, wooded ravines, shaded river banks, thickets and, less commonly, flat deciduous woodlands; occasional in the western and south-central portions of the state. Best known from bluffs of the Minnesota River, particularly westward. On steep slopes, and especially where plants have flowering culms hanging over precipitous ledges, the subglobose fruits of this species often "roll" short distances downslope from a parent plant; no doubt many other fruits are later washed downslope by rain. For *C. saximontana,* and probably also for *C. backii,* gravity (which is greatly aided by the roundish shape of the fruits of these species) often seems to serve as an effective short-distance dispersal mechanism for diaspores (Wheeler, 1981a).

C. scirpiformis Mack. *Scirpinae*

Prairie swales; local in area 8 and the northwestern portion of 4. It appears to be rare in the state. Some workers (e.g. Fernald, 1950) treat it as *C. scirpoidea* Michx. var. *scirpiformis* (Mack.) O'Neill & Duman.

C. scoparia Willd. *Ovales*

Moist meadows, ditches, clearings, wet sandy margins of lakes and, less commonly, pastures and old fields, moist ledges, and "bog" and swamp borders; frequent in the northern two thirds of the state, occasional in the southern one third.

C. sparganioides Willd. *Bracteosae*

Deciduous forests (mesic to dry); occasional to frequent in areas 5, 6, 7, uncommon in 4.

C. sprengelii Spreng. *Longirostres*

Deciduous forests (dry, mesic and, more rarely, wet), river banks, thinly-wooded hillsides and, less commonly, roadside embankments and the margins of rock outcrops; common throughout the state, except in the northeast, where it is very infrequent. The plants often grow in large colonies, and they invariably have thick, pale brown fibrous bases due to partial decomposition of old leaves (Thomas, 1982).

C. sterilis Willd. *Stellulatae*

Fens that are calcareous and persistently wet; infrequent to occasional in areas 4, 5, 8, uncommon in 3, 6. Probably best known from fens bordering the Mississippi River just southwest of Mendota (Dakota County). Unlike some closely related species (e.g. *C. interior*), the spikelets of this sedge, particularly the terminal one, invariably lack prolonged clavate staminate bases. Some workers (e.g. Gleason and Cronquist, 1963) treat it as *C. muricata* L. var. *sterilis* (Carey) Gl.

C. stipata Willd. *Vulpinae*

Floodplain forests, conifer and mixed conifer-hardwood swamps, alder swamps, marshes, woodland swales and pond margins, wet ditches, shrub-carrs, moist to wet meadows and pastures, and the borders of ponds and streams; frequent to common throughout the state, except in the far west, where it is occasional.

C. stricta Lam. *Acutae*

Wet meadows, marshes, ditches, and the margins of swamps, "bogs", lakes, and streams; frequent to common throughout the state, except in the southeast, where it is occasional. This sedge is often a dominant in wet meadows, and at some localities its tussocks are prominent over large areas. Most Minnesota material is var. **strictior** (Dew.) Carey, but var. **stricta** also occurs at scattered localities in the eastern half of the state; these two taxa have not been mapped separately.

C. supina Willd. *Lamprochlaenae*

Known from cliff-talus at Clearwater Lake in northern Cook County (Butters and Abbe, 1953; Wheeler, 1983b). There is also a report of the plant from South Fowl Lake (Bailey, 1892), but no specimen has been seen. *C. supina* is a circumpolar, low-arctic plant (Raymond, 1951; Given and Soper, 1981) with disjunct populations known from southern Manitoba (Scoggan, 1957, 1978), southern Ontario (Morton, personal communication), and northeastern Minnesota, with the latter having the southernmost stations in North America (Butters and Abbe, 1953). It is very possible that this species was more common in Minnesota during late-glacial time, and that it is a relict of wider distribution in the past (Butters and Abbe, 1953; Wheeler, 1983b). Some support for this comes from Michigan (Miller and Benninghoff, 1969), where macrofossil material of this species has been reported (dated between 13,300 and 12,500 years B.P.). At the present time it appears to be very rare in Minnesota. Our material may be referred to var. **spaniocarpa** (Steud.) Boivin [*C. supina* ssp. *spaniocarpa* (Steud.) Hult.].

C. **sychnocephala** Carey *Ovales*

Damp sandy shores of lakes and streams, swales, marshes, and moist to wet meadows; occasional to frequent throughout the state, except in the northeast and southeast corners, where it is uncommon. According to Hudson (1977), it appears to be a plant of the early stages of succession, not persisting for long after a closed perennial cover gets established.

C. **tenera** Dew. *Ovales*

Thinly-wooded hillsides, woodland margins, wooded river banks, and moist meadows; occasional to frequent throughout the state.

C. **tenuiflora** Wahlenb. *Heleonastes*

Open and wooded oligotrophic and mesotrophic "bogs", floating peat mats surrounding acid and, more rarely, alkaline kettle-hole lakes, fens (usually associated with strings in patterned fens), and conifer swamps; occasional in areas 1, 2, 3, uncommon in 4, 5. In areas 4 and 5, it is mostly restricted to tamarack swamps. In the Red Lake Peatland, it grows primarily on the strings of patterned fens but is also known from hummocks in the poor- and rich-fen wooded islands (Wheeler *et al.*, 1983).

C. **tetanica** Schkuhr *Paniceae*

Low prairies, swales, moist meadows, ditches, and the marshy margins of ponds; frequent to common in areas 5, 8, 9, occasional in 4 and the western portion of 2, infrequent in 3, 6, introduced in 1 (rare). Dried herbarium specimens of *C. tetanica* and *C. meadii* are sometimes difficult to separate, but in the field the two entities are fairly distinctive. *C. tetanica* grows primarily in wet, peaty sites and typically has narrow leaves (2–4.5 mm wide) and pistillate spikelets that are often loosely flowered at the base (the lower perigynia barely or not overlapping). In contrast, *C. meadii* grows in much drier sites, such as in dry prairies, and generally has broader leaves (3–7 mm wide) and pistillate spikelets that are usually tightly compacted, even at the base. The distributions of the two taxa in Minnesota are somewhat similar, but some differences are noteworthy. *C. tetanica* is of frequent occurrence in peaty meadows in Lake of the Woods, western Beltrami, and Clearwater counties, but *C. meadii* is unknown from these counties (they essentially lack prairie sites). On the other hand, *C. tetanica* is very rare or absent from the extreme southeastern corner of Minnesota (part of the Driftless Area), an area lacking low, wet, calcareous sites. However, *C. meadii* is known from various "goat" prairies in this area. The same situation, as regards the presence of *C. meadii* and the absence of *C. tetanica,* also seems to hold throughout the remainder of the Driftless Area (Hartley, 1966).

C. tonsa (Fern.) Bickn. *Montanae*

Margins of pine forests, sand barrens, sandy ridges and rocky ledges, and sandy disturbed sites (e.g. sand and gravel pits, roadside shoulders and embankments, clearings and openings); occasional in the eastern half of the state, particularly northward. Here we choose to be traditional and treat *C. tonsa* and *C. umbellata* as separate species, but because in Minnesota these two entities more or less frequent the same habitats and sometimes grow together, one may be justified in treating them as varieties of the same species. When treated as a variety of *C. umbellata* (as the epithet *umbellata* is used by Fernald (1942, 1950) and in this paper), this entity becomes var. *tonsa* Fern. But for those (e.g. Mackenzie, 1931–1935, 1940; Voss, 1972b) who recognize *C. rugosperma* Mack. to be the true *C. umbellata* Schkuhr *ex* Willd., then this entity, when treated as a variety, becomes *C. rugosperma* var. *tonsa* (Fern.) E. Voss. See comments under *C. abdita* and *C. umbellata.*

C. torreyi Tuckerm. *Virescentes*

Thinly-wooded hillsides and coulees and, less commonly, prairies, mesic meadows, and sparsely-wooded river banks; infrequent to occasional in the western half of the state, uncommon in the eastern half. Although most recent manuals (e.g. Fernald, 1950; Gleason and Cronquist, 1963; Hermann, 1970) give this species as ranging no farther eastward than Minnesota, it also occurs, albeit rarely, in extreme western Wisconsin (Read, 1976; Zimmerman, 1976).

C. **tribuloides** Wahlenb. *Ovales*

Floodplain forests, woodland swales and pond margins and, less commonly, moist meadows, roadside ditches and embankments, and the margins of lakes and ponds; occasional to frequent in the eastern half of the state (particularly southward), infrequent in the western half. Like *C. projecta* (see comments under this species), *C. tribuloides* also produces shoots on old prostrate culms that become an effective means of vegetative reproduction (Weatherby, 1945).

C. **trichocarpa** Schkuhr *Paludosae*

River banks, abandoned river channels and ox-bows, and wet prairies; known from scattered sites throughout the state, except in the north-central and northeastern portions, where it is unknown. Because in Minnesota fruiting material of this species often seems to be scarce or absent, it may well be more common in the state than our present collections suggest.

C. **trisperma** Dew. *Heleonastes*

Wooded ombrotrophic bogs, wooded oligotrophic and mesotrophic "bogs", and conifer swamps; frequent to common in areas 1, 2, 3, occasional in 4, uncommon in the northern portion of 5. Clearly one of the most frequently-occurring carices in wooded "bogs" in the northern half of the state. In areas 4 and 5, it is mostly restricted to tamarack swamps. In the Red Lake Peatland, where it is often a dominant species, this plant occurs in forested ombrotrophic bogs and on wooded poor- and rich-fen islands (Glaser *et al.,* 1981; Wheeler and Glaser, 1982; Wheeler *et al.,* 1983).

C. **tuckermanii** Dew. *Vesicariae*

Conifer and mixed conifer-hardwood swamps, alder swamps, floodplain forests, woodland swales and pond margins, abandoned river channels and ox-bows and, less commonly, wet meadows; occasional to frequent in areas 1, 2, 3, 4, uncommon in 5. See comments under *C. crinita*.

C. typhina Michx. *Squarrosae*

Floodplain forests of large rivers, especially the Mississippi and St. Croix rivers (Wheeler, 1979); very infrequent in areas 5, 6, 7. In the extreme southeastern corner of the state, this species is often associated with *C. muskingumensis* and *C. grayi* and, more rarely, with *C. davisii.*

C. umbellata Willd. *Montanae*

Margins of pine forests, sand barrens, and sandy disturbed sites (e.g. sand and gravel pits, roadside shoulders and embankments, clear-cut and burned-over areas, railroad tracks, trails and paths); occasional in the eastern half of the state, infrequent in the western half. It is considered by Handel (1978a) to be a myrmecochore. Some workers (e.g. Mackenzie, 1931–1935, 1940; Voss, 1972b) call this entity *C. rugosperma* Mack. See comments under *C. abdita* and *C. tonsa.*

C. vaginata Tausch *Paniceae*

Wooded mesotrophic "bogs" and conifer swamps; occasional in areas 1, 2 and the northern portion of 3. Although frequenting "bogs" and swamps, this circumpolar species seems to be uncommon in upland peatlands in the state. The American plant is sometimes distinguished (e.g. Mackenzie, 1931–1935, 1940) from the Eurasian entity as *C. saltuensis* Bailey.

C. vesicaria L. *Vesicariae*

Wet meadows, marshes, margins of lakes and streams and, less commonly, wet ditches and "bog" and swamp borders; frequent in areas 1, 3, occasional in 2, 4, infrequent in 5, 6.

C. viridula Michx. *Extensae*

Peaty meadows and wet sandy margins of lakes and, less commonly, roadside ditches and the edges of rock pools; occasional in the northern half of the state, infrequent in the southern half. Best known from northwestern Minnesota, where it is locally abundant in wet meadows, particularly those dominated by *C. lasiocarpa.*

C. vulpinoidea Michx. *Multiflorae*

Moist to wet meadows, marshes, ditches, shrub-carrs, the margins of lakes and streams and, less commonly, swampy woods; frequent to common throughout the state. One of the most frequently-occurring sedges in roadside verges.

C. woodii Dew. *Paniceae*

Locally abundant in rich deciduous woodlands; known from scattered sites in areas 3, 6, 7. Because the plant fruits very early (about mid-May and even earlier), it is easily overlooked at other times. Thus, it is probably more common in Minnesota than present collections suggest. It was first correctly reported for the state by Hartley (1966); an earlier, erroneous report (Moore and Tryon, 1946) was based on a specimen of *C. blanda.* Some workers (e.g. Gleason and Cronquist, 1963) treat this entity as *C. tetanica* Schkuhr var. *woodii* (Dew.) Wood.

C. xerantica Bailey *Ovales*

Known from bluff-tops bordering Watab Lake in northern Cook County (Butters and Abbe, 1953; Wheeler, 1983b). The isolated presence of *C. xerantica* in Cook County may indicate that the plant was more widespread in the state during the xerothermic period. However, because this species is known from stations in North Dakota (McGregor *et al.,* 1977) and Manitoba (Scoggan, 1957, 1978), its migration to Minnesota in more recent times is possible (Wheeler, 1983b). Presently, it appears to be very rare in the state.

DOUBTFUL AND EXCLUDED TAXA

Carex argyrantha Tuckerm.

Fernald (1950) and Scoggan (1978) included Minnesota within the range of *C. argyrantha,* apparently based on an earlier listing for the state by Moore and Tryon (1946). No specimen, however, has been seen to support its presence in the state. This taxon is known neither from Wisconsin (Zimmerman, personal communication) nor Manitoba (Scoggan, 1957, 1978) and, based on the distribution for the species given by Gleason and Cronquist (1963), it seems unlikely that it occurs in Minnesota.

Carex digitalis Willd.

Reported for Minnesota by Mackenzie (1931–1935), but no confirming specimen has been seen. It seems unlikely that this eastern species (ranging eastward from eastern Wisconsin) occurs in the state.

Carex lupuliformis Sartwell

Reported for Minnesota by Mackenzie (1931–1935), apparently based on an earlier report made by Sheldon (1894). Some recent authors (Fernald, 1950; Gleason and Cronquist, 1963; Scoggan, 1978) have also included Minnesota within the range of the species. Owing to the lack of a confirming specimen, it must be excluded from the flora at the present time. But because the species occurs in Wisconsin (Read, 1976) and Iowa (Gilly, 1946), it is not improbable that it does extend into southeastern Minnesota.

Carex panicea L.

This European species was reported for Minnesota by Fernald (1950) and Hultén (1958), apparently based on an earlier listing for the state by Moore and Tryon (1946). No confirming specimen for Minnesota has been seen. Although this species is now naturalized along the eastern coast of North America (Fernald, 1950; Hultén, 1958), its occurrence in Minnesota seems highly unlikely.

Carex picta Steud.

A specimen of *C. picta* collected by J. A. Stevenson in 1917 (June 22) and purported to be from Beltrami County (near Bemidji) is in the Univeristy of Minnesota Herbarium. On the same herbarium sheet is a specimen of *C. willdenovii* Willd., also otherwise unknown from Minnesota. Both *C. picta* and *C. willdenovii* were reported from Minnesota by Fernald (1950), apparently based on the Moore and Tryon (1946) list. Neither species is known from Wisconsin (Zimmerman, personal communication) or Iowa (Gilly, 1946). Because both of these carices would be so far from the ranges given for them by some workers (e.g. Gleason and Cronquist, 1963), it seems best to tentatively reject them both as part of the Minnesota flora and to suggest confusion in place record labeling. According to Gleason and Cronquist (1963), *C. picta* ranges from southern Indiana to Alabama and Louisana, and *C. willdenovii* from Massachusetts to Ontario and southern Indiana then south to Georgia and Texas.

Carex squarrosa L.

An immature specimen of *C. squarrosa* collected by Rev. Z. L. Chandonnet (no date or number given) and purported to be from Mahnomen County ("White Earth Reservation, Fish Lake") is in the University of Minnesota Herbarium. Although reported from Minnesota by various workers (e.g. Moore and Tryon, 1946; Fernald, 1950; McGregor *et al.*, 1977), the locality is so far out of range as to be suspicious. Therefore, we tentatively reject it from the

Minnesota flora, awaiting further verification. The species is not known from Wisconsin (Zimmerman, personal communication), and it is apparently restricted to the southern one third of Iowa (Gilly, 1946).

Carex suberecta (Olney) Britton

Reported for Minnesota by Mackenzie (1931–1935) and others (Fernald, 1950; Gleason and Cronquist, 1963), but no confirming specimen has been seen. Because this species is known from Wisconsin (Read, 1976) and Iowa (Gilly, 1946), it may well occur in southern Minnesota.

Carex torta Tuckerm.

Mackenzie (1931–1935) reported *C. torta* from Minnesota apparently on the basis of a collection (MIN) made in Houston County (Winnebago Valley) by H. L. Lyon in 1899 (June 8). Some recent authors (Moore and Tryon, 1946; Fernald, 1950; Gleason and Cronquist, 1963; Scoggan, 1987) have also included Minnesota within the range of the species, apparently based on Mackenzie's report. However, the specimen upon which the original report was based is actually *C. emoryi* Dew.

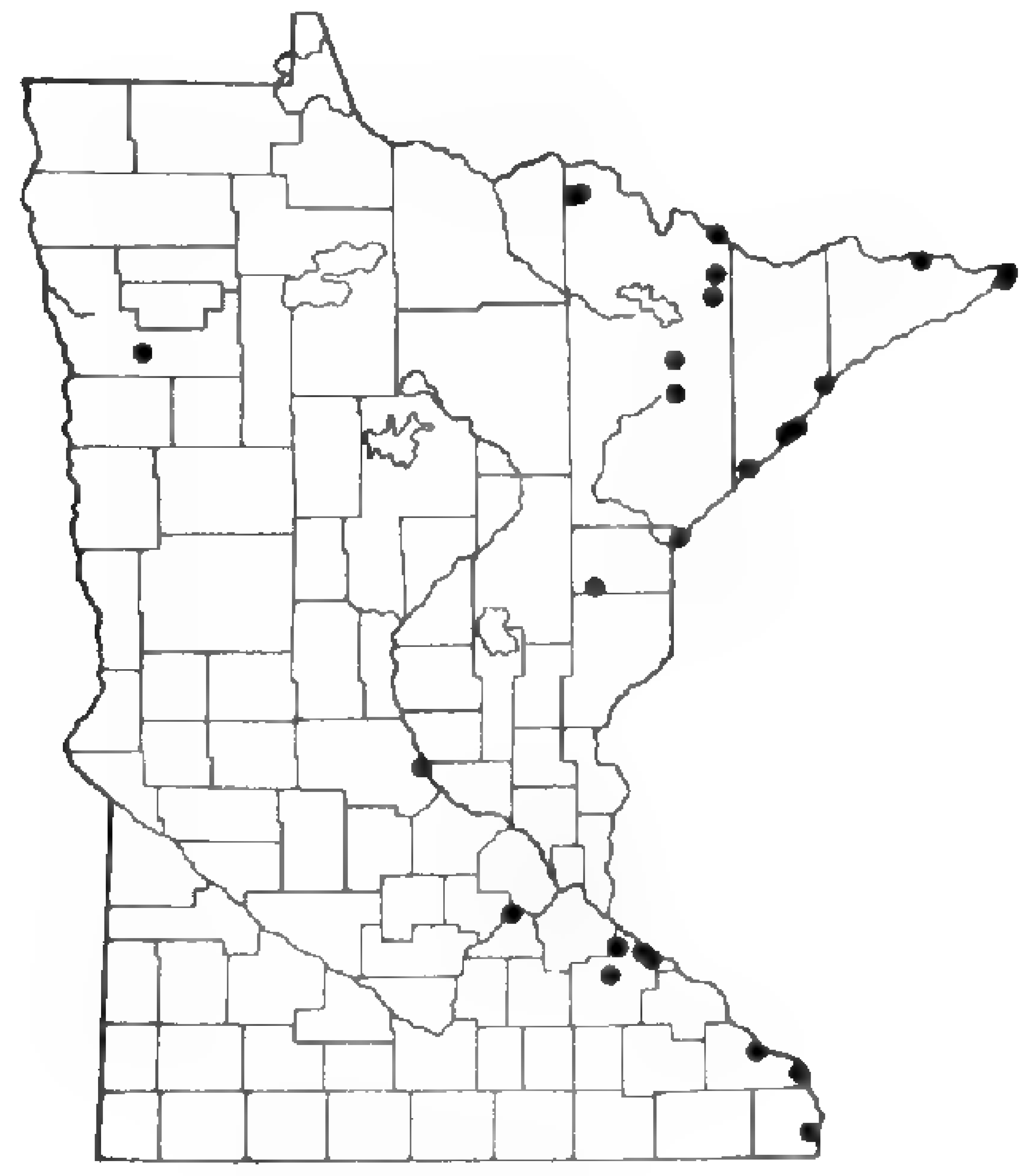
Carex willdenovii Willd.

It seems best to reject *C. willdenovii* as part of the Minnesota flora. For specific details see under *C. picta* above.

ACKNOWLEDGMENTS

We thank Prof. Eville Gorham for reading and criticizing the manuscript; Dr. Paul H. Glaser and Mr. Welby Smith for placing their *Carex* collections at our disposal; Dr. Anton A. Reznicek, Dr. James H. Zimmerman, and Dr. John K. Morton for information on the status of some carices in Michigan, Wisconsin, and Ontario, respectively; and the curators of those herbaria whose specimens were used in the preparation of the maps. We gratefully acknowledge the Hayden Fund of the University of Minnesota (Department of Botany) for financial support to help with publication costs.

DISTRIBUTION
MAPS OF
142
MINNESOTA
CARICES



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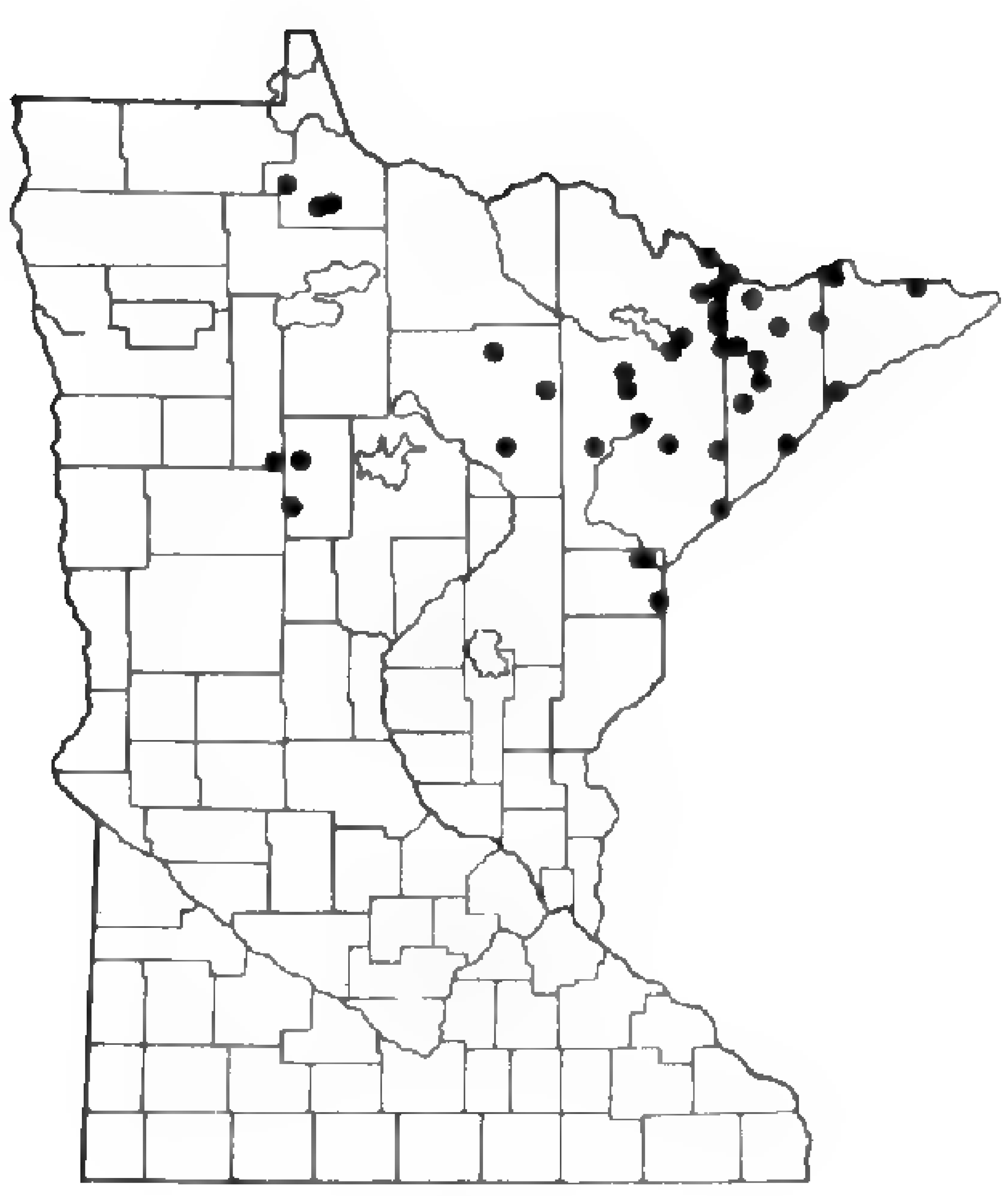

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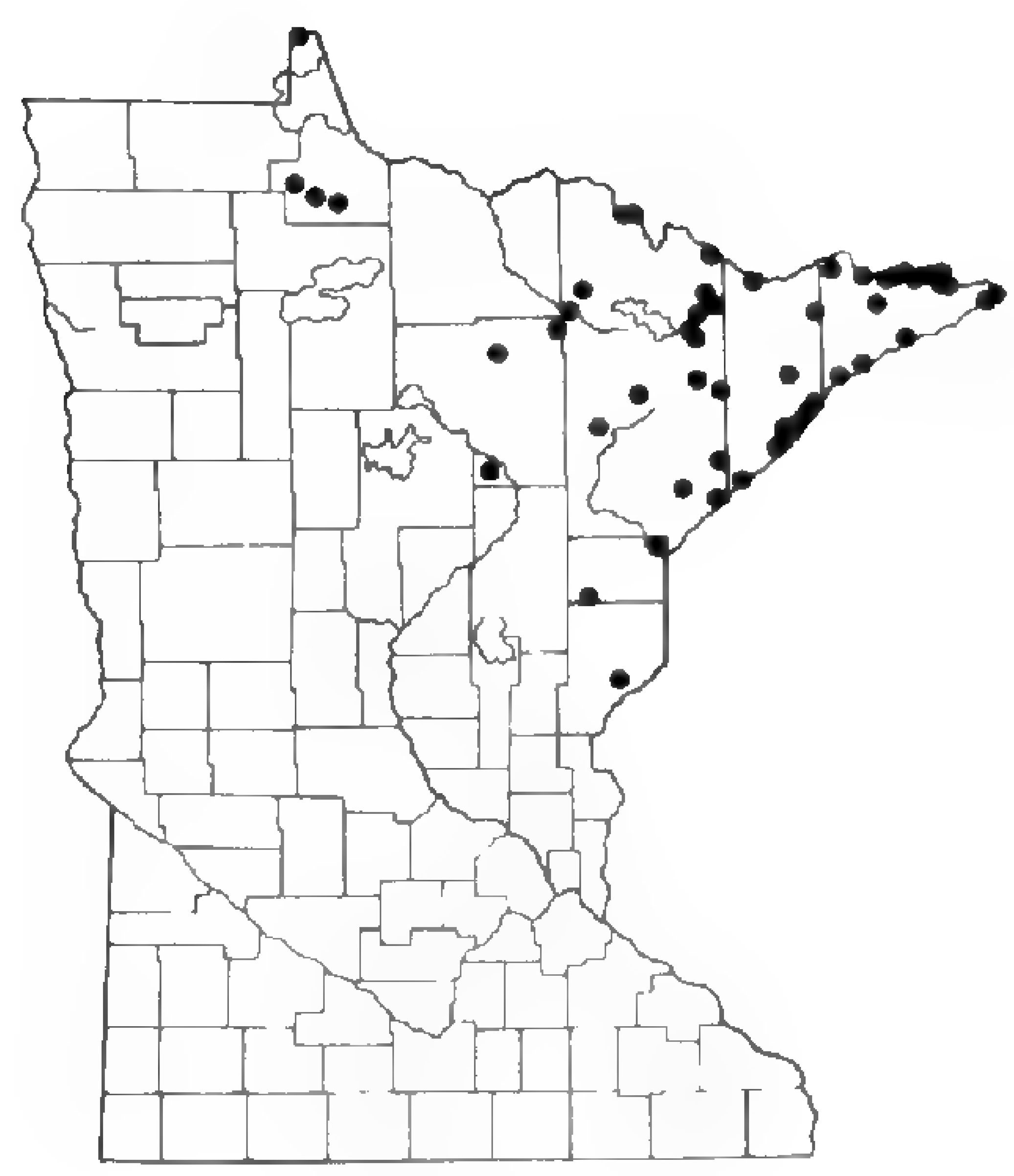

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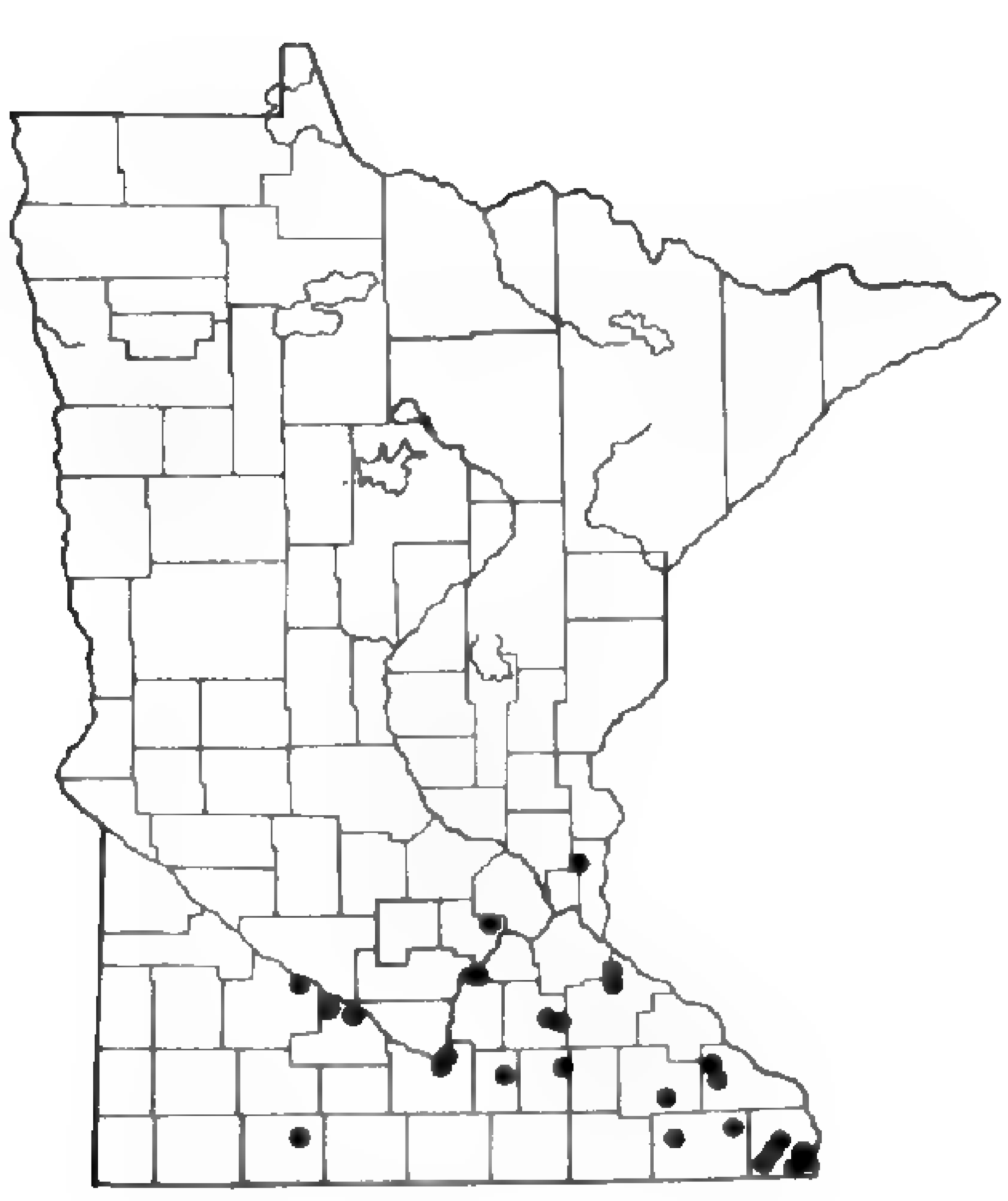

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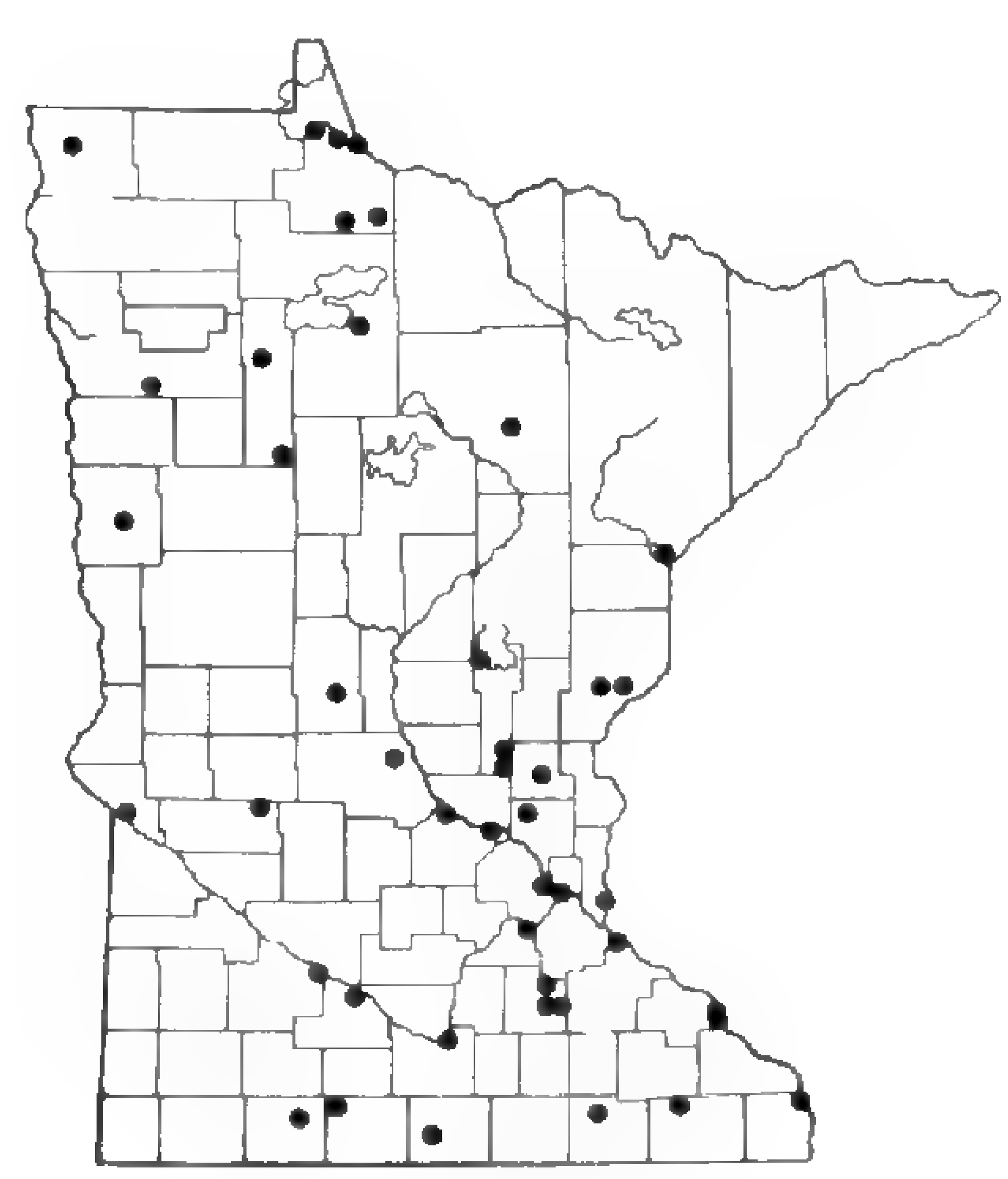

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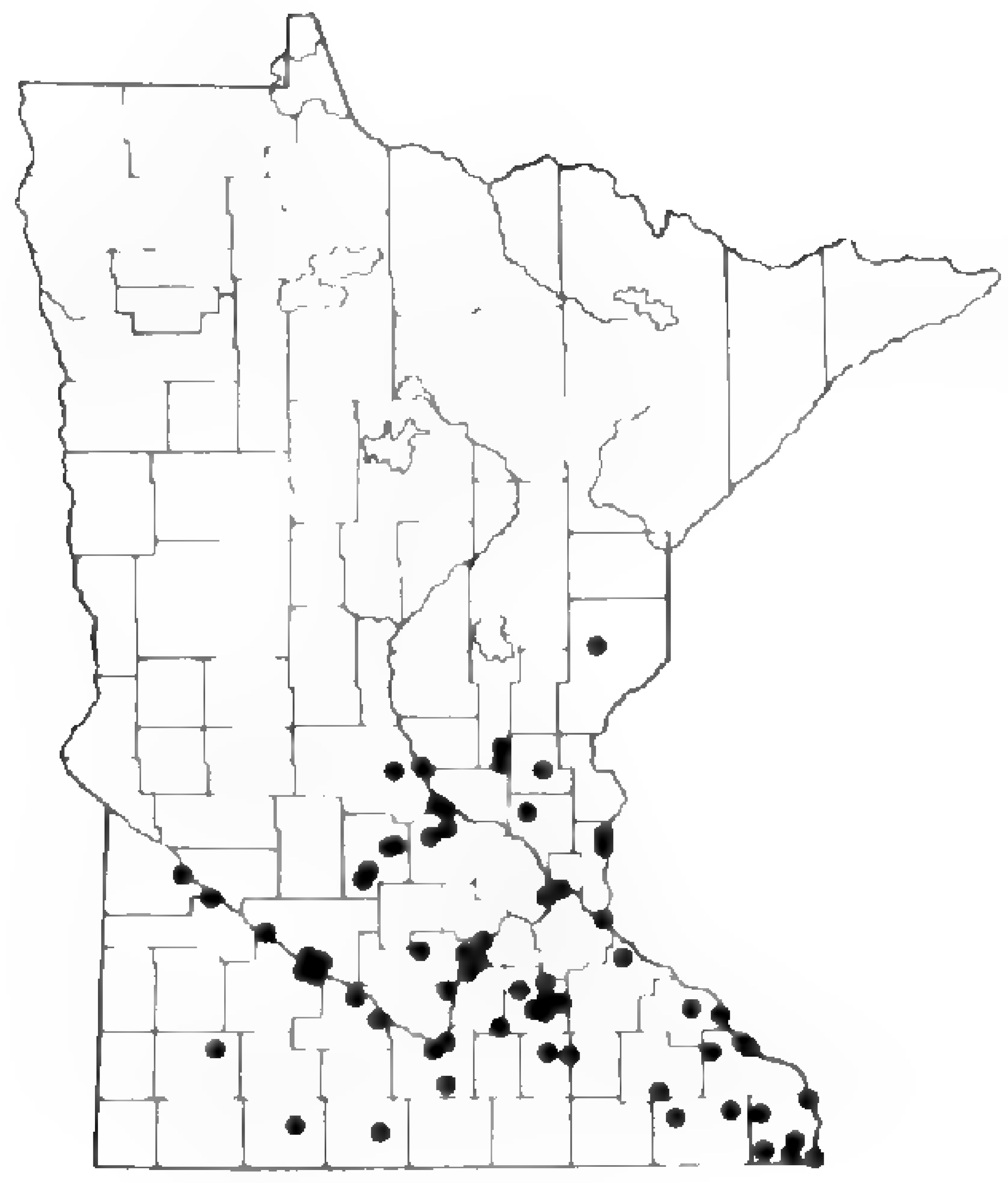

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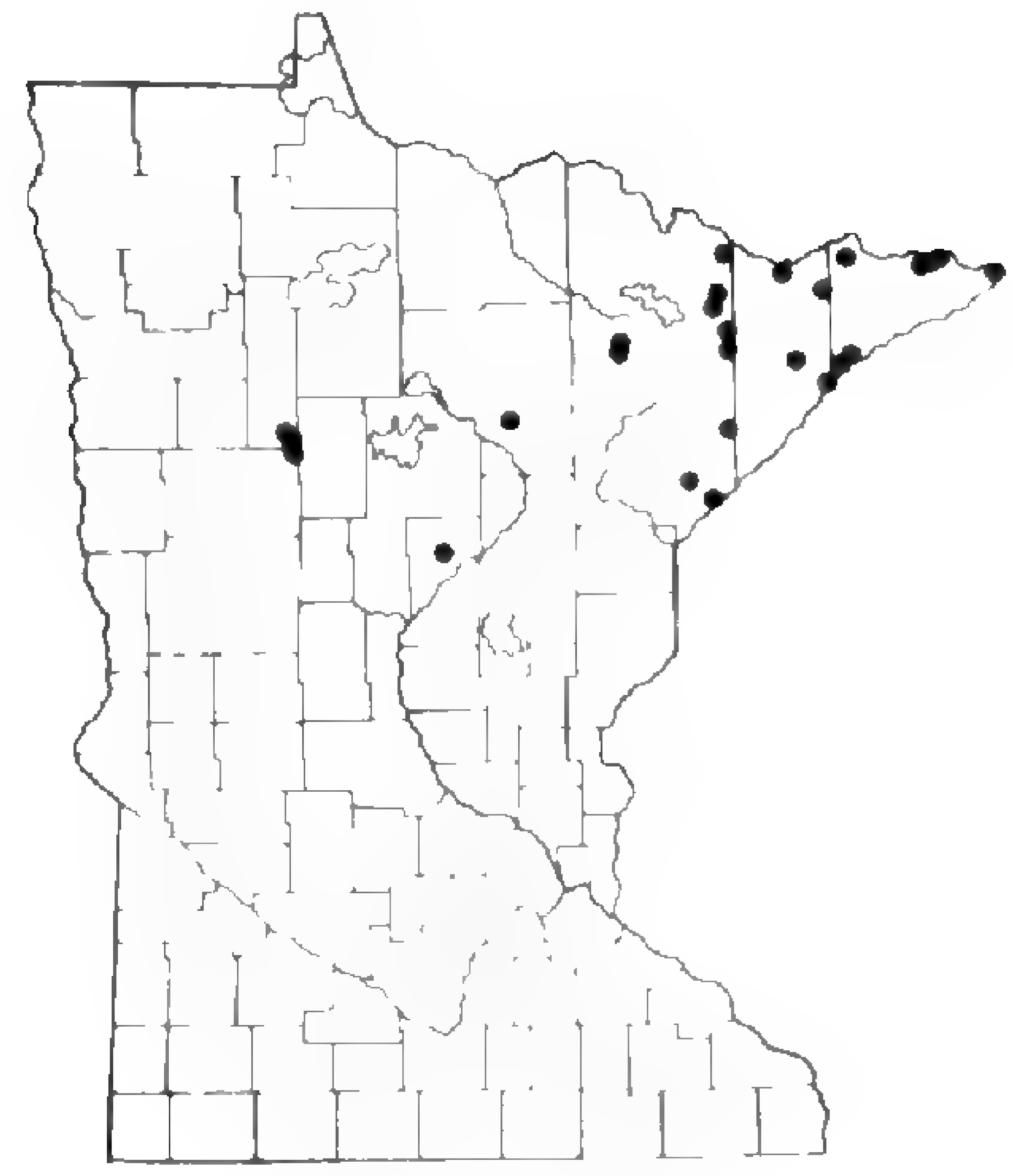

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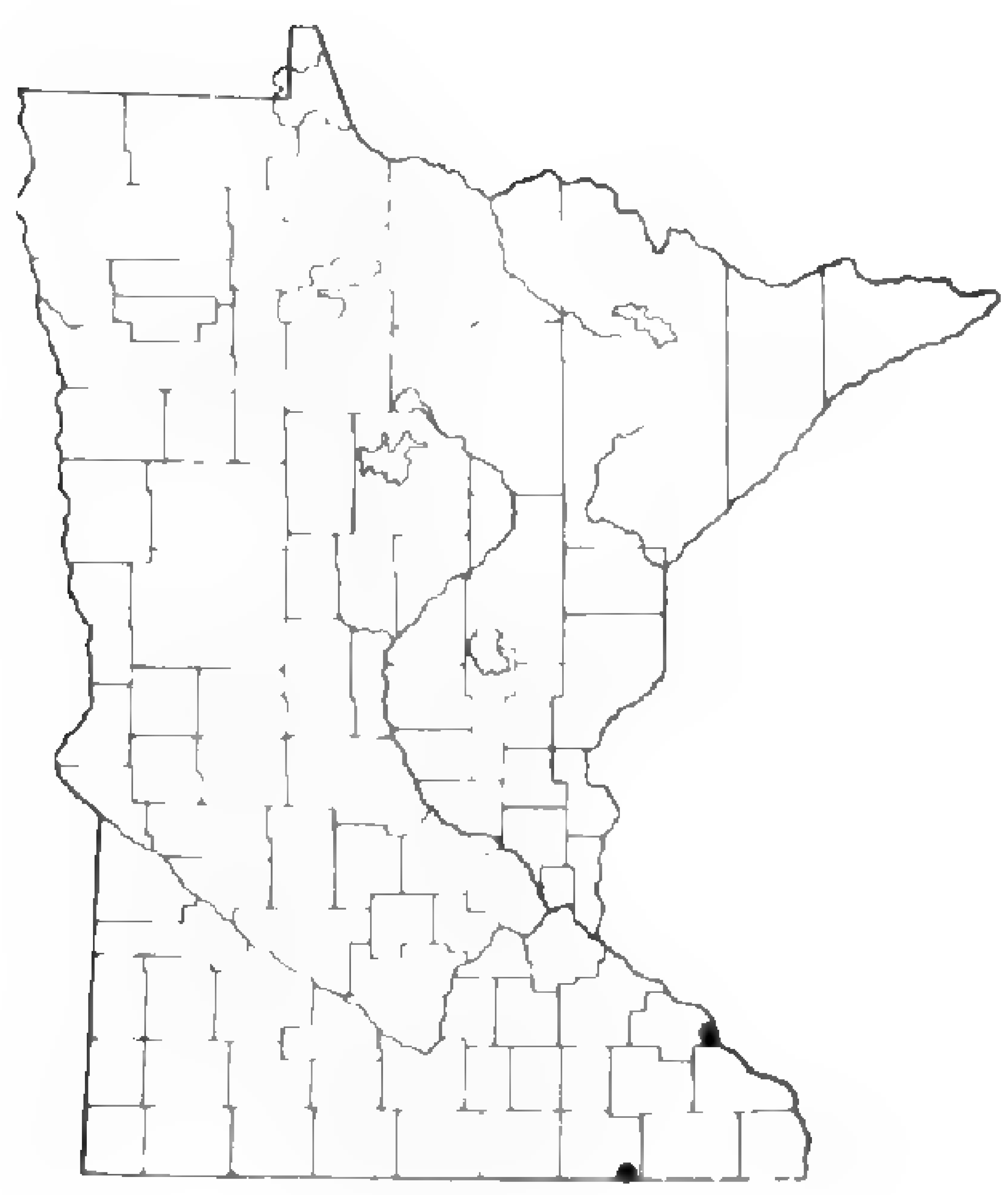

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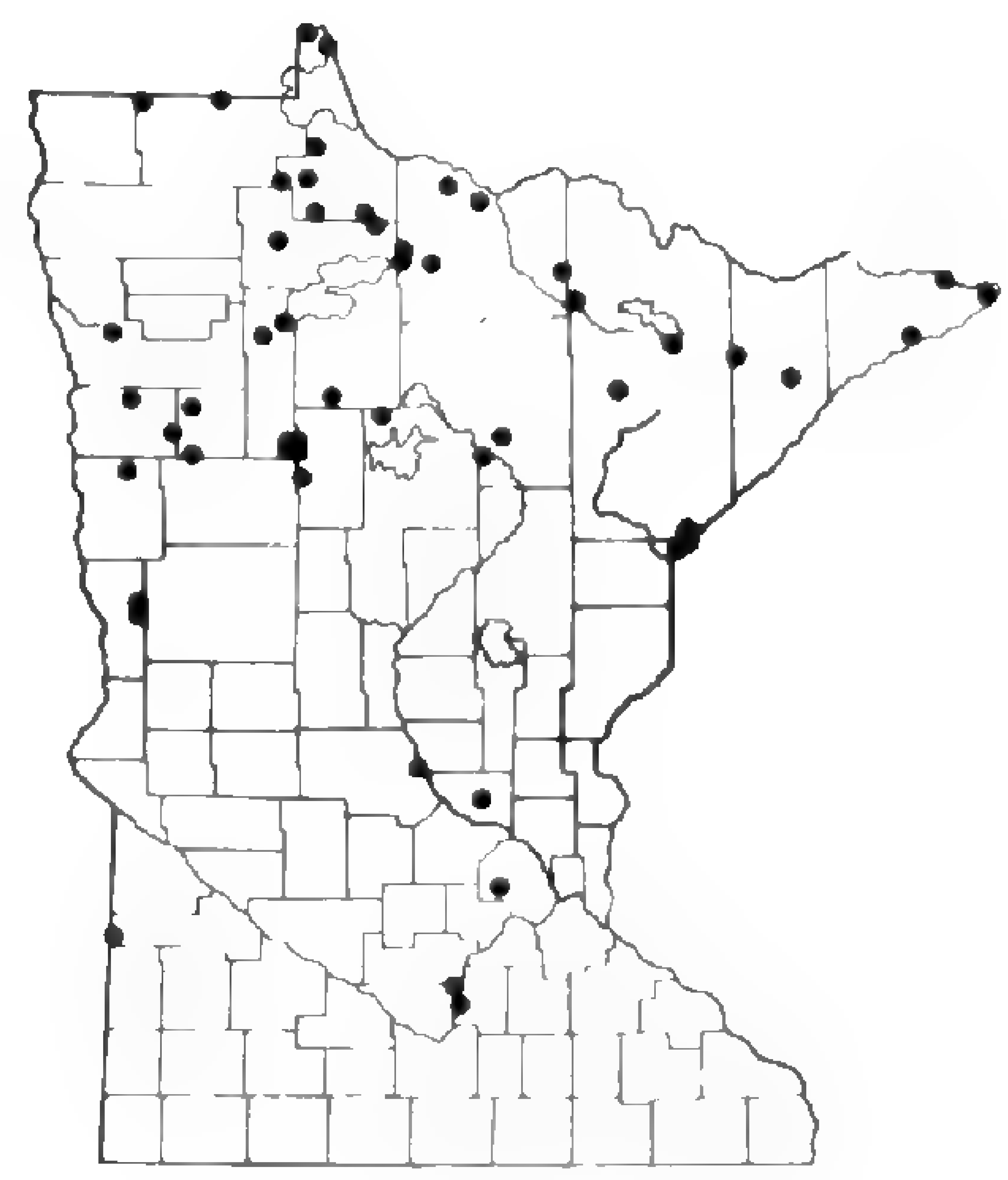

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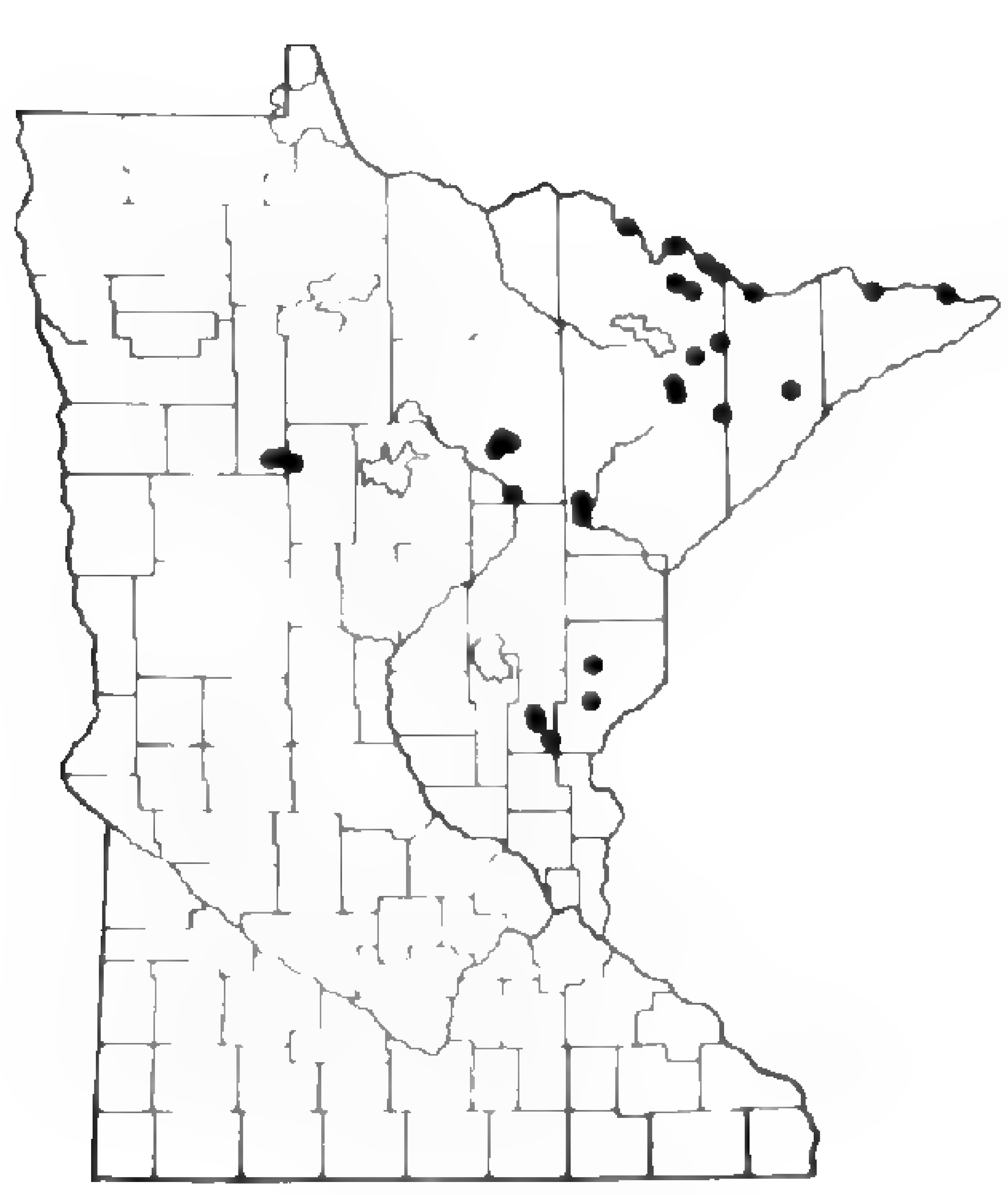

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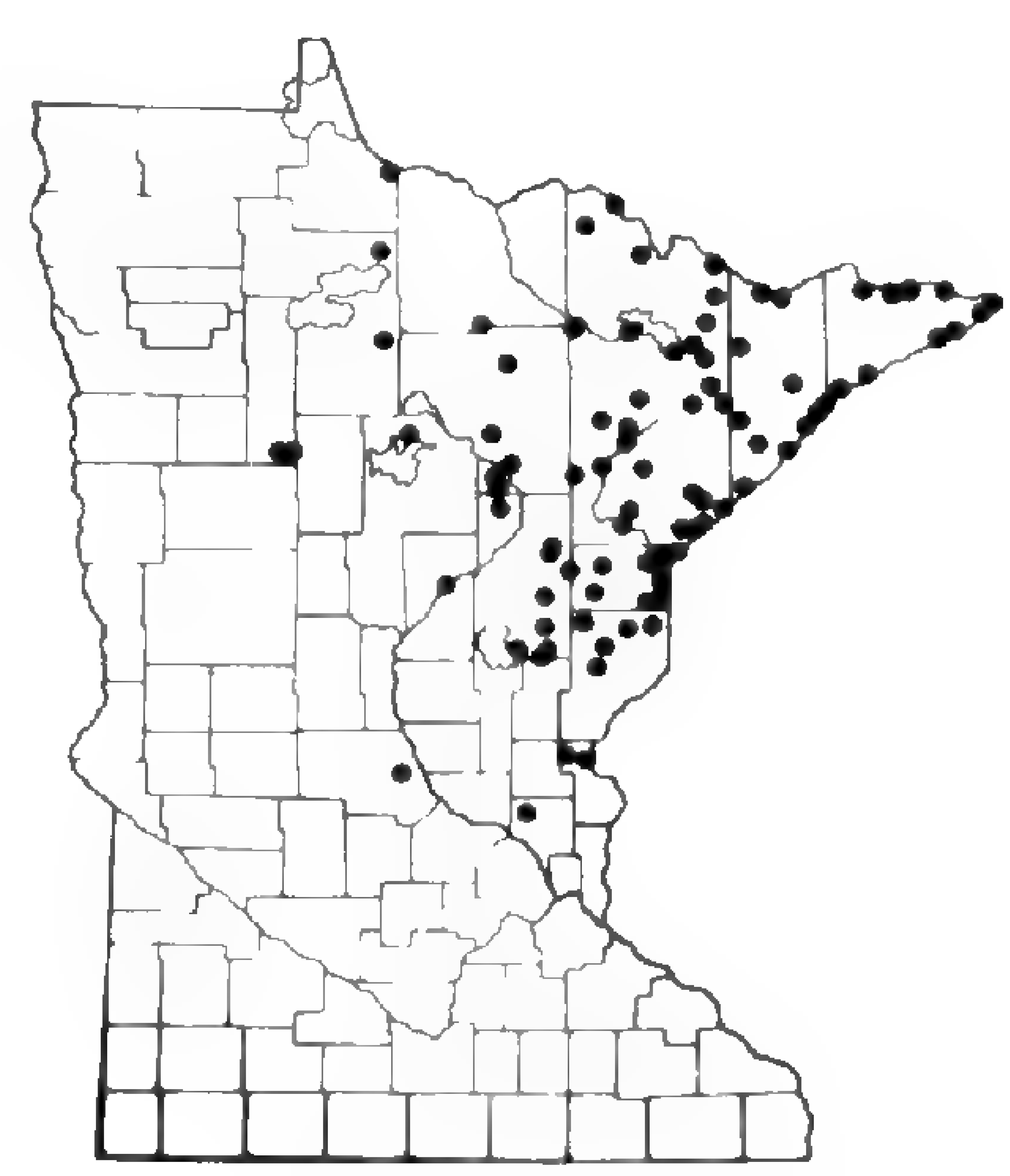

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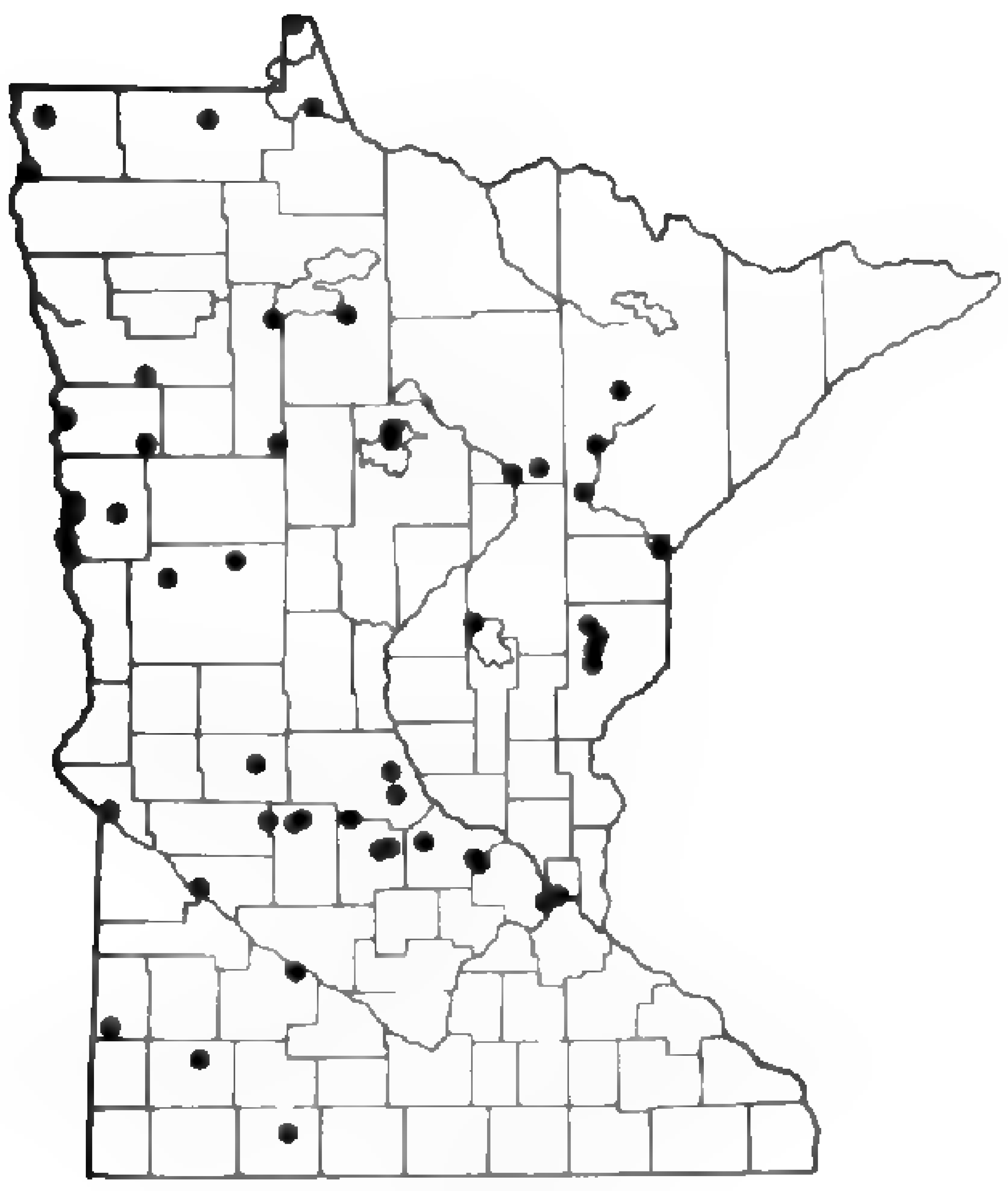

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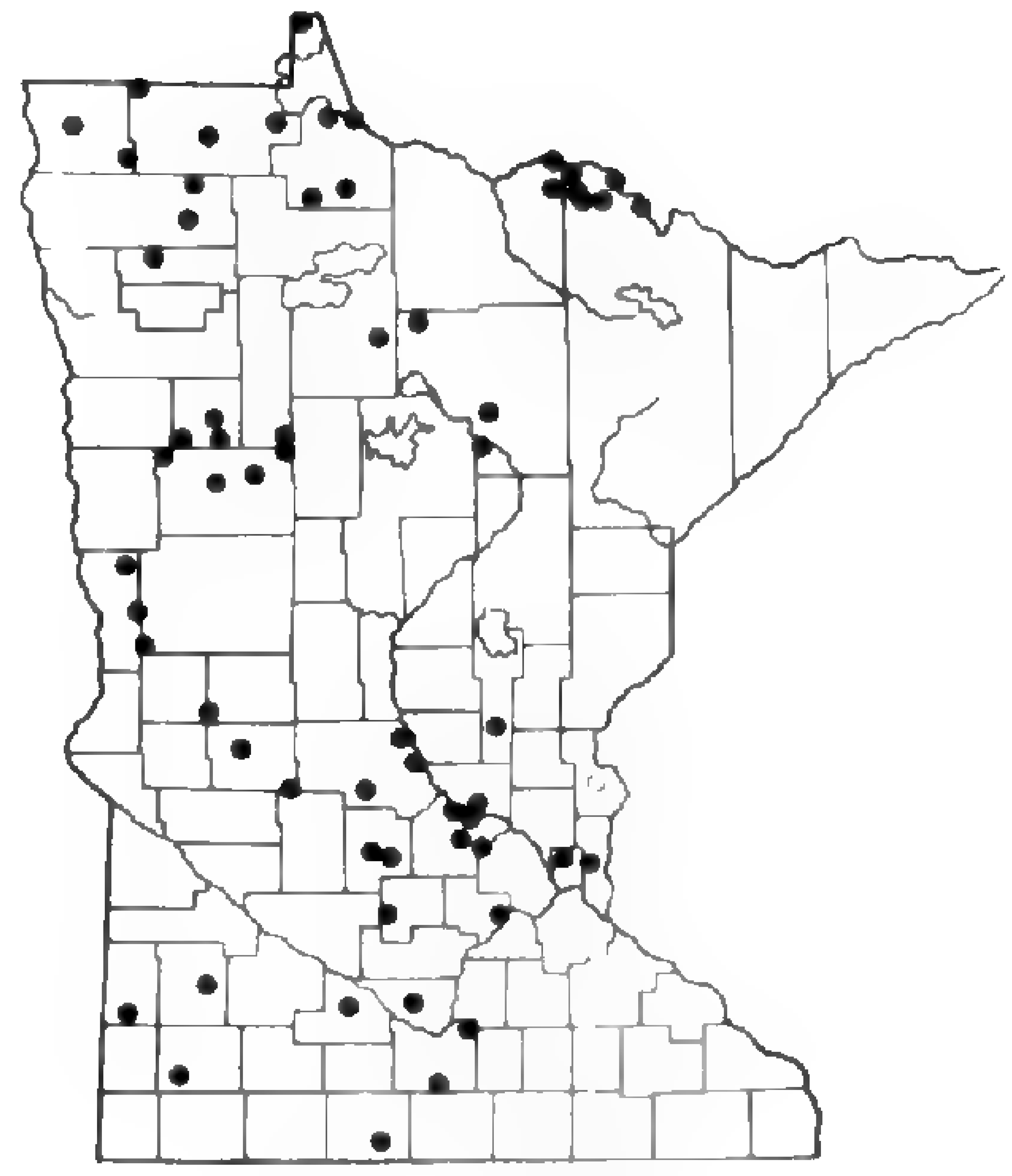

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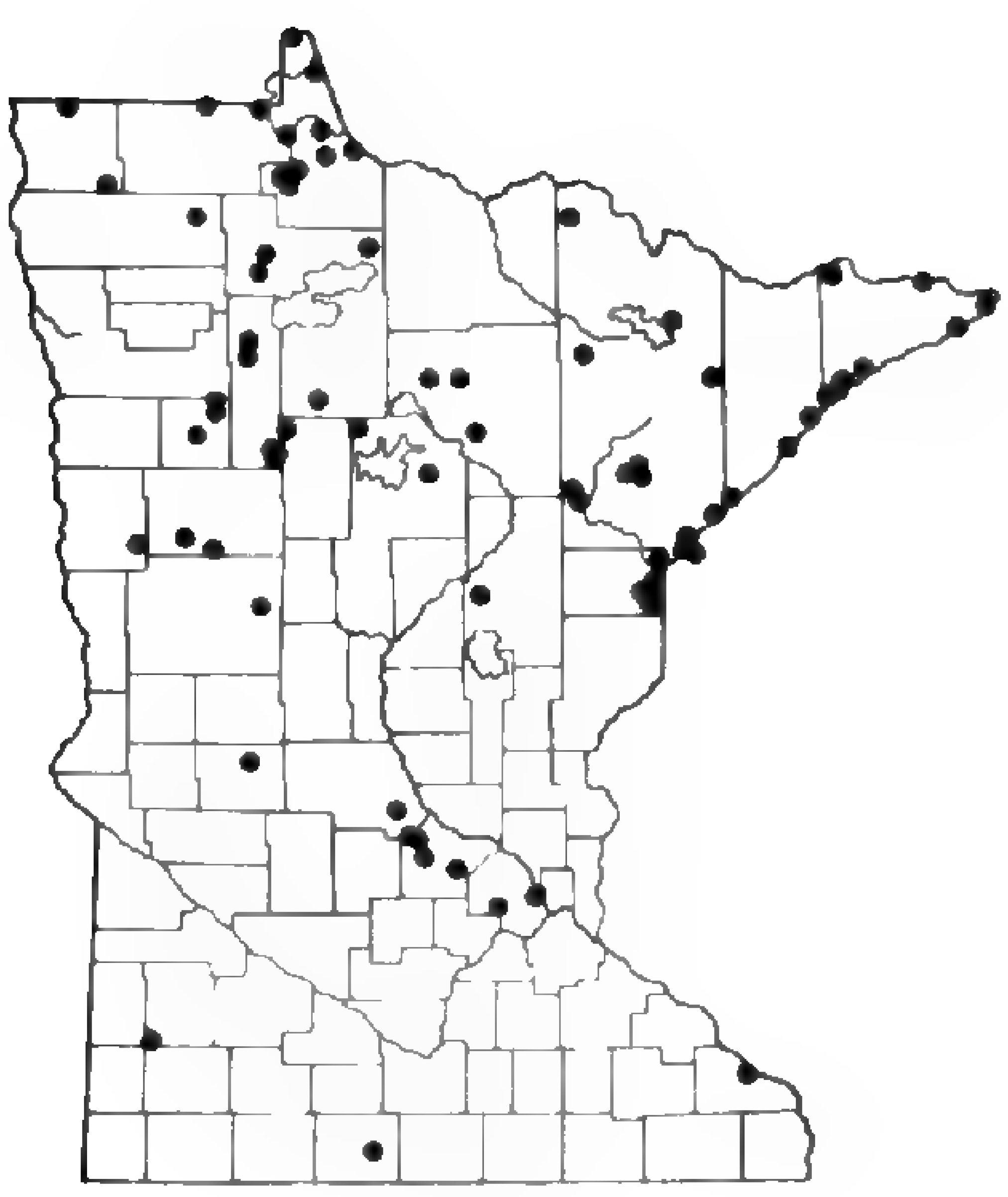

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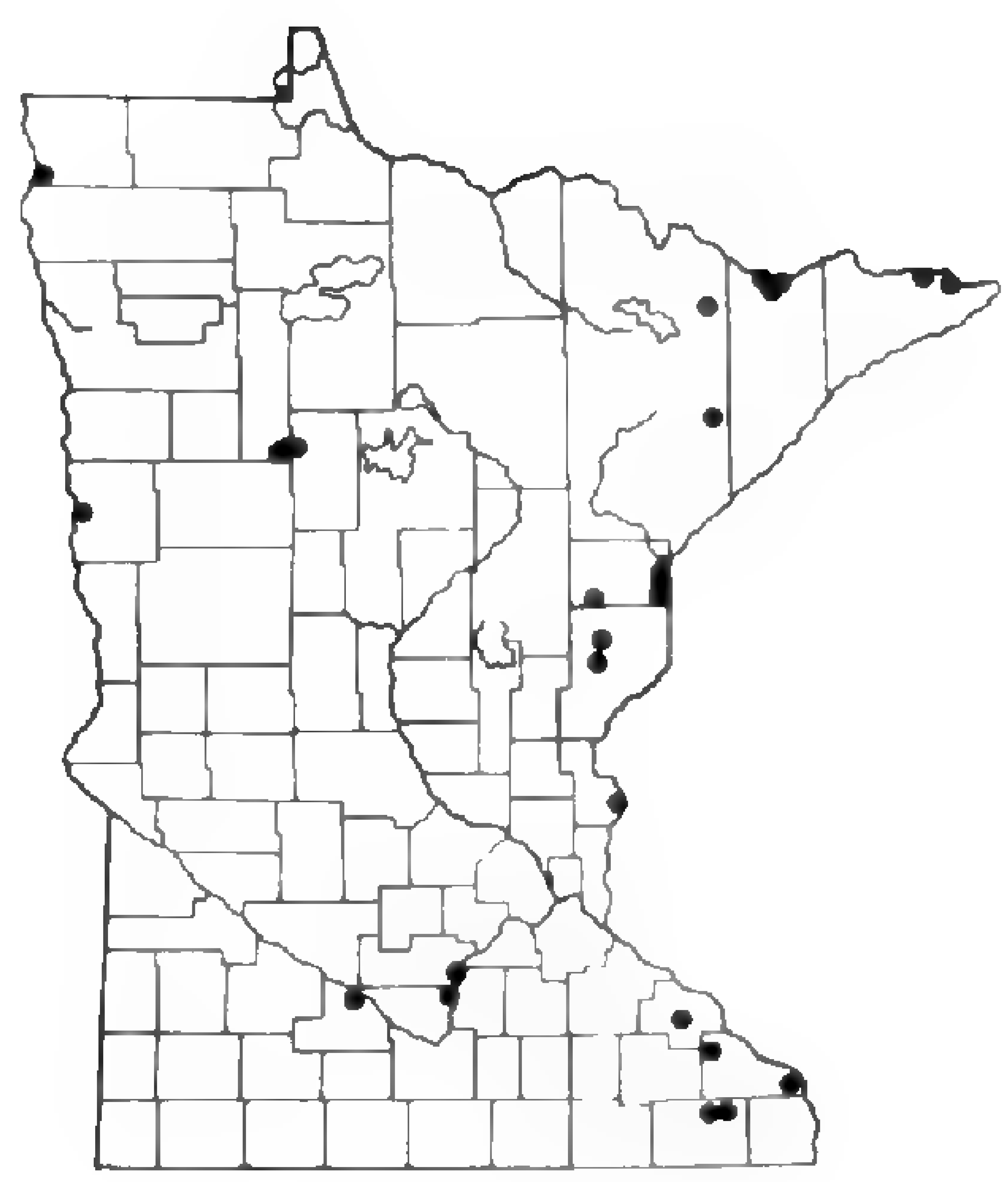

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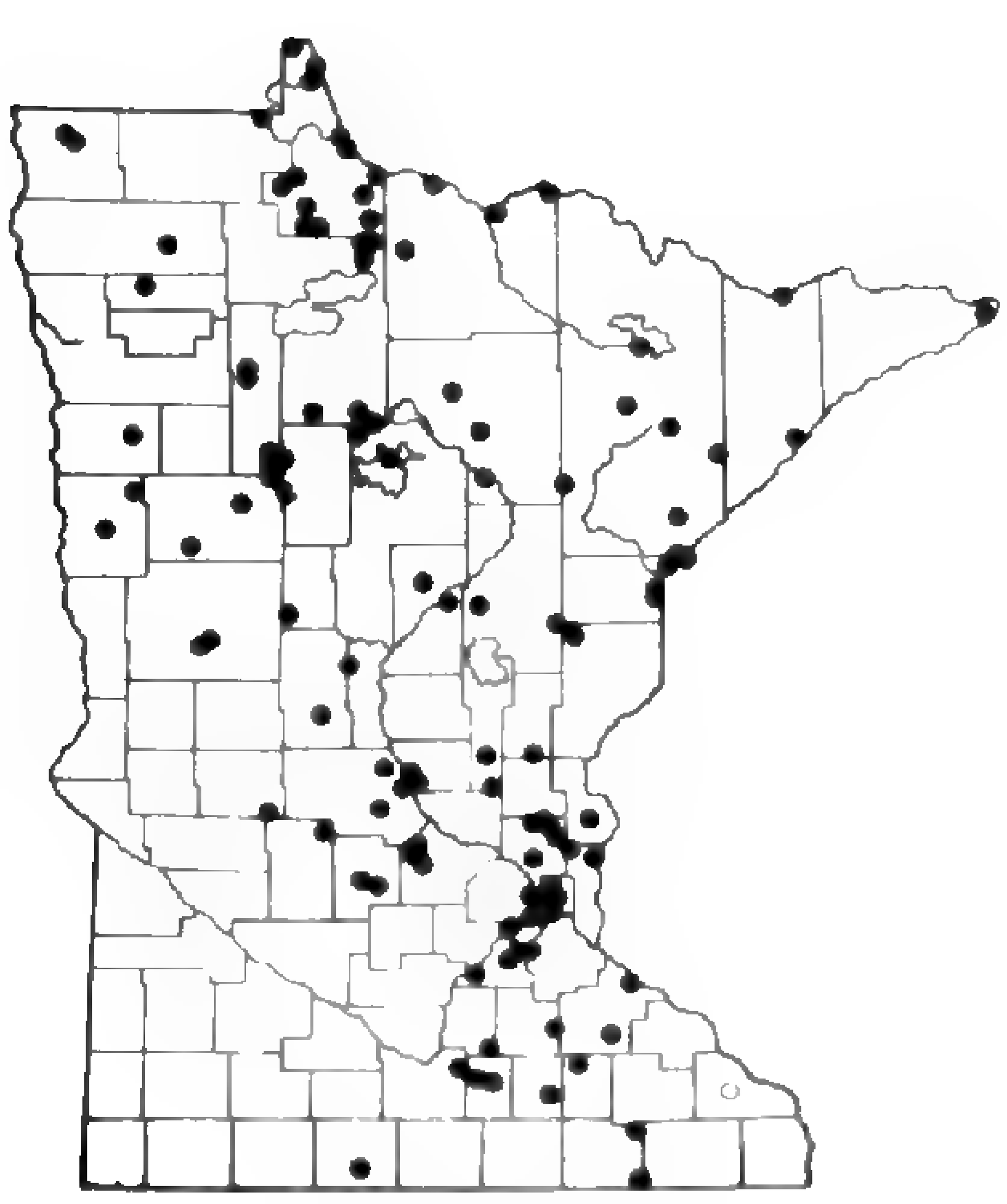

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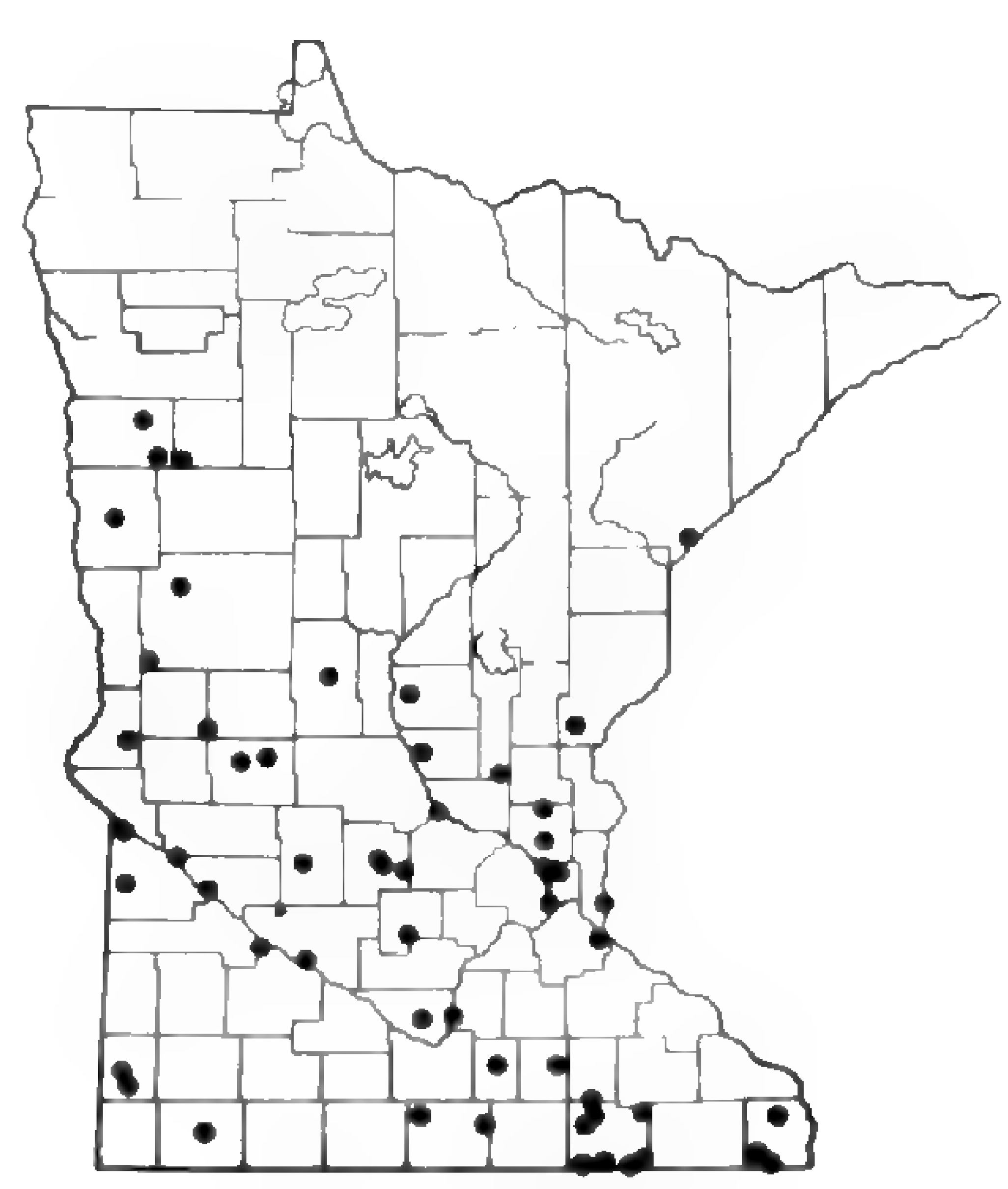

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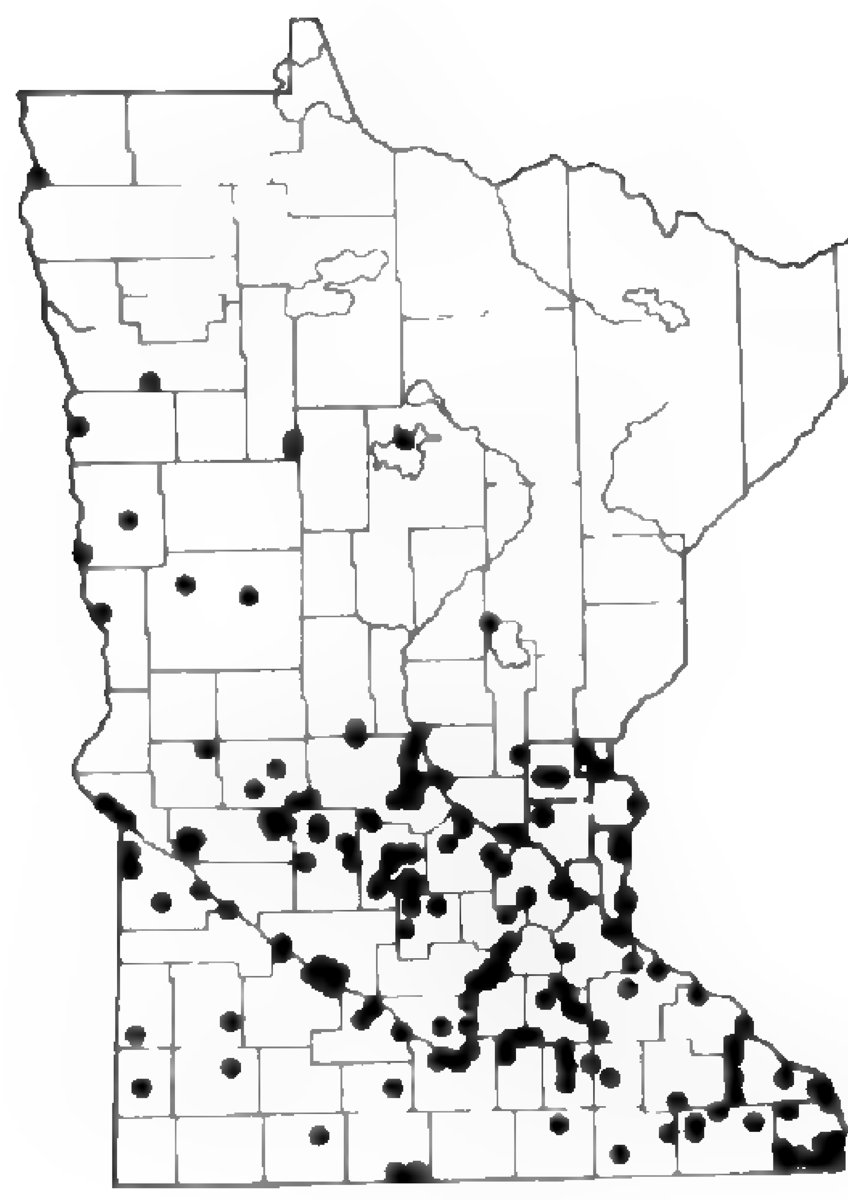

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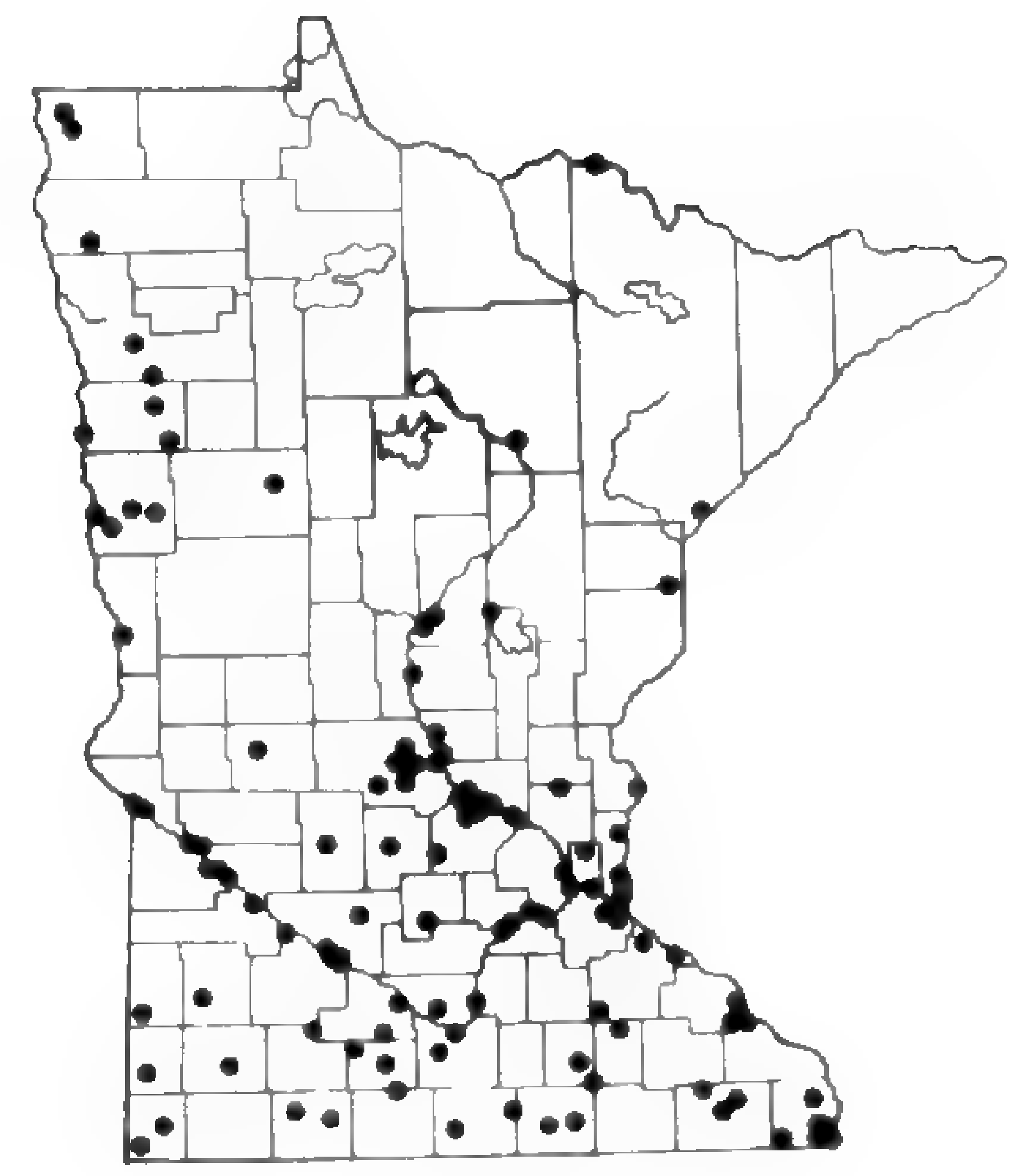

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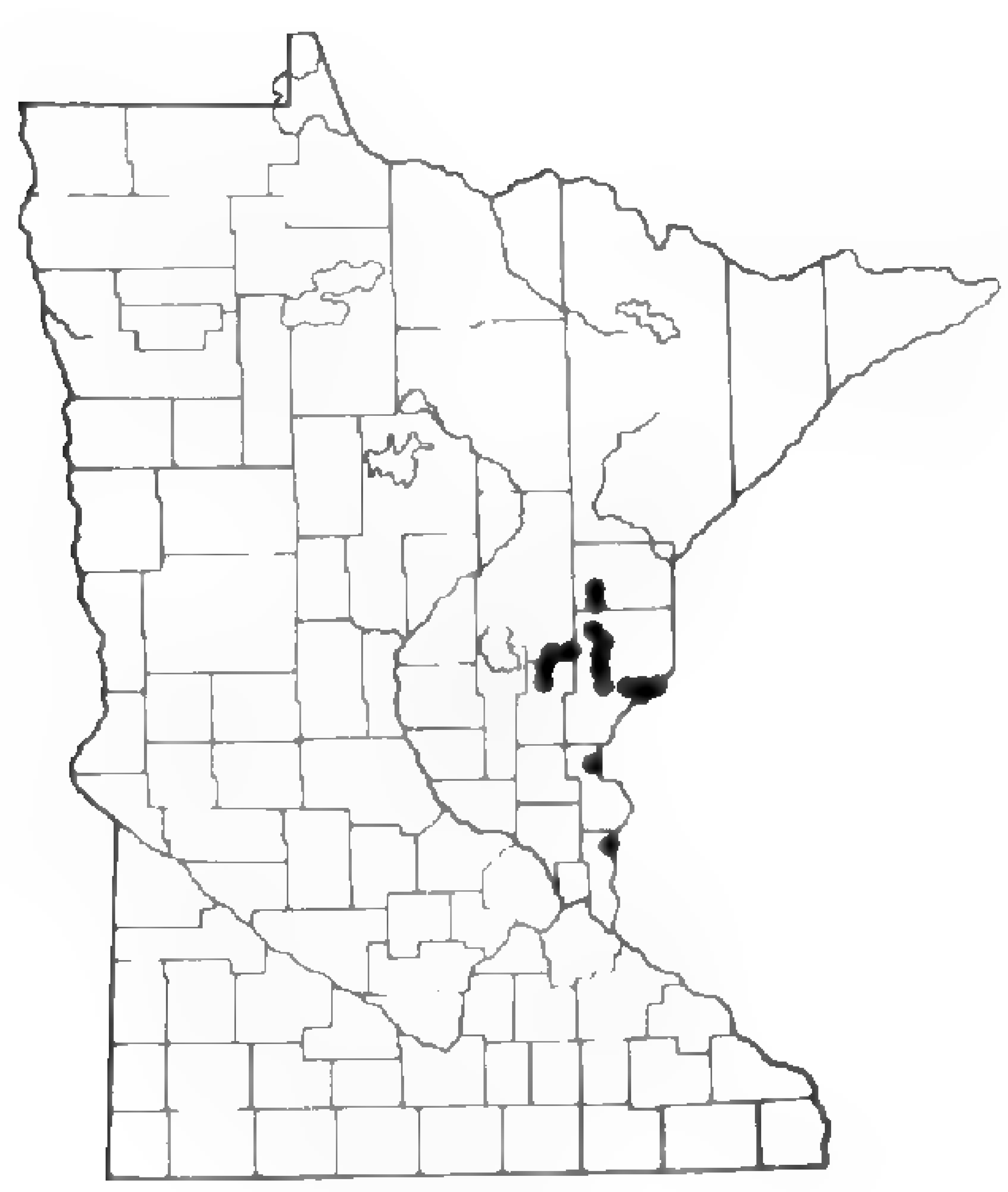

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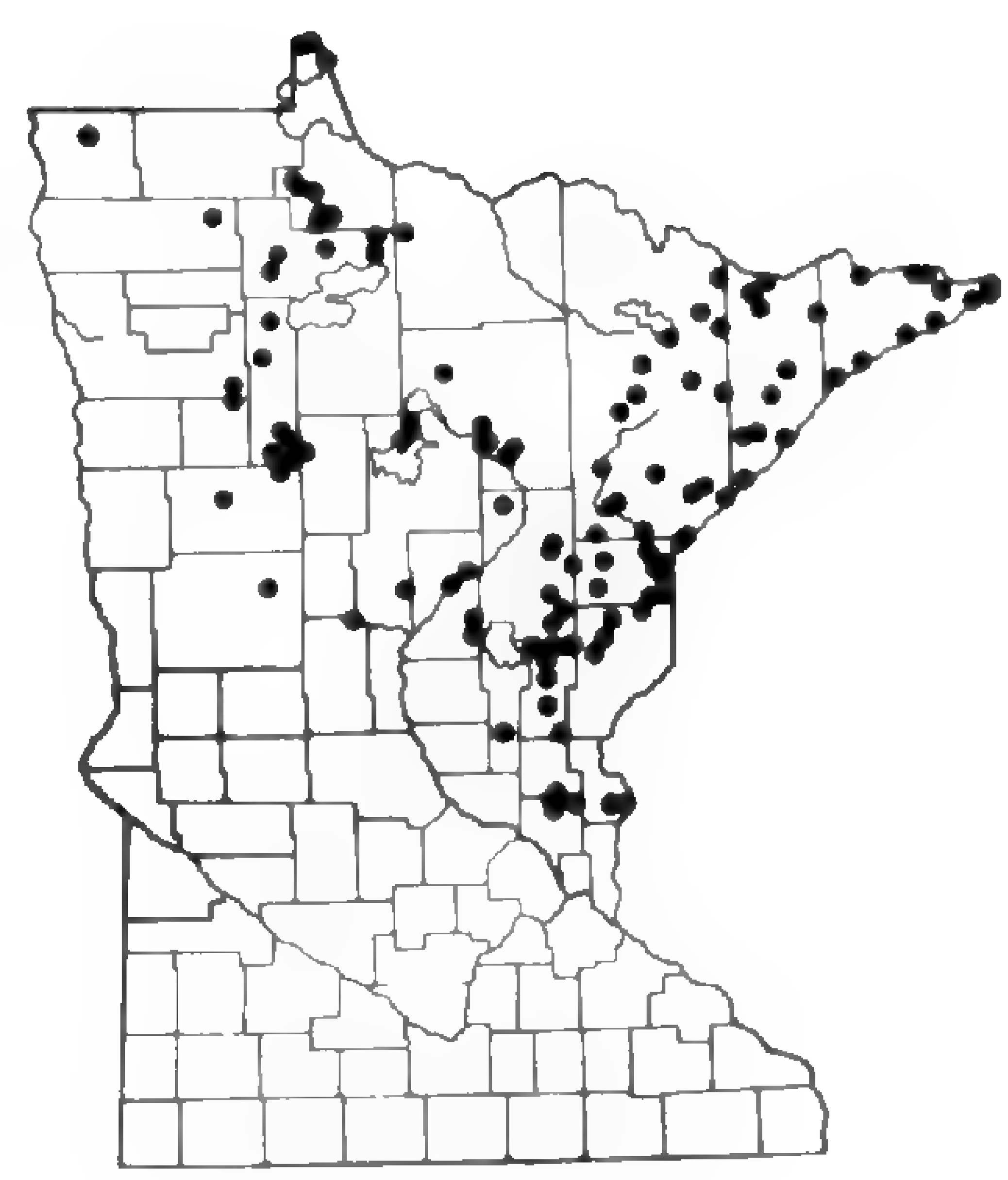

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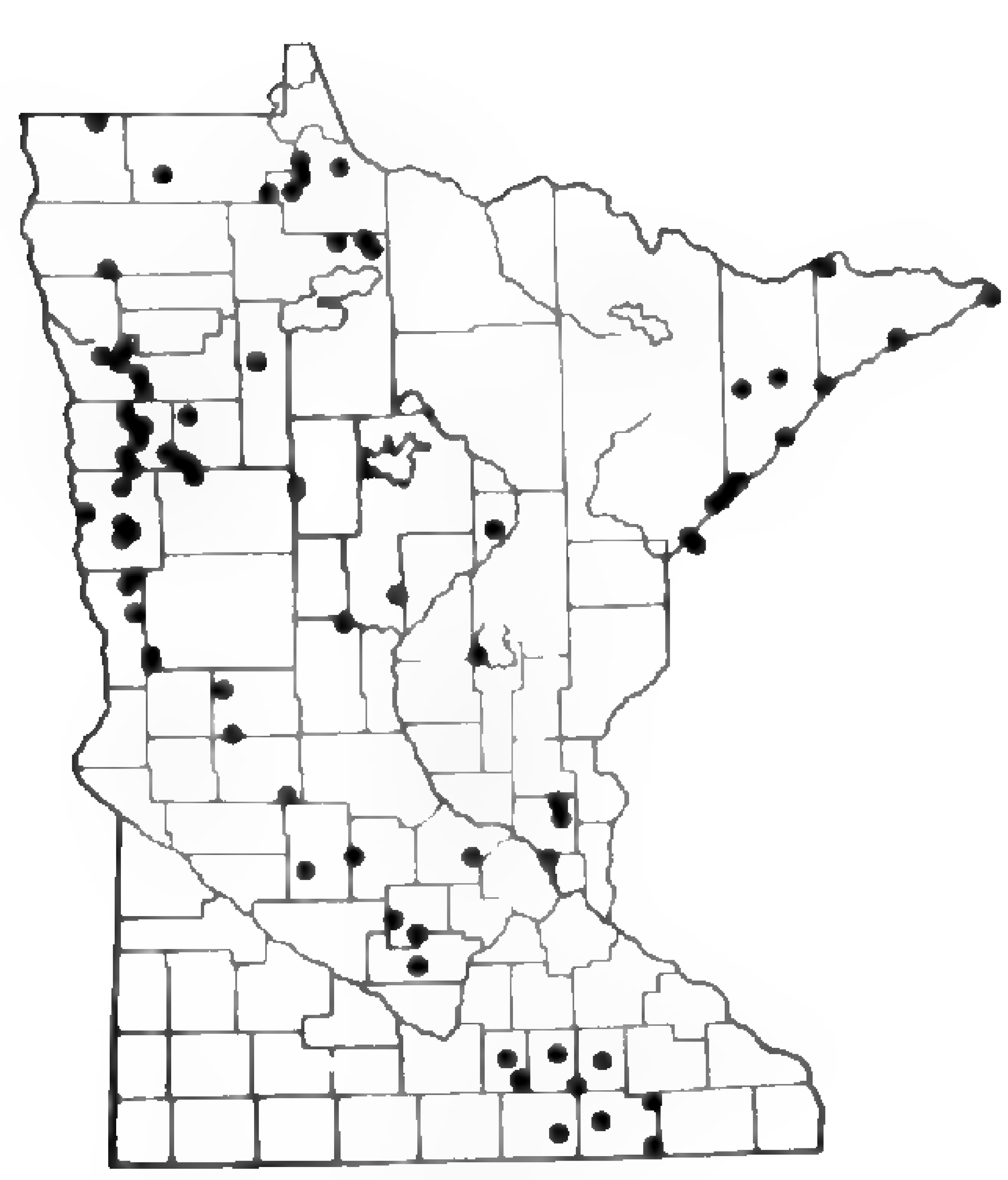

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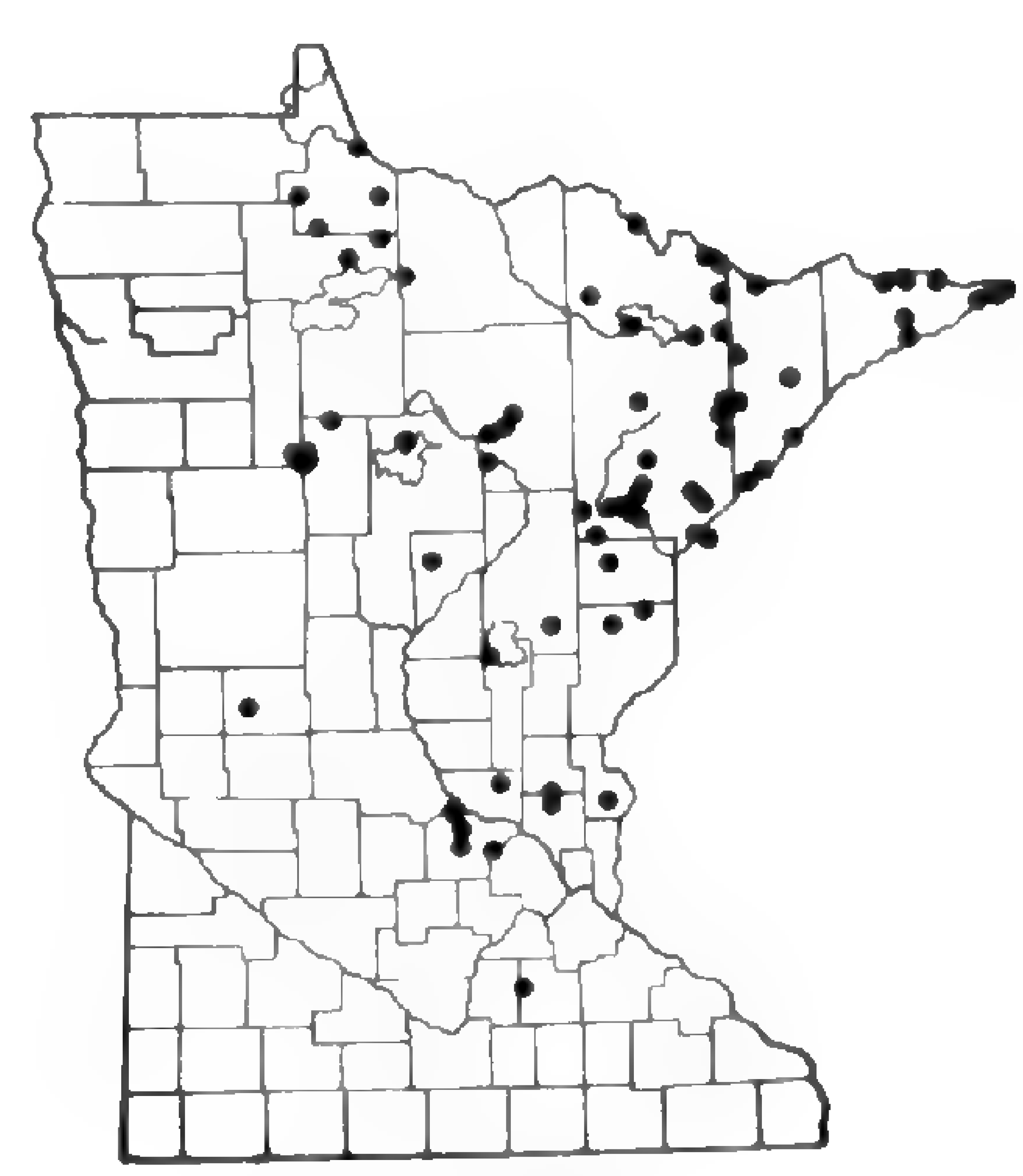

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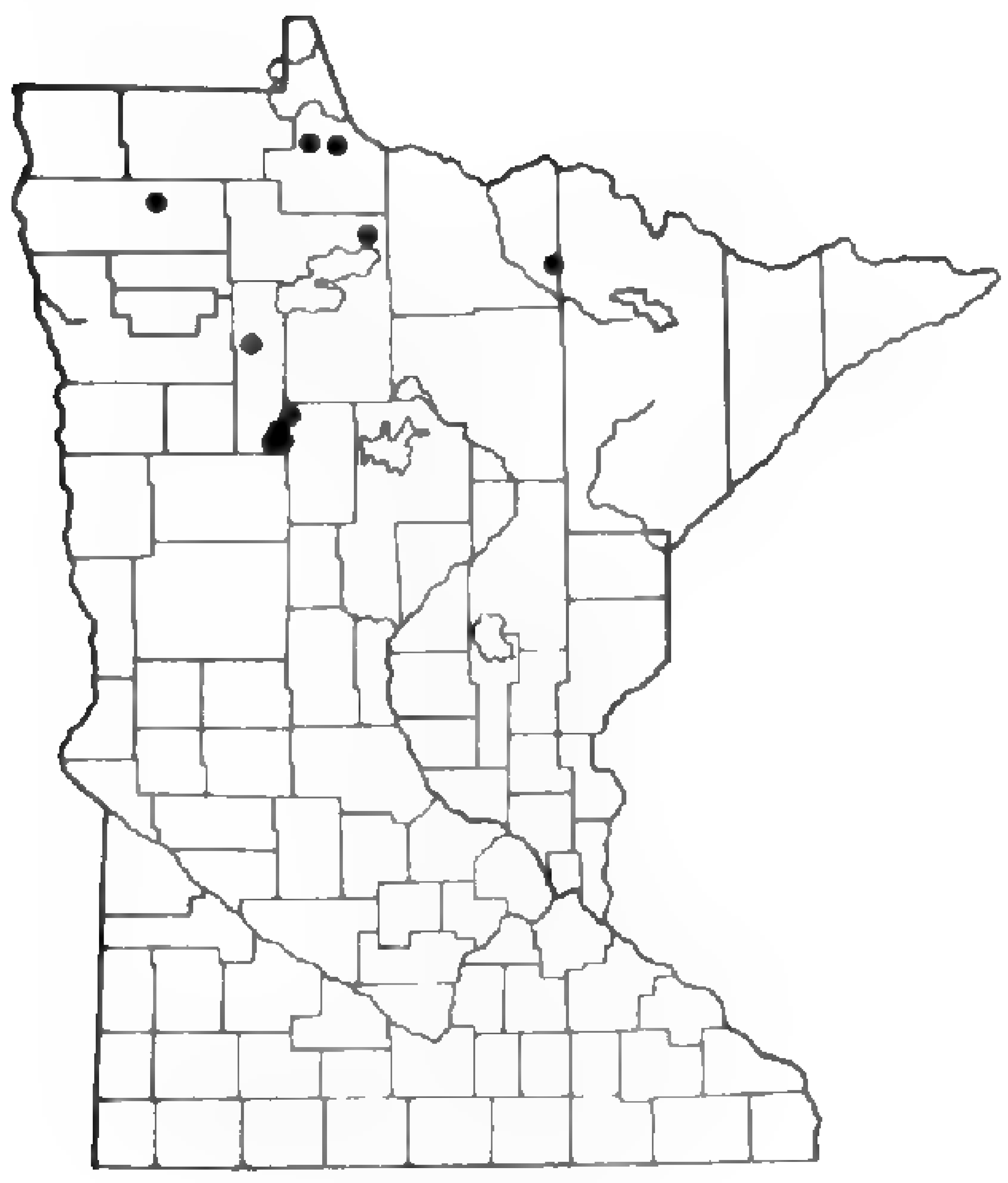

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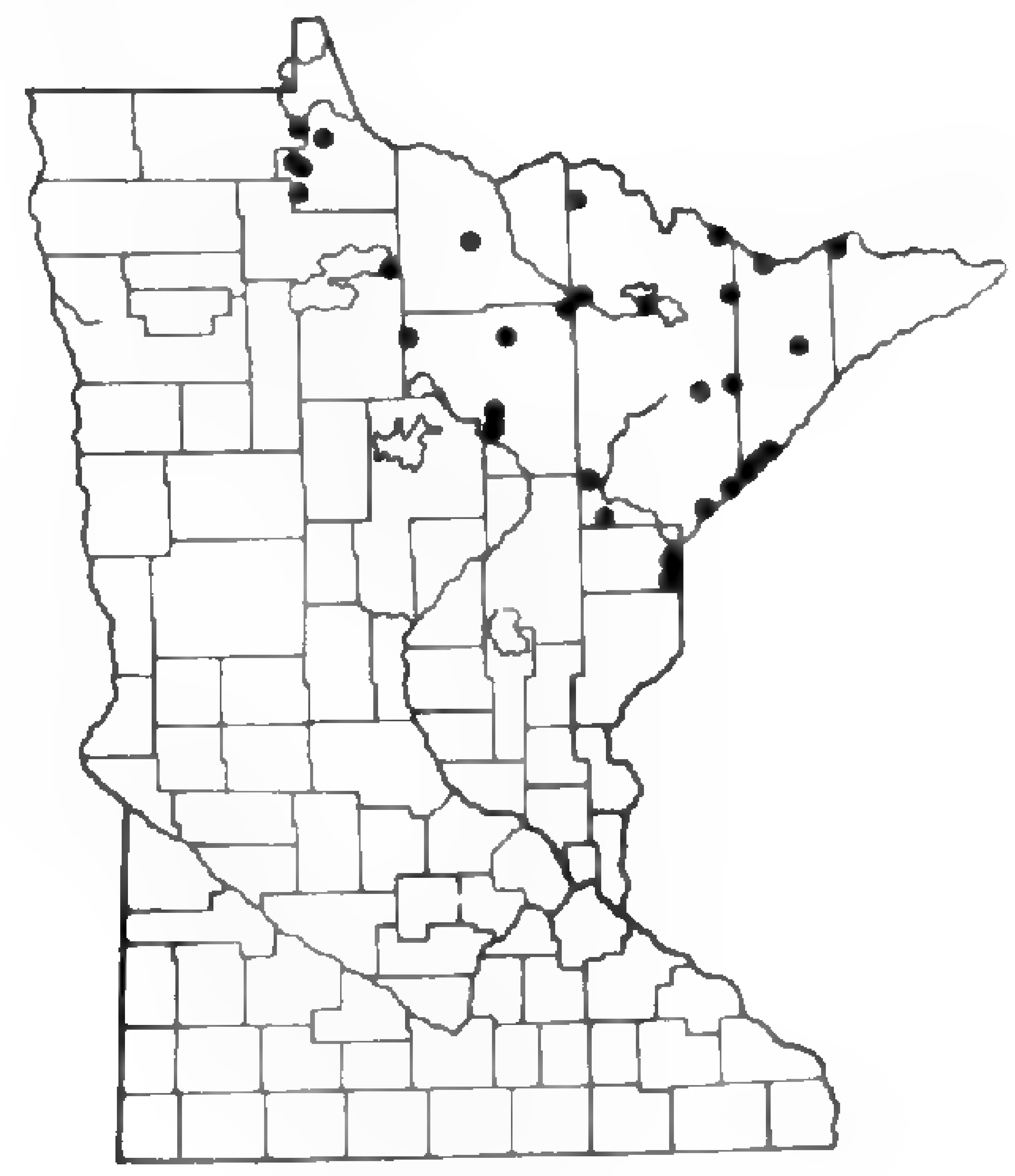

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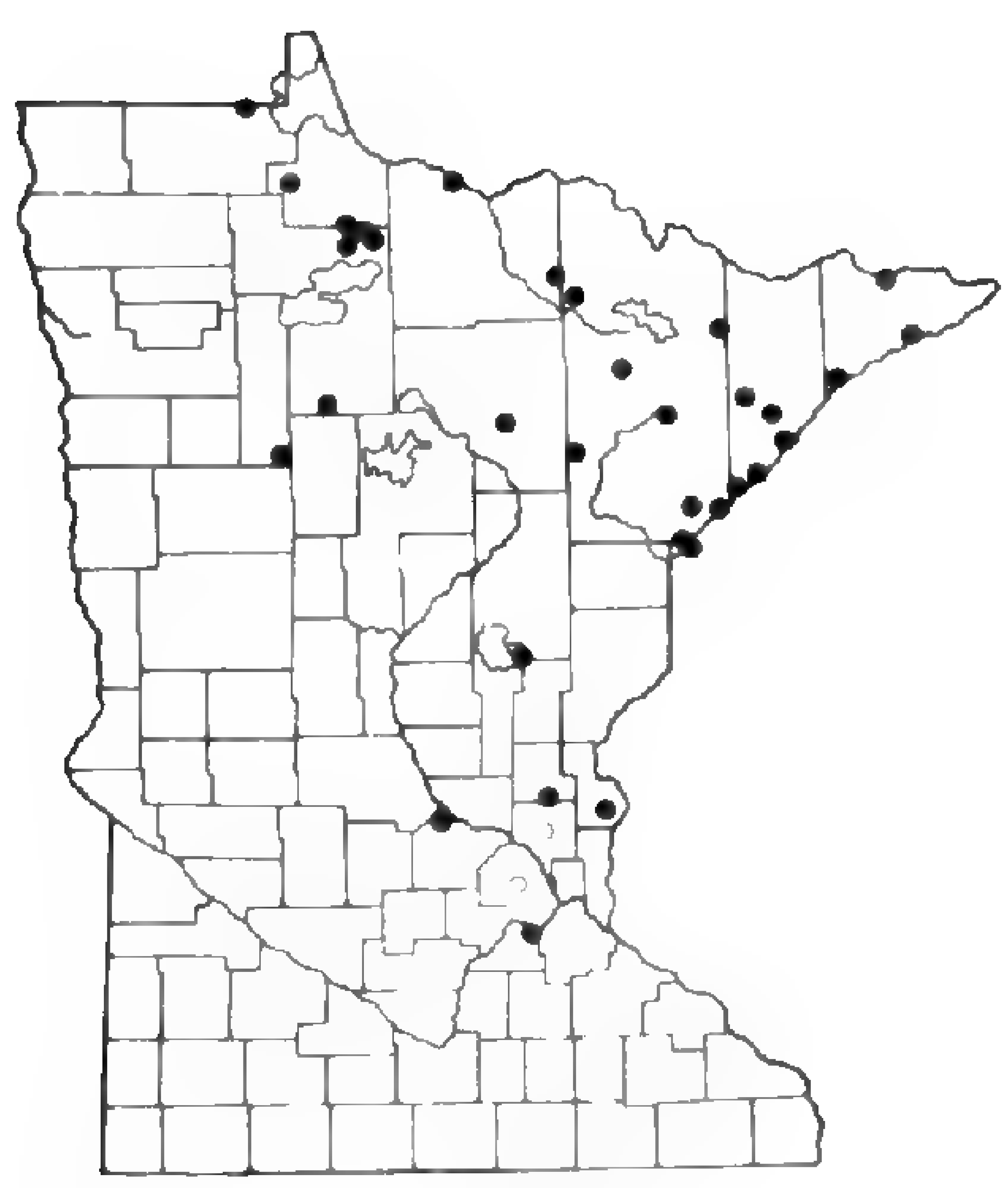

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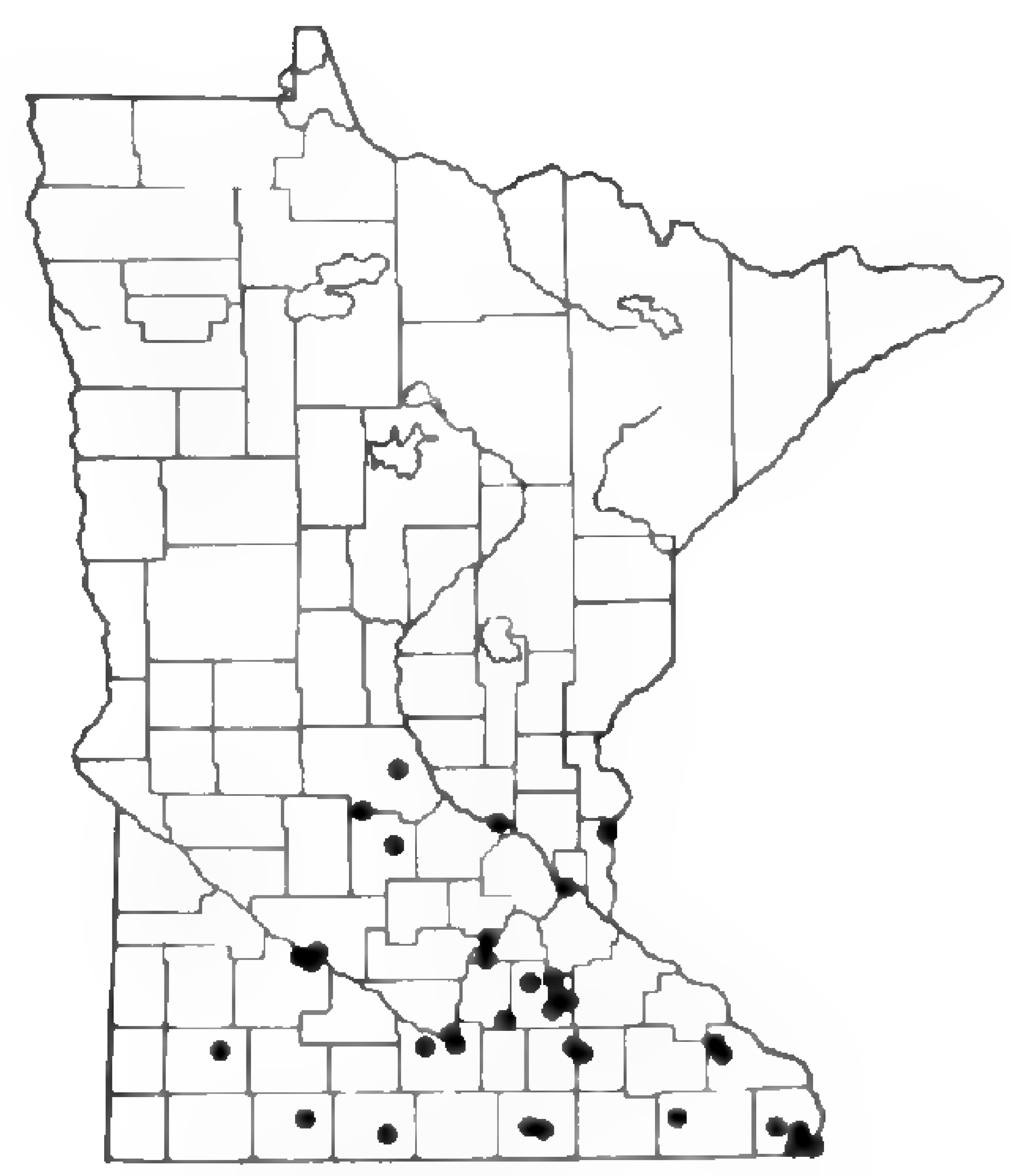

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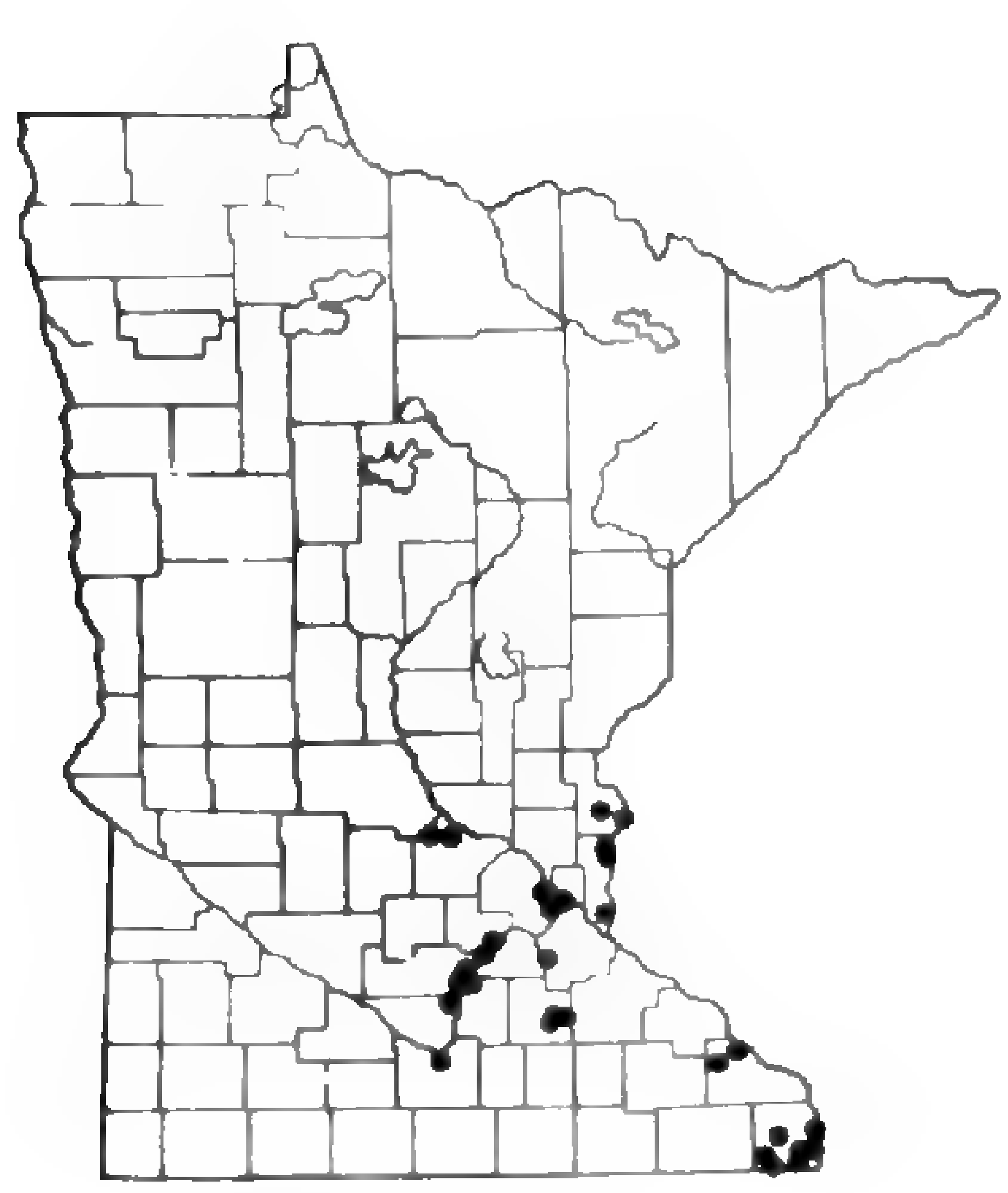

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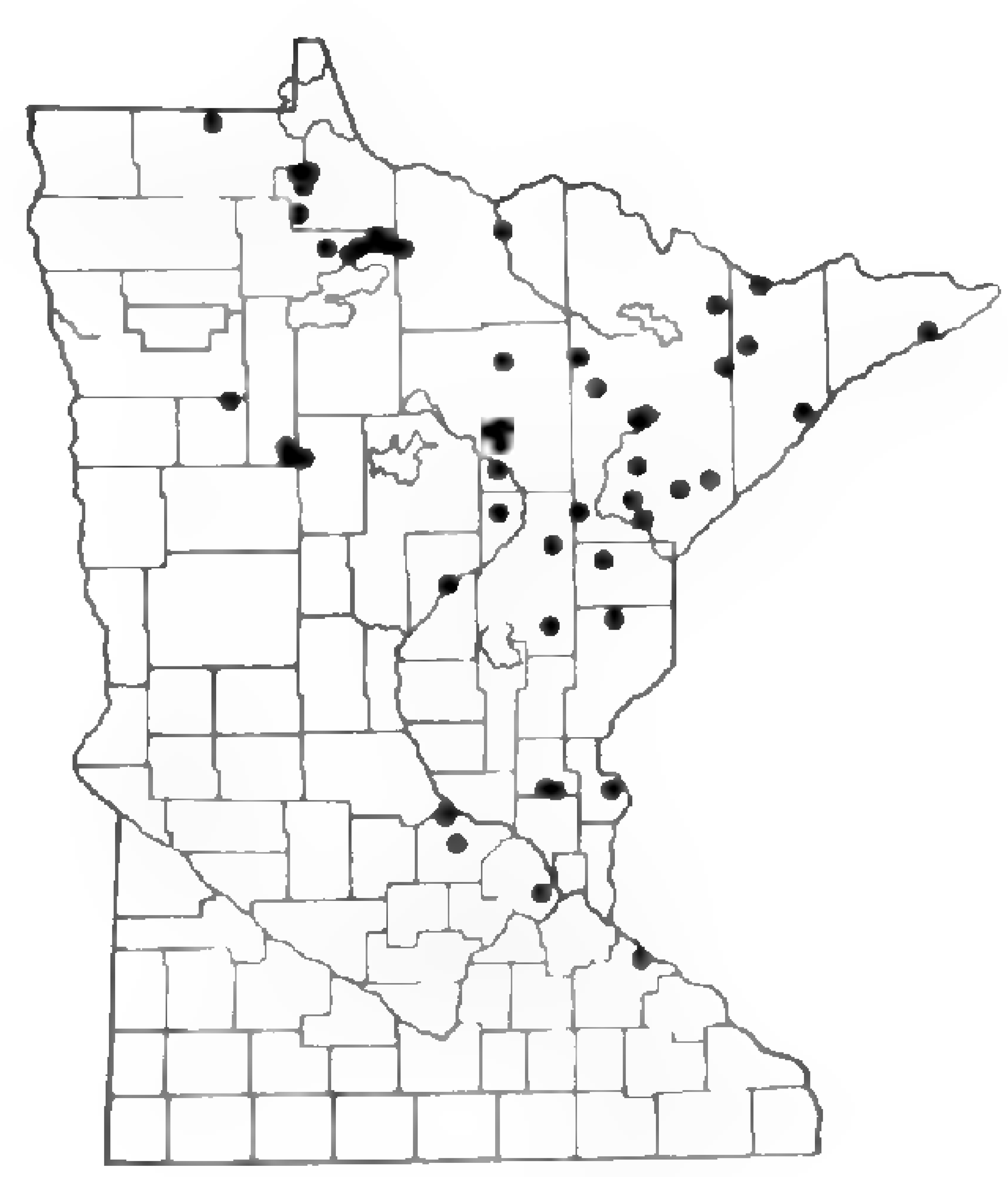

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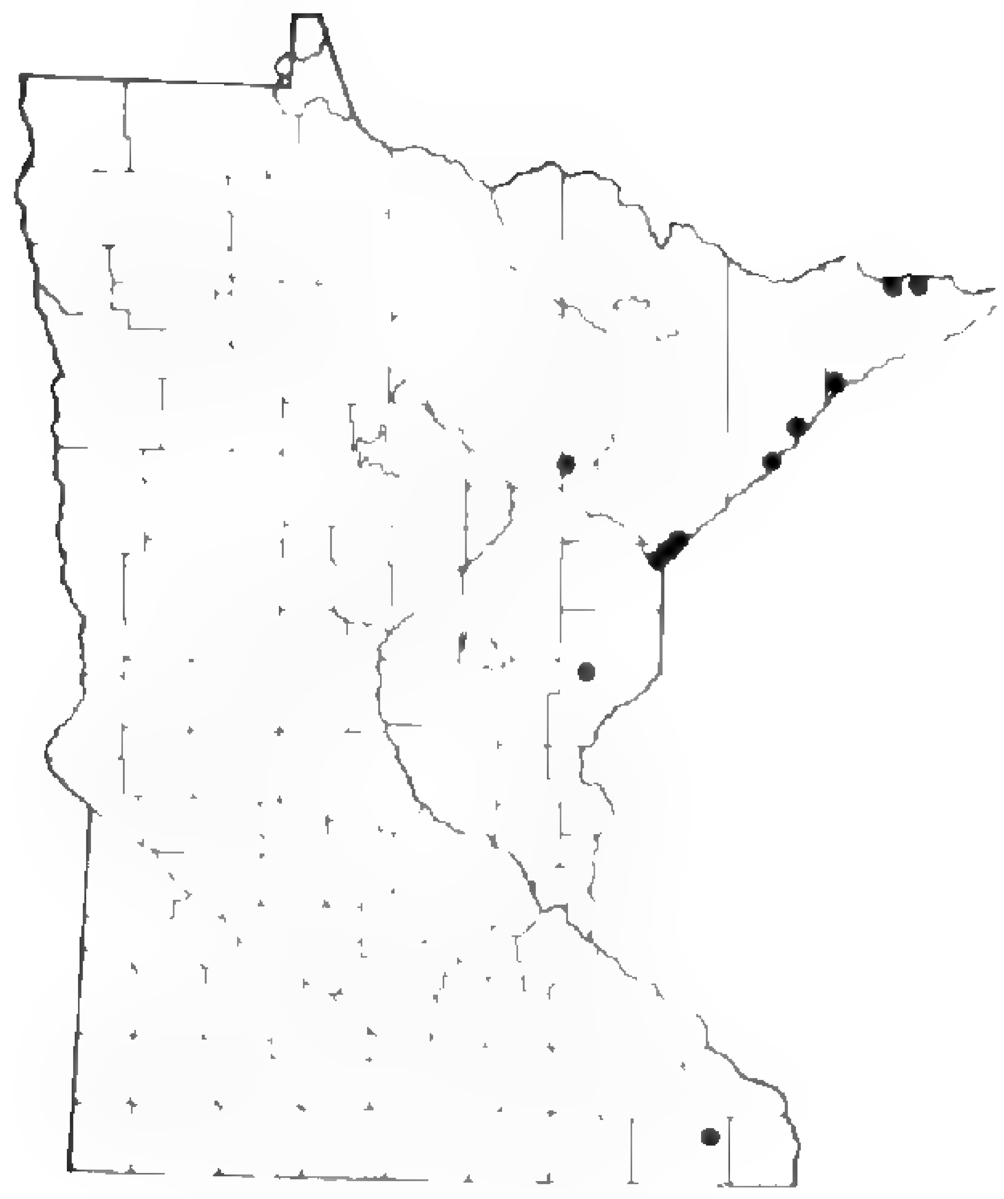

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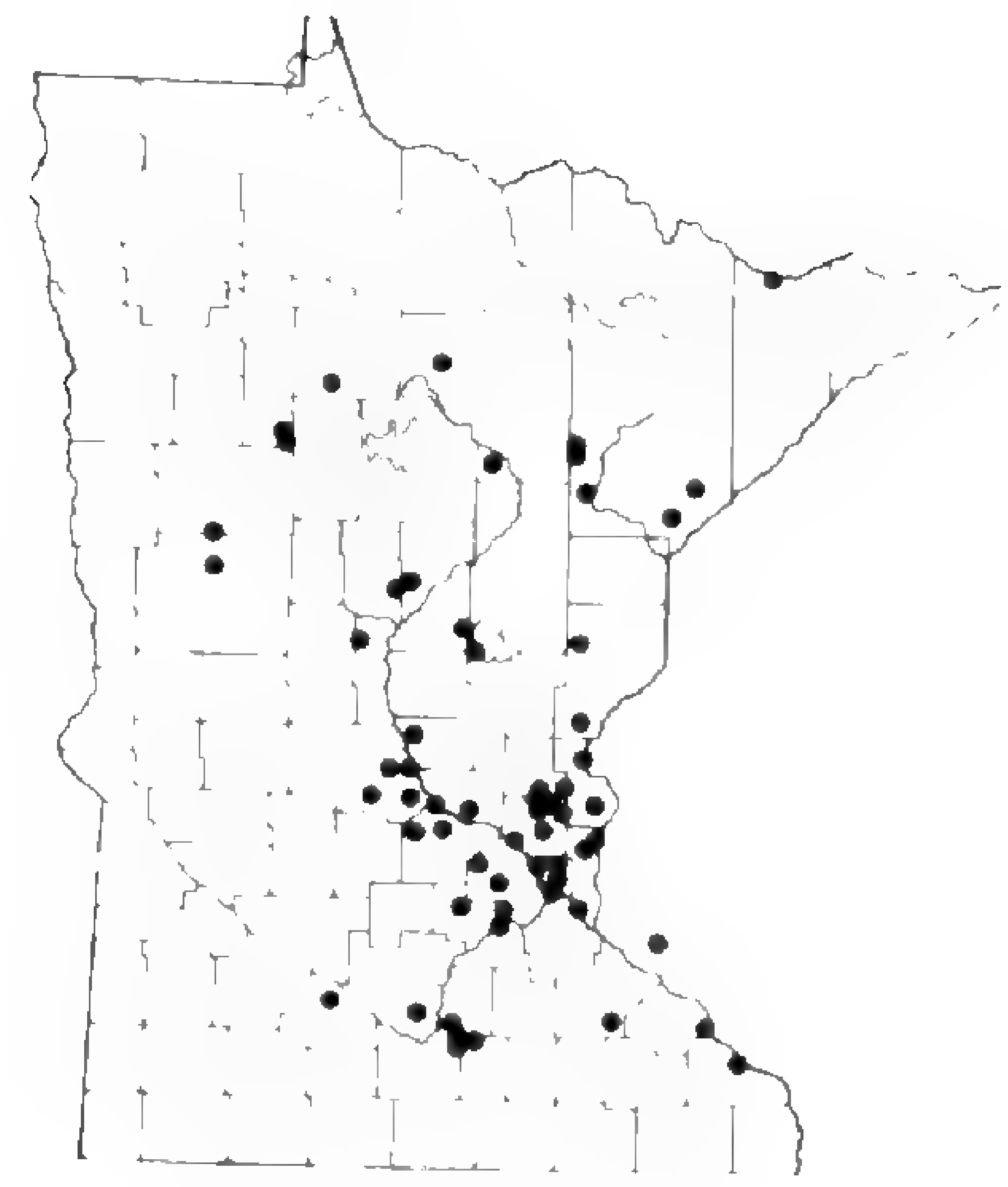

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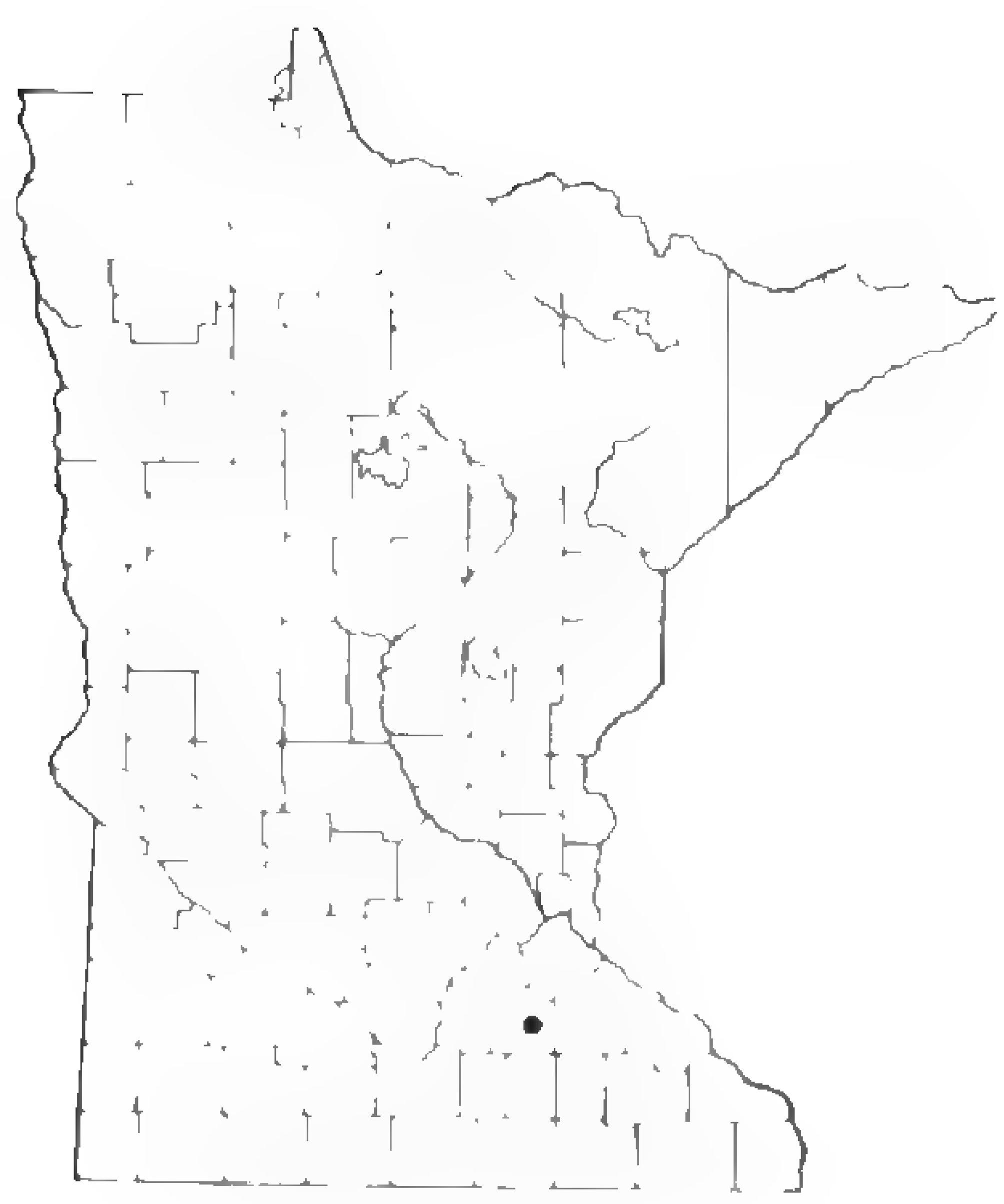

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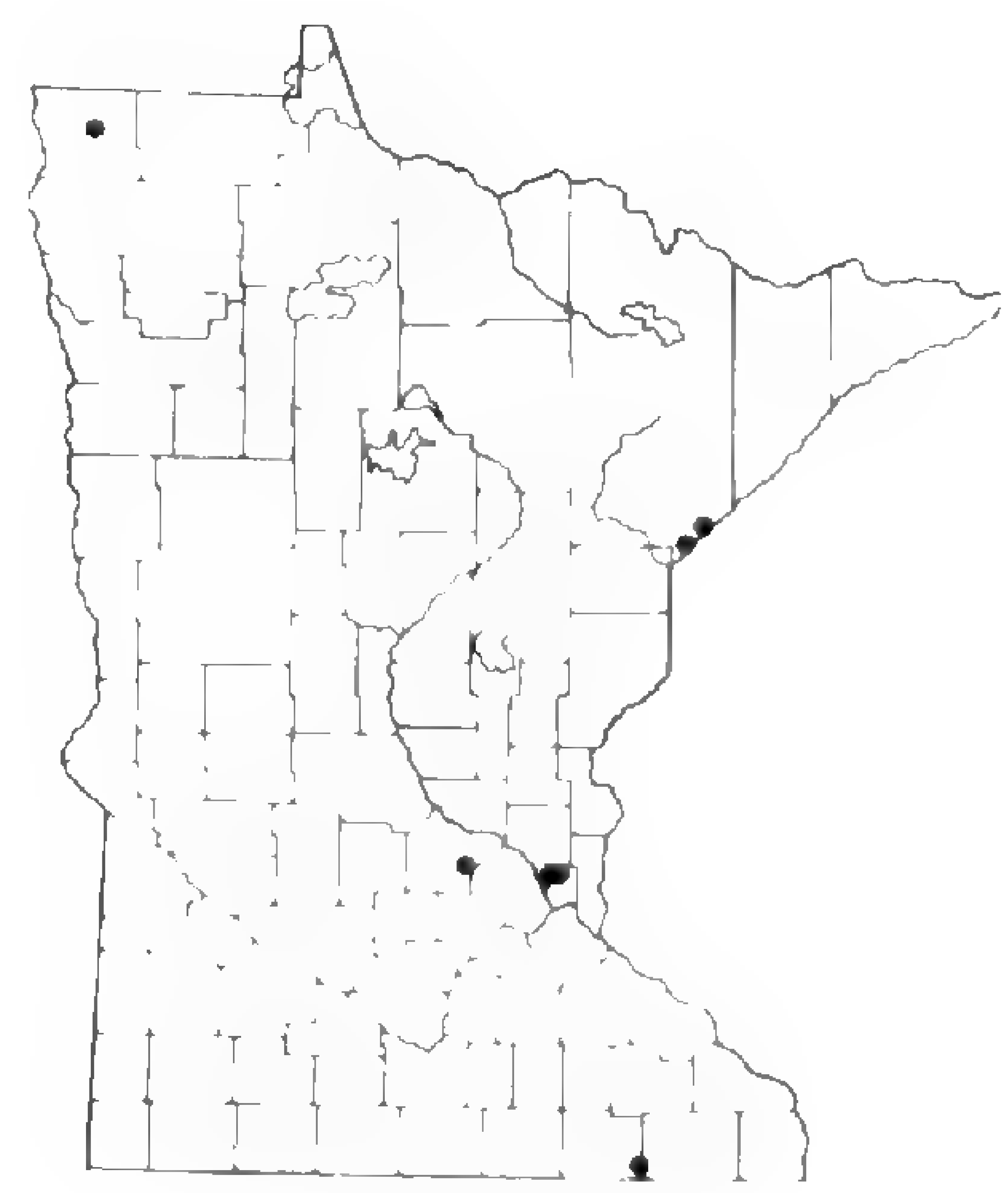

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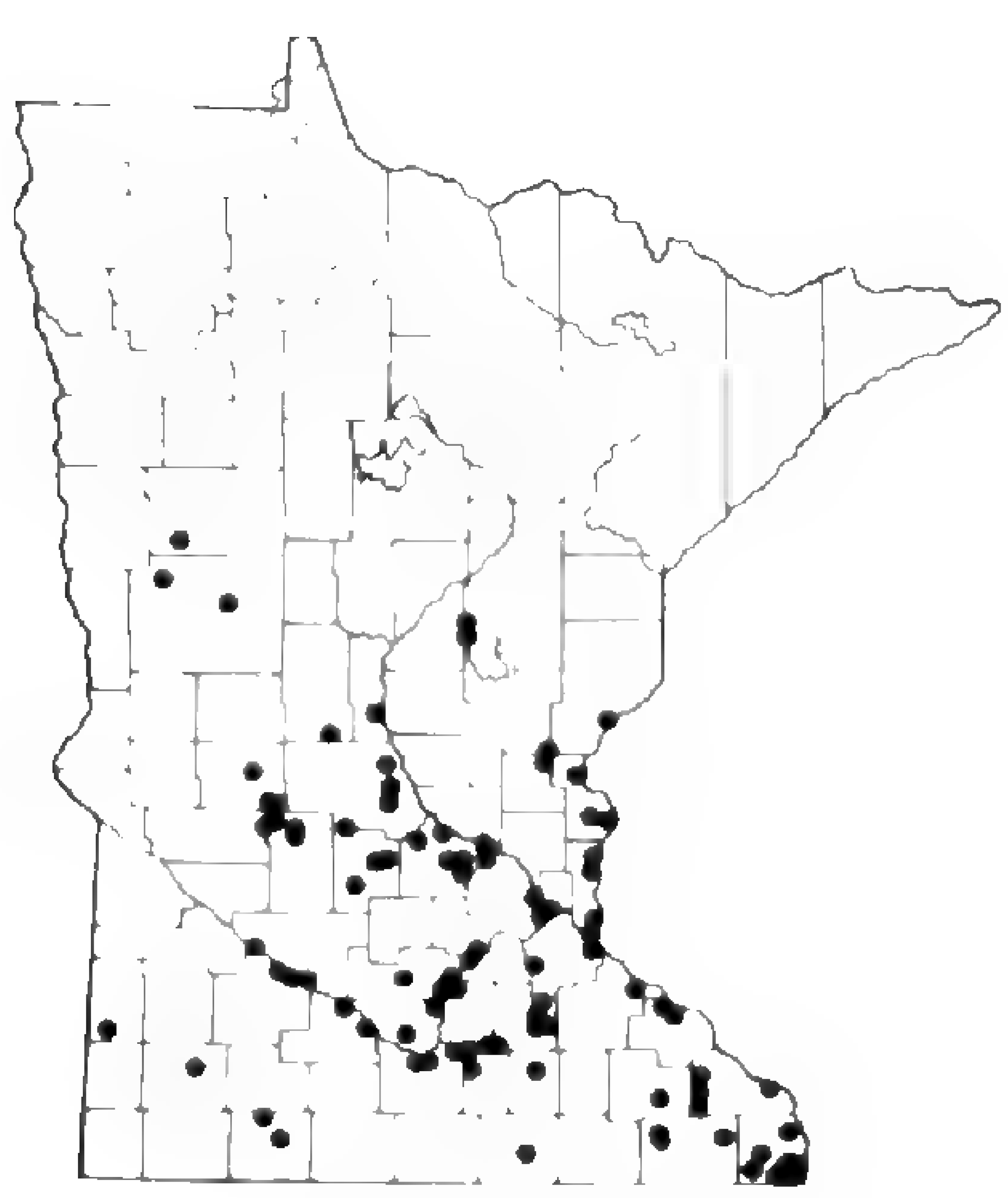

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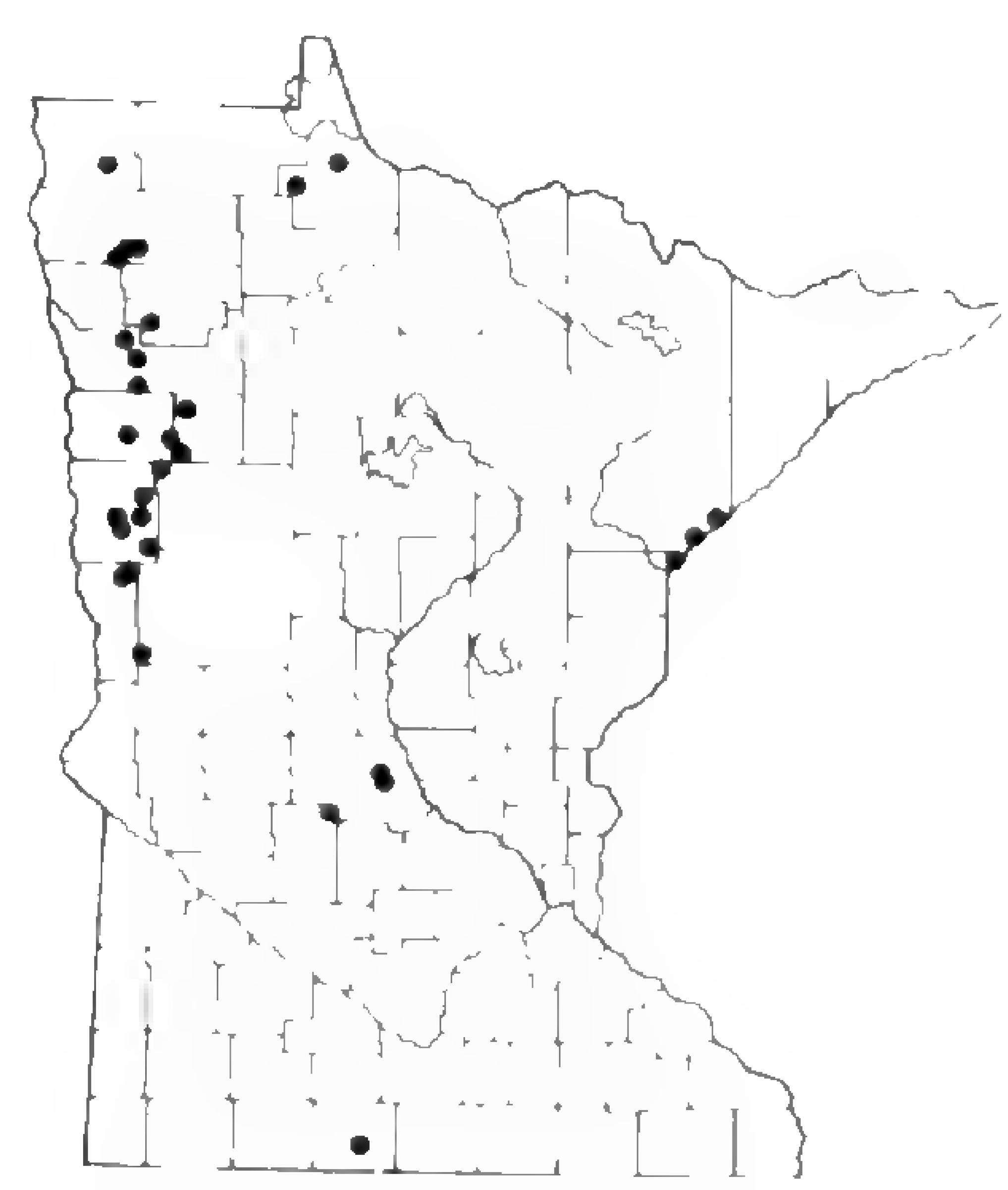

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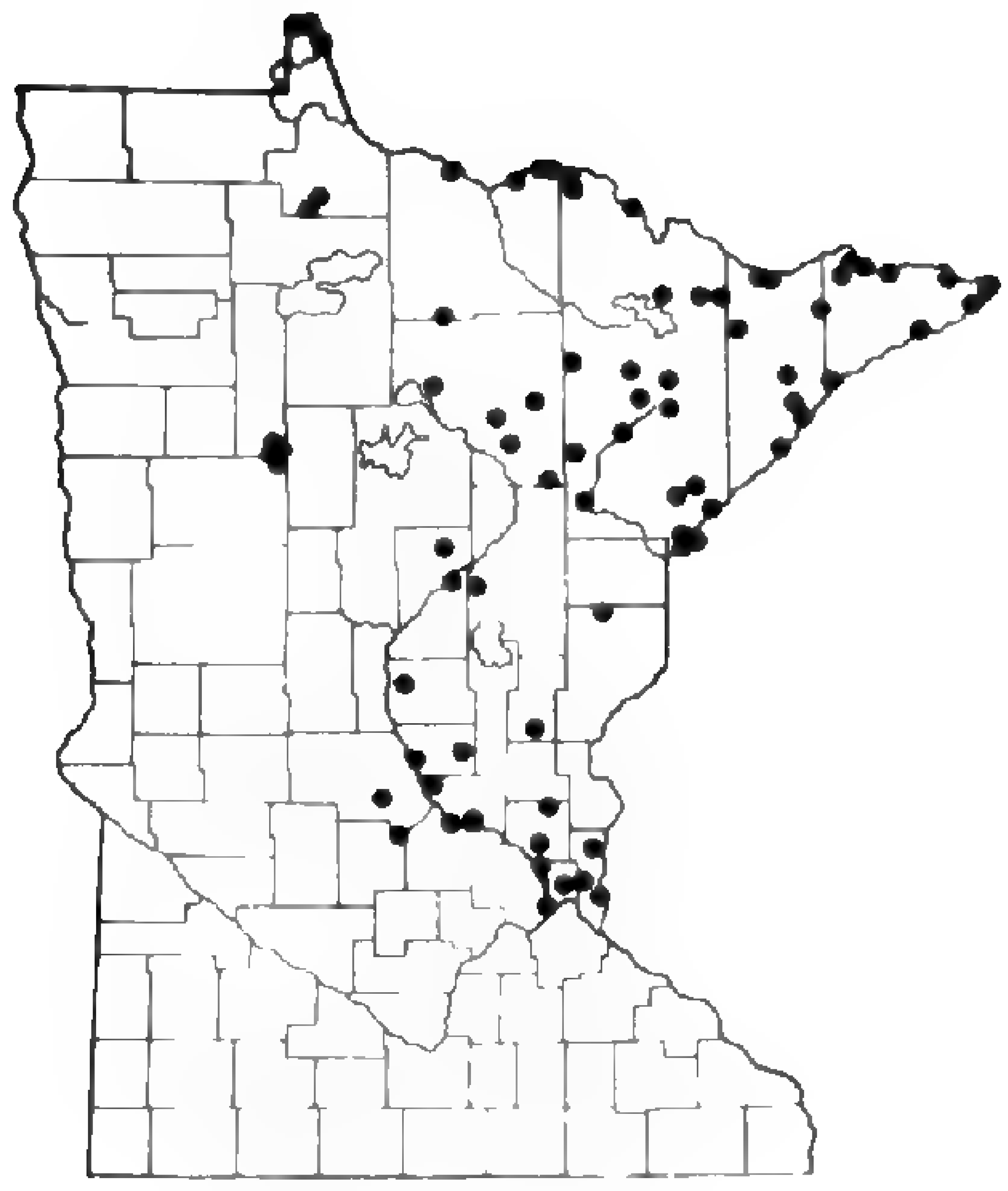

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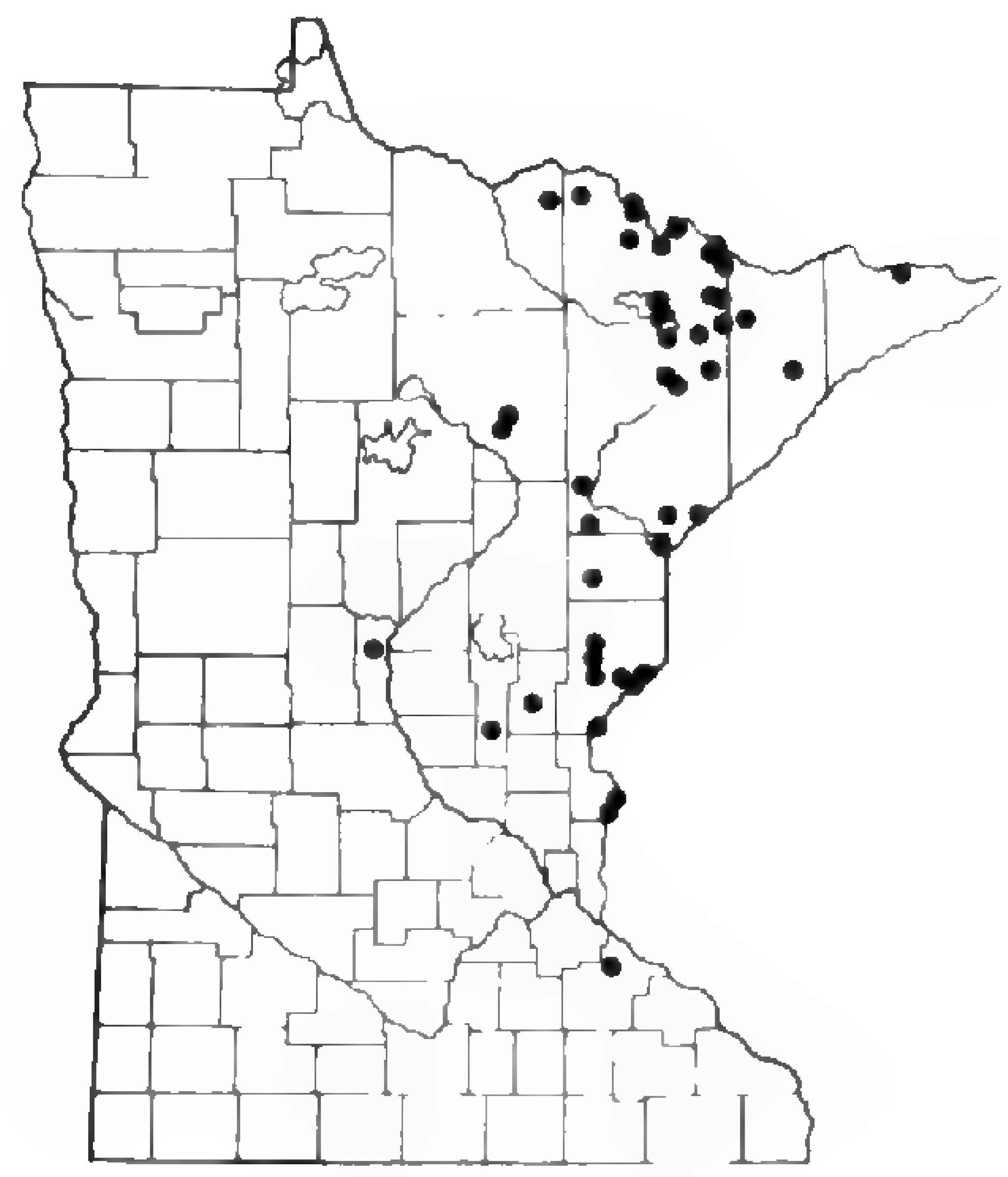

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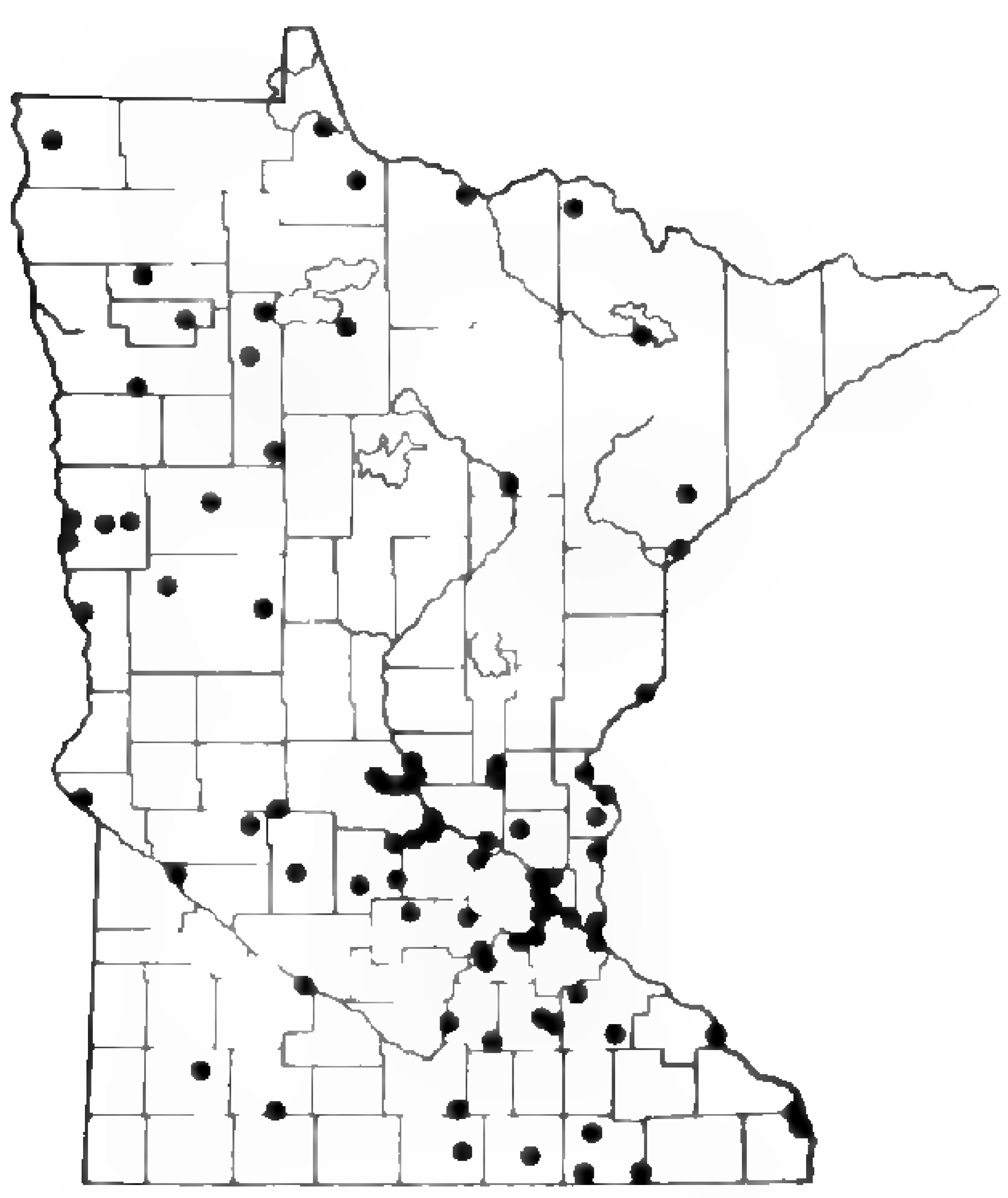

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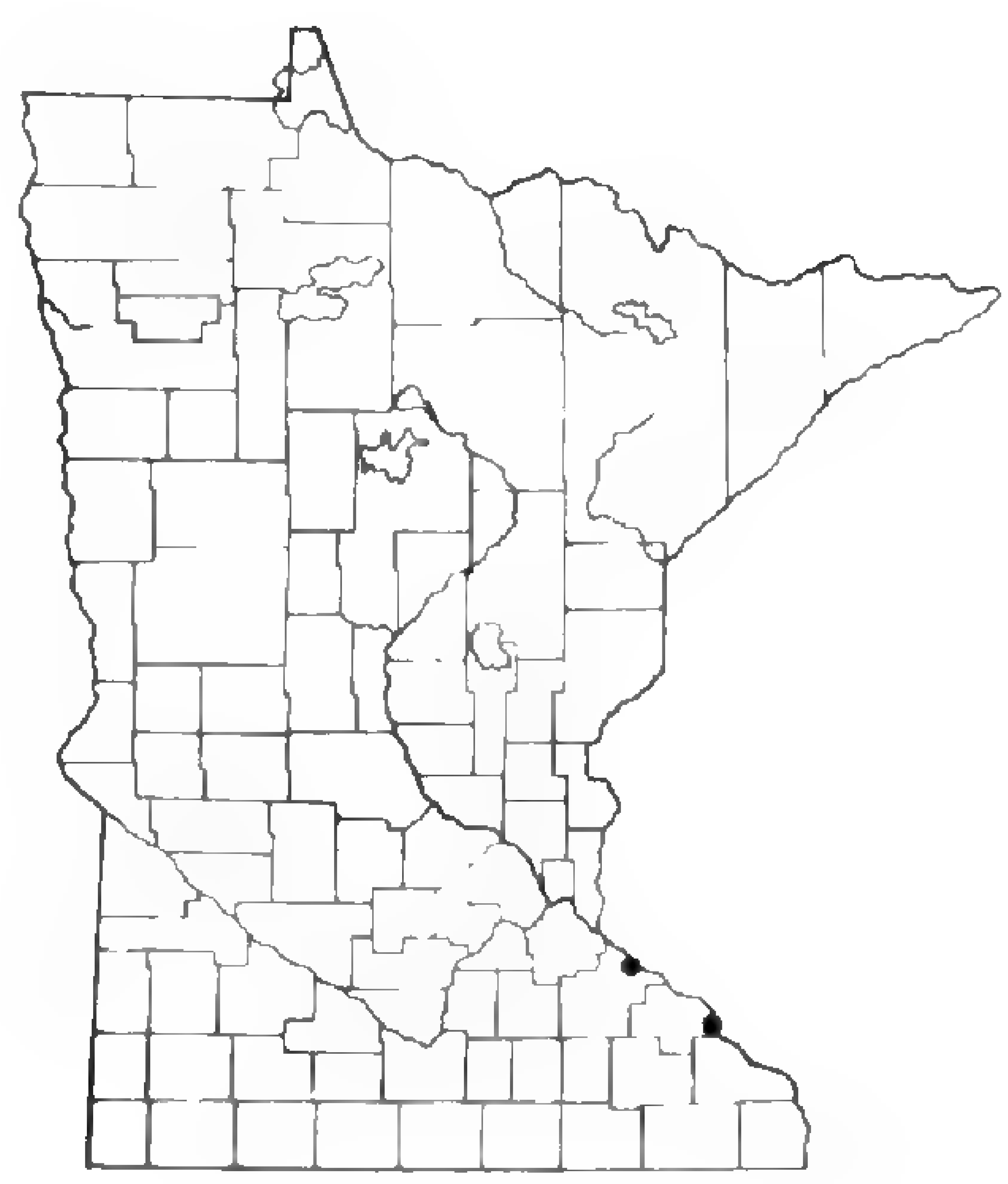

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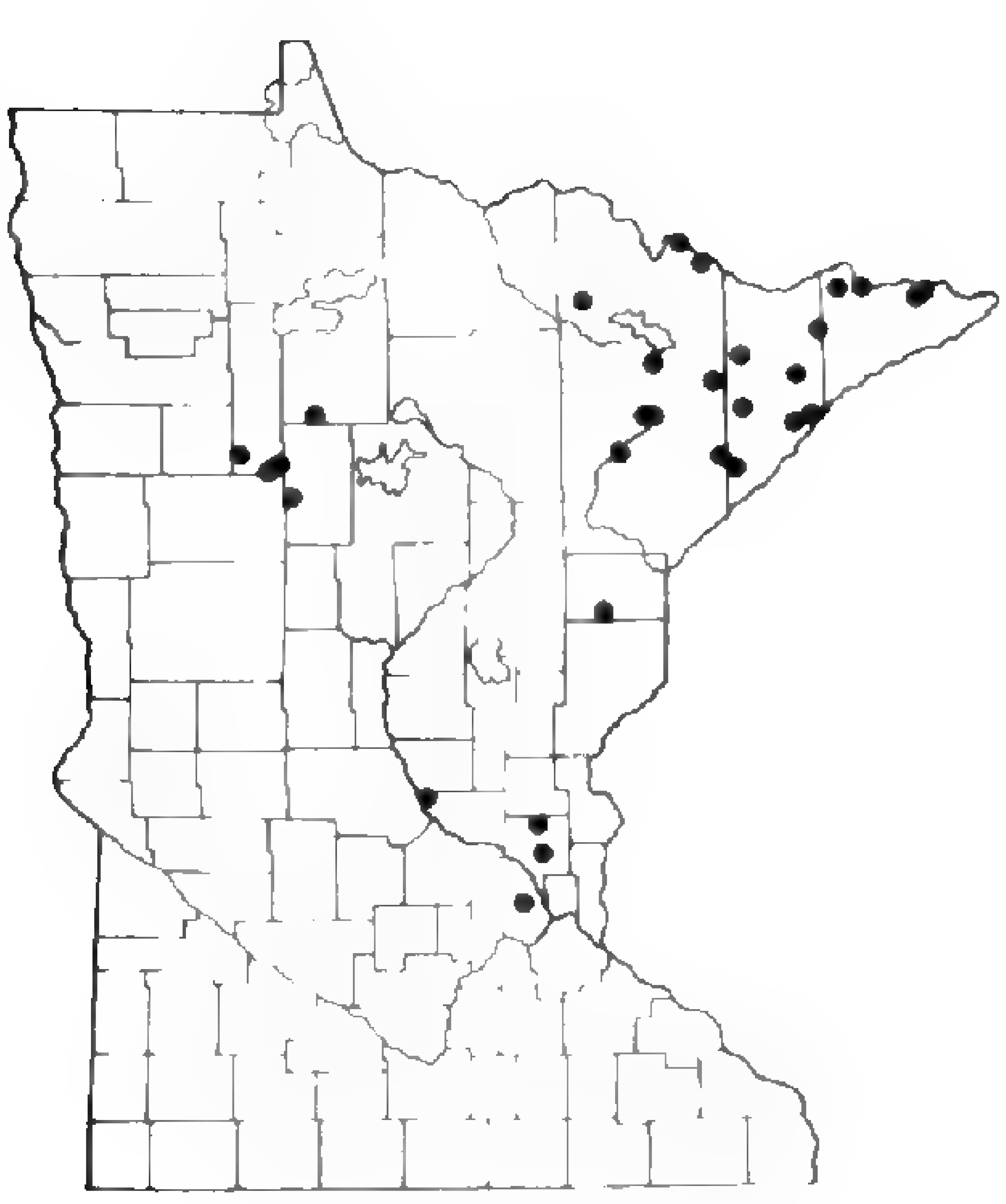

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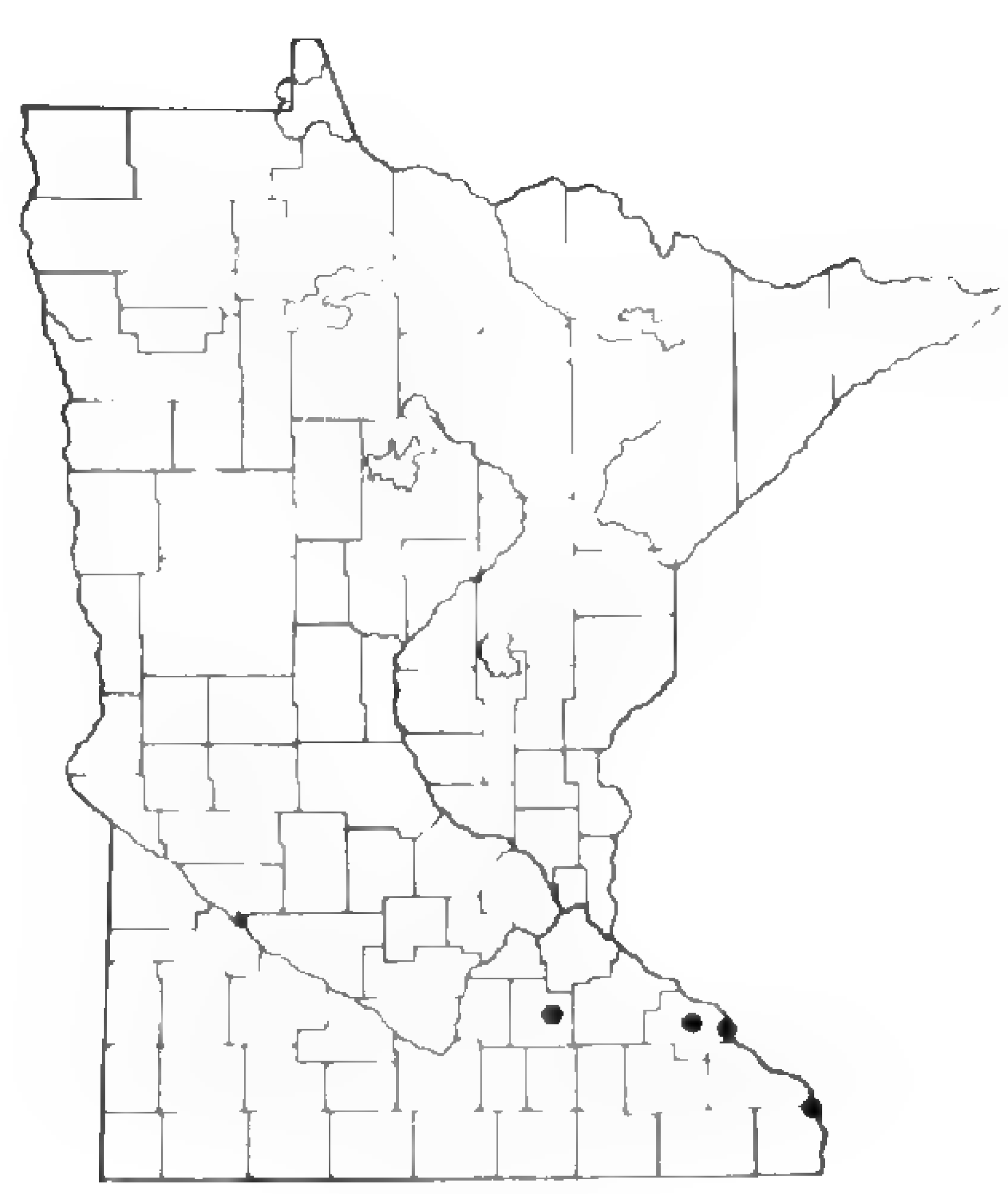

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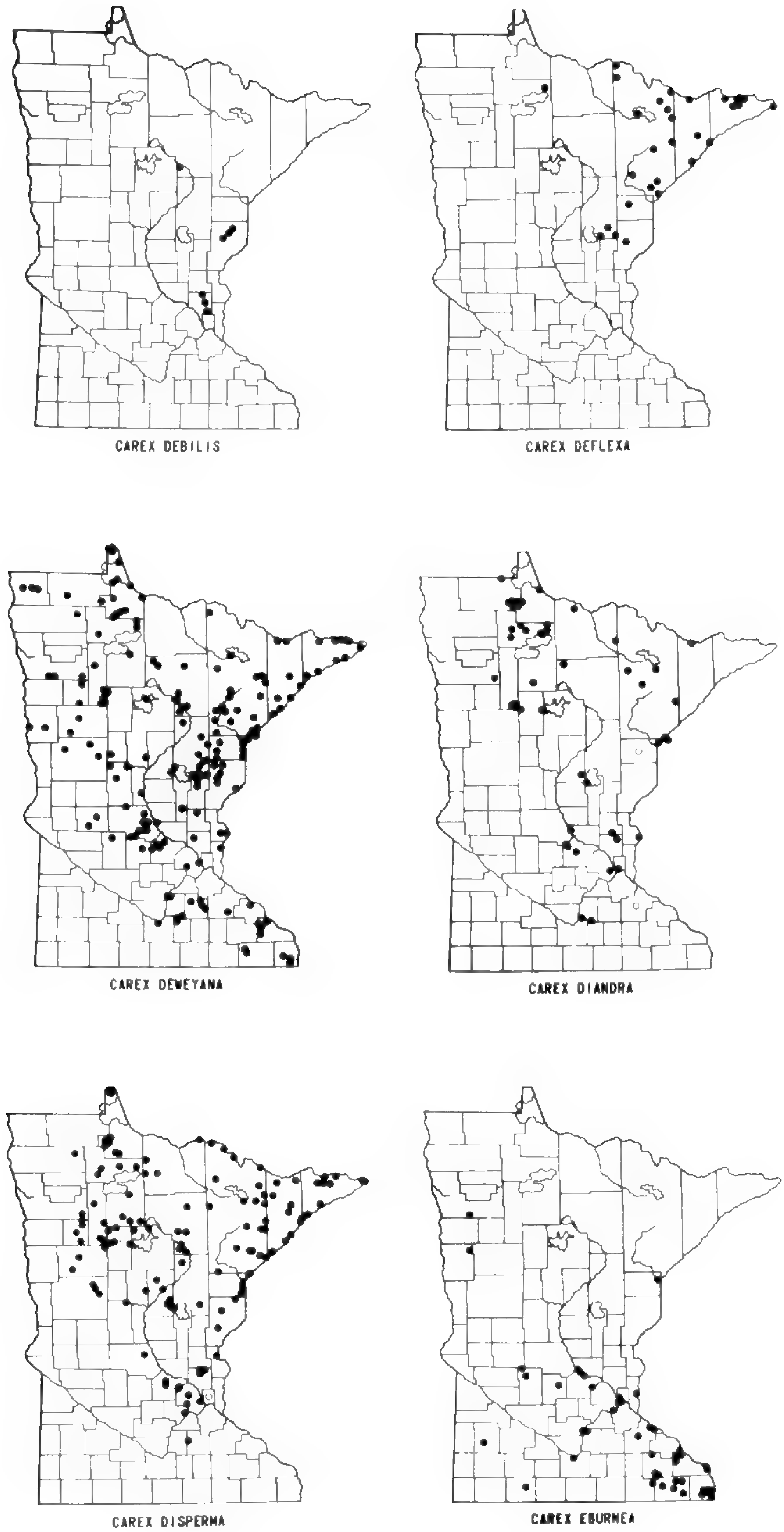
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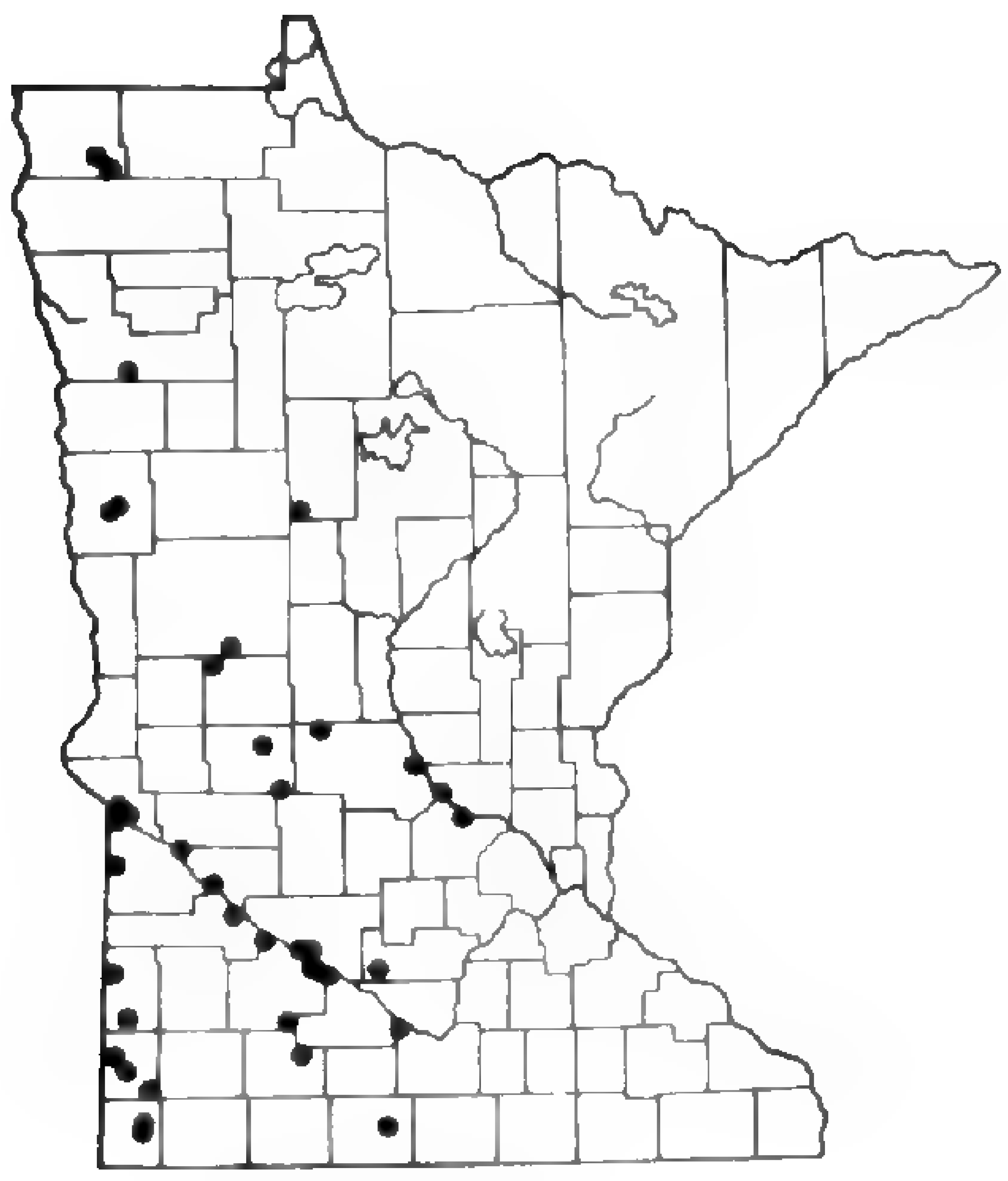

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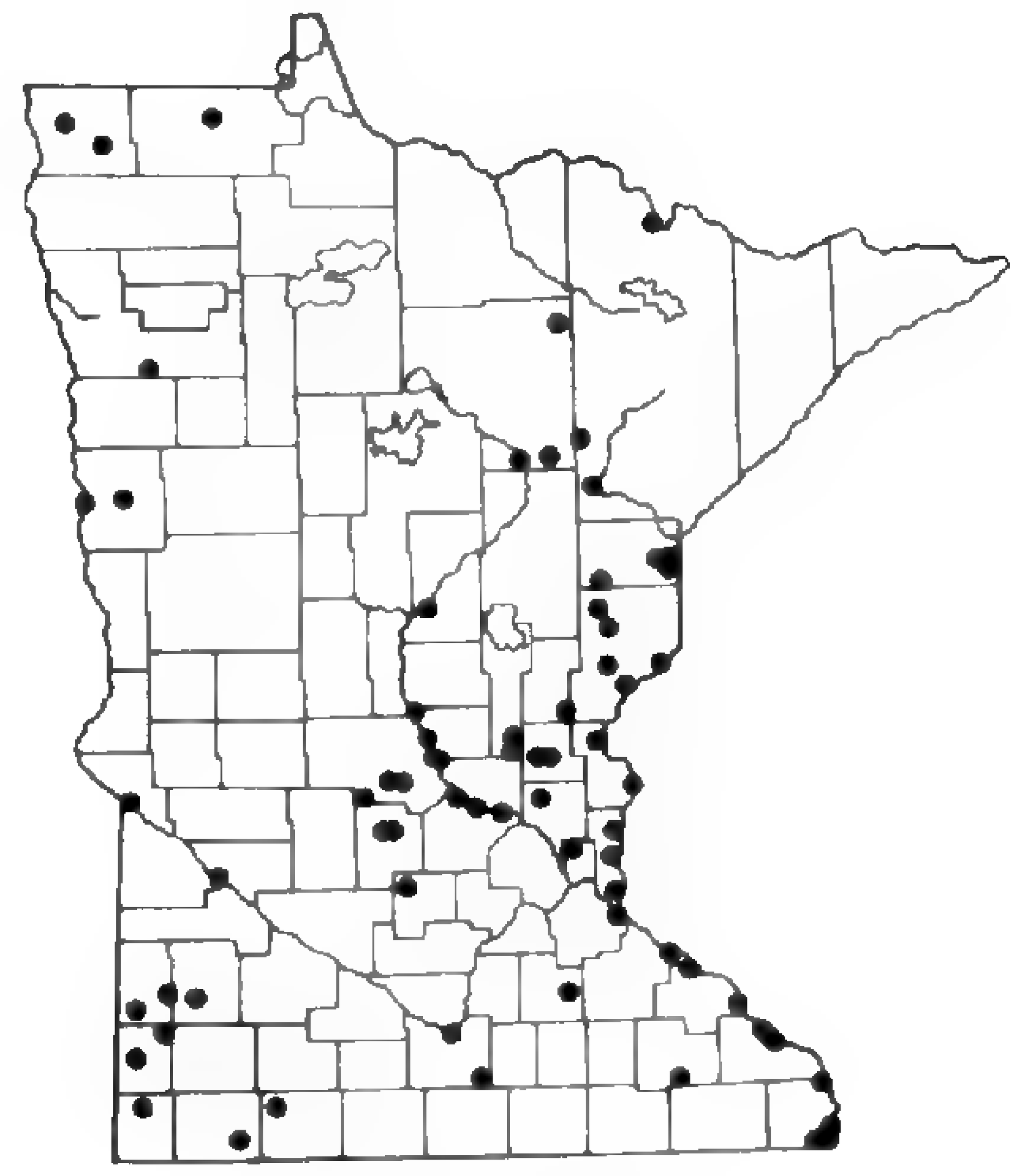

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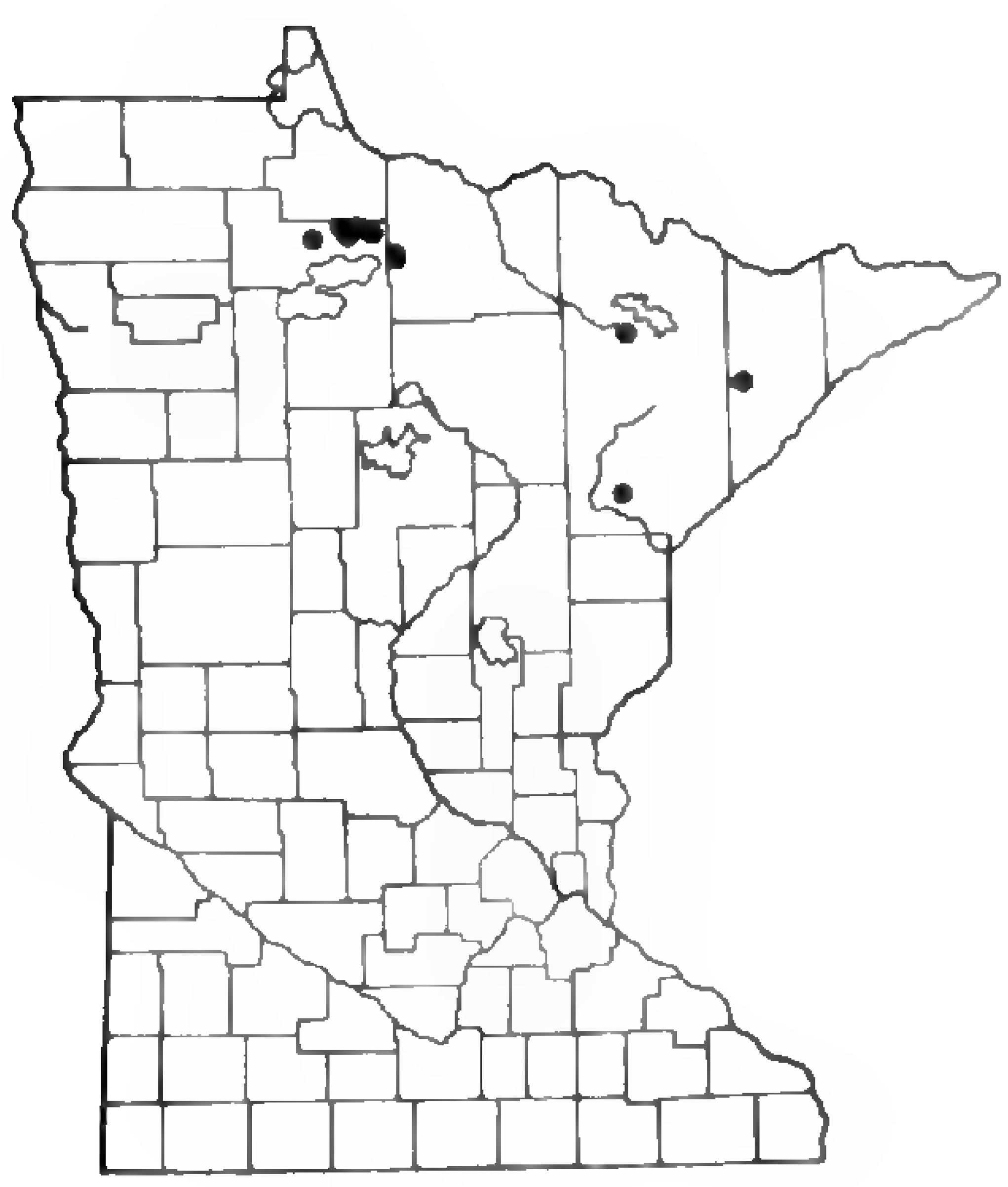

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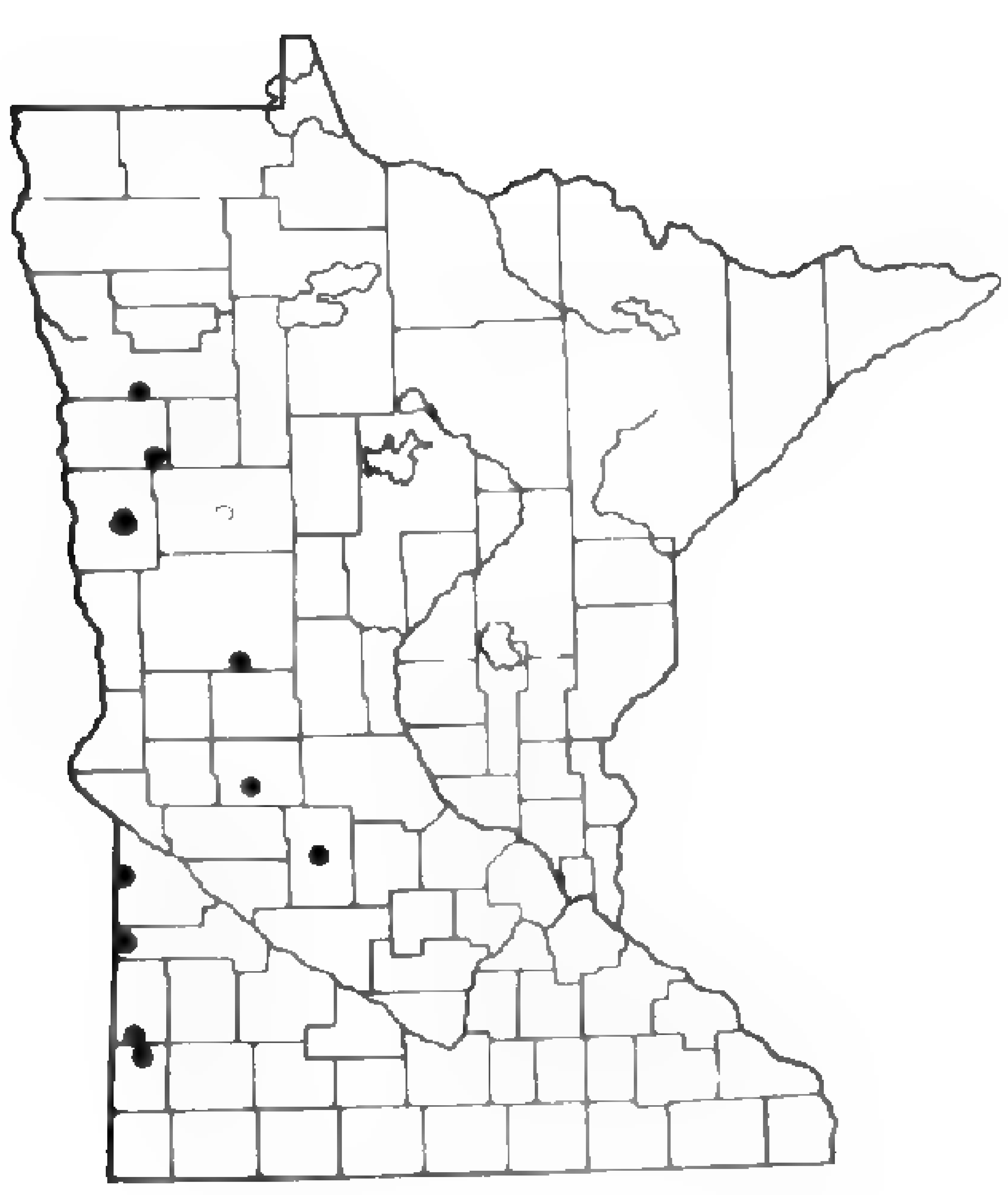

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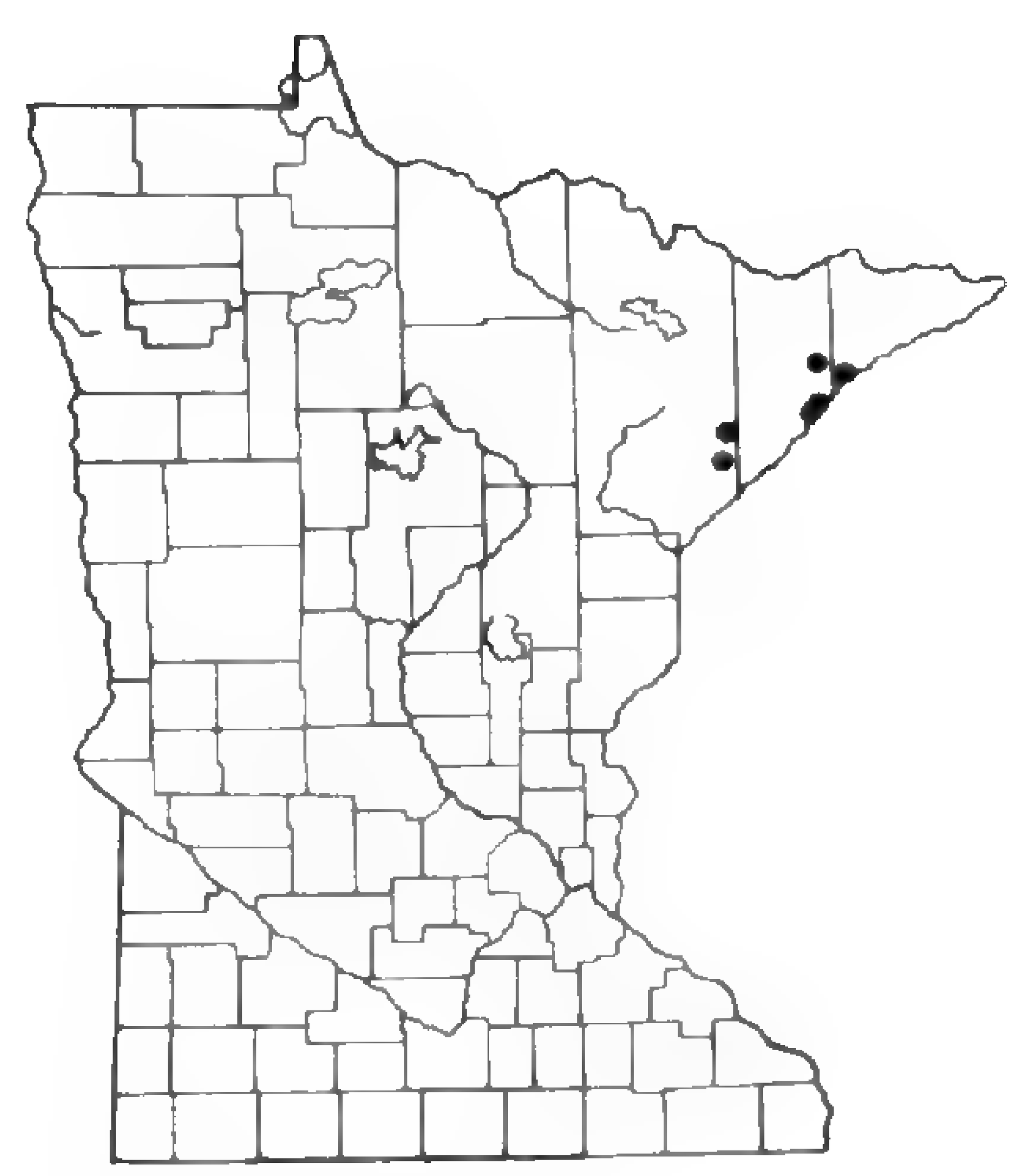

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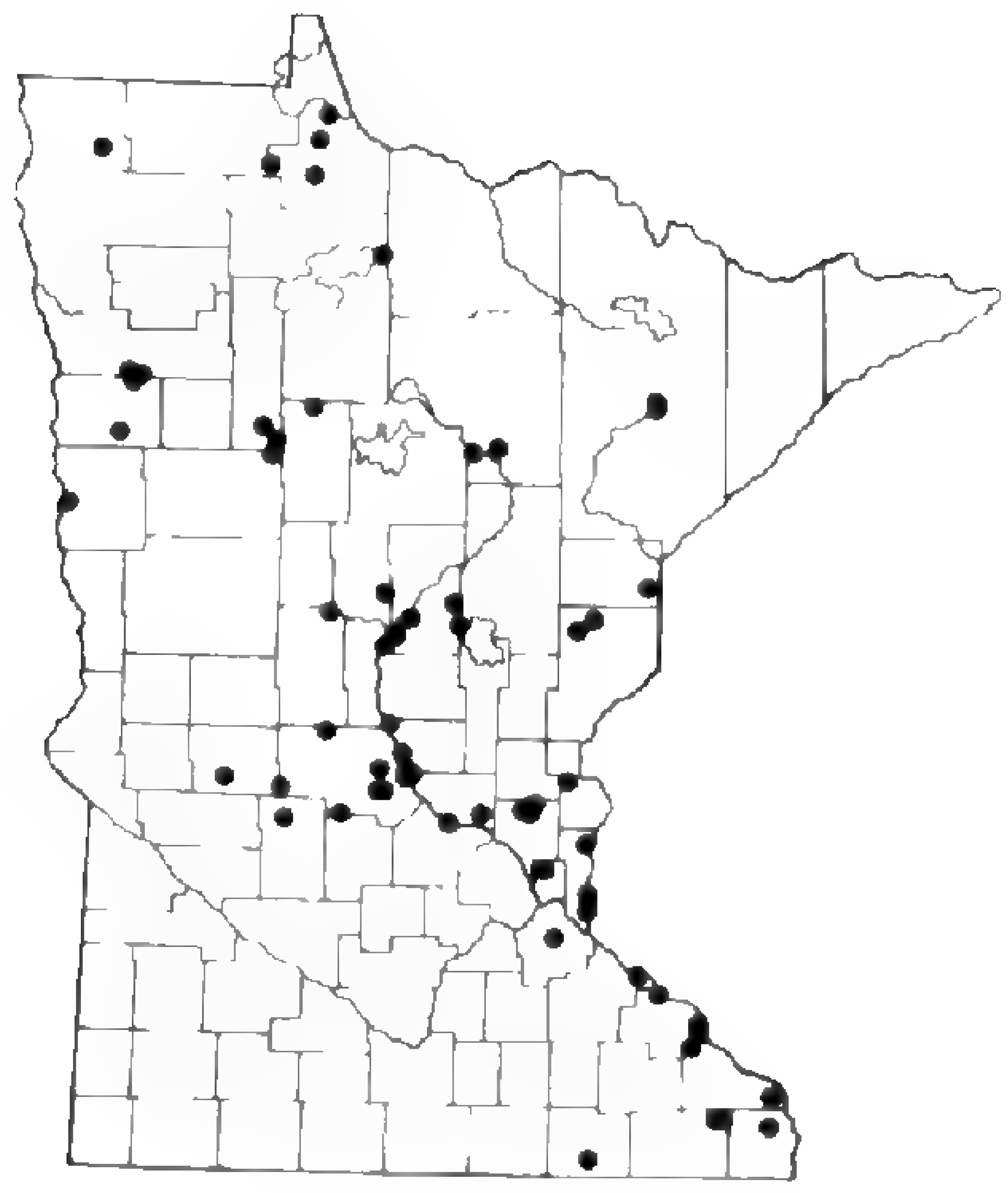

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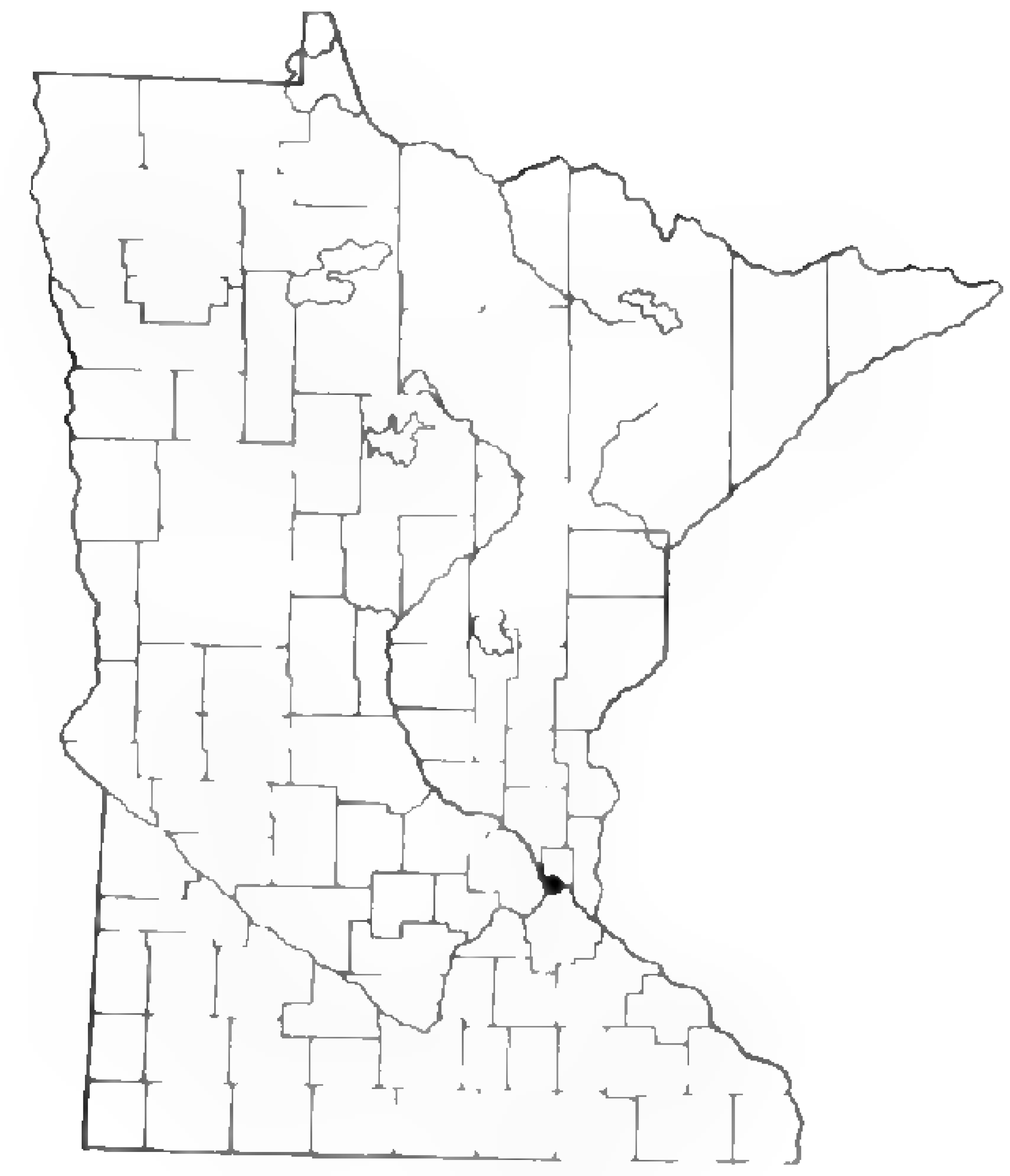

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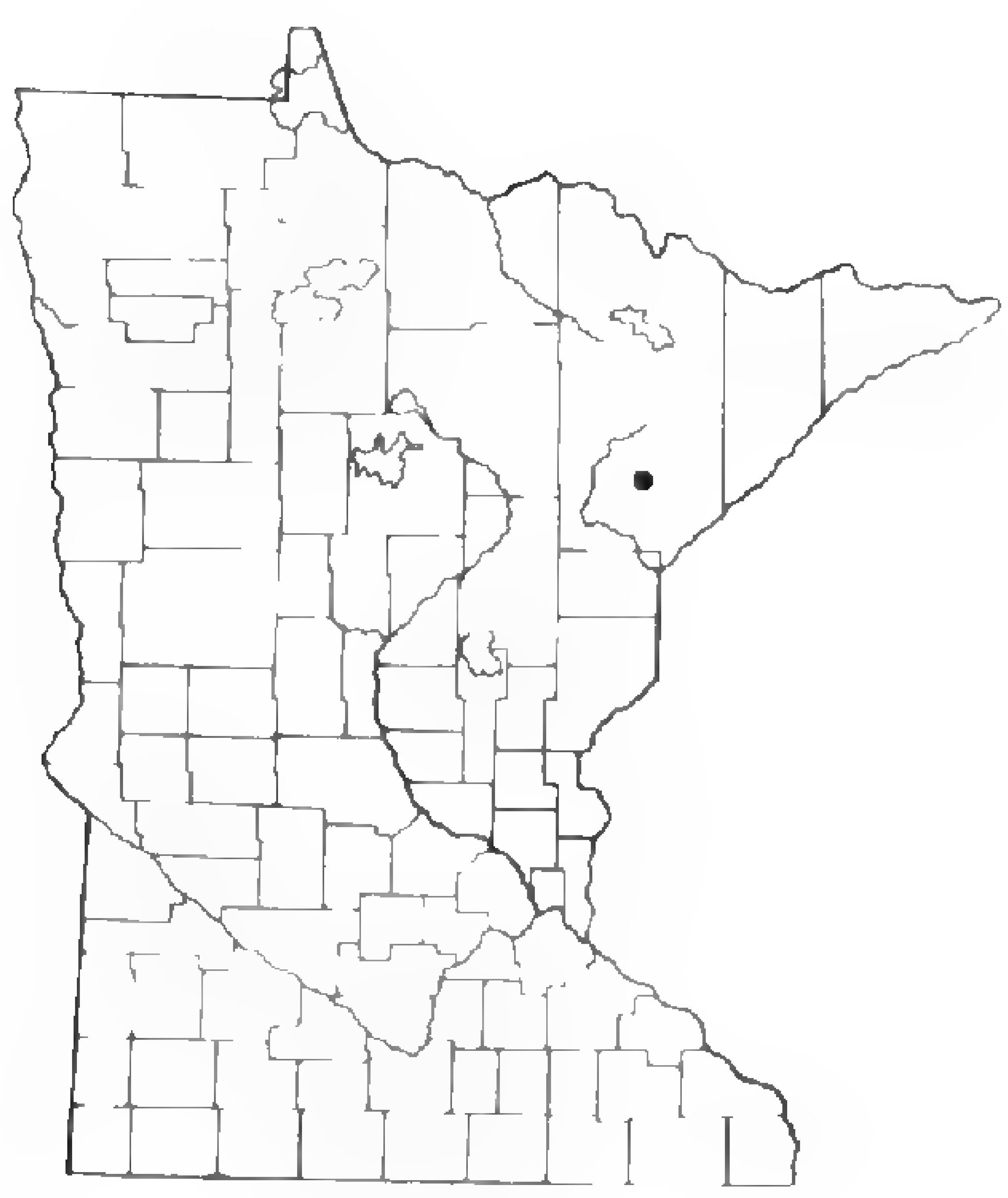

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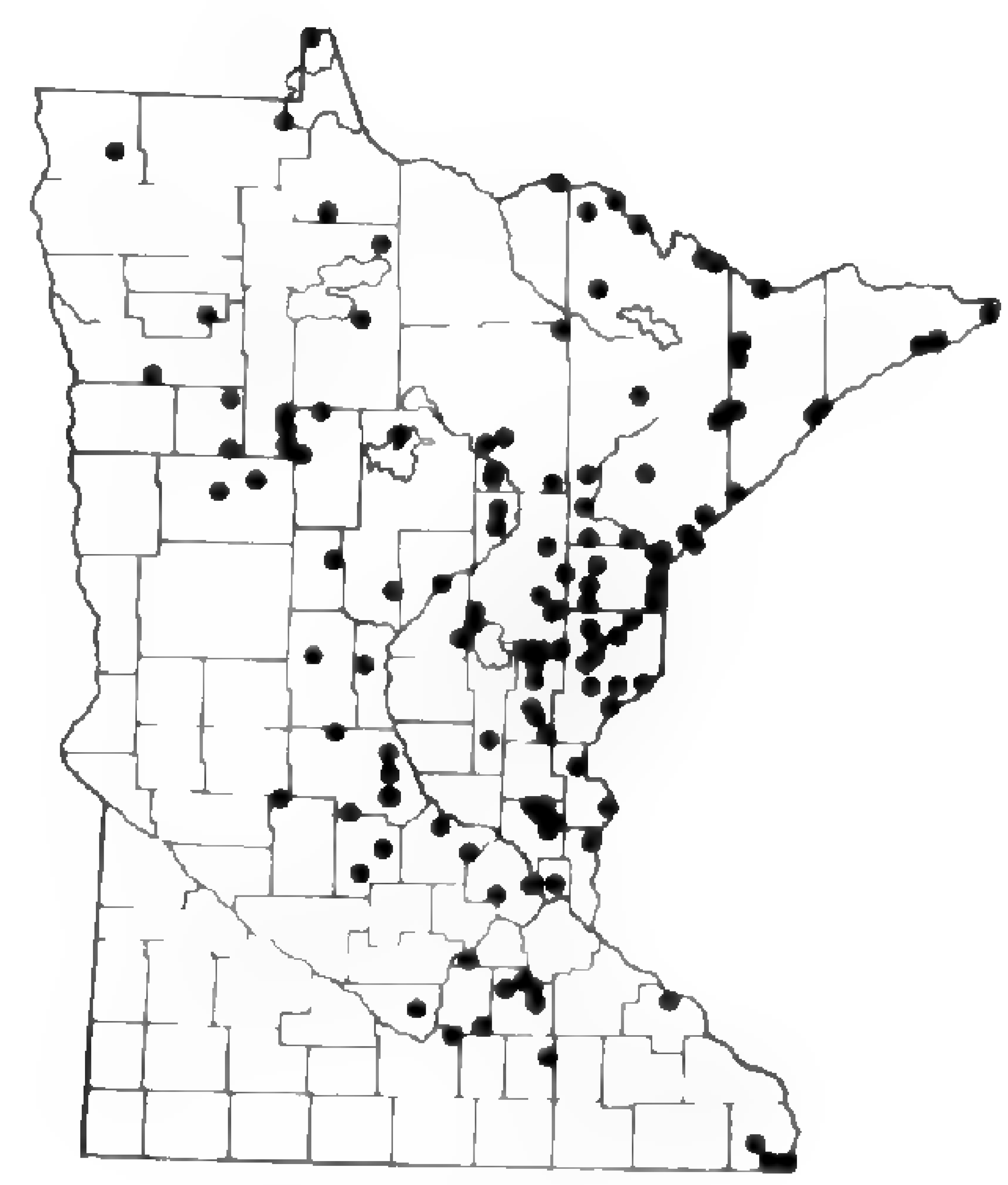

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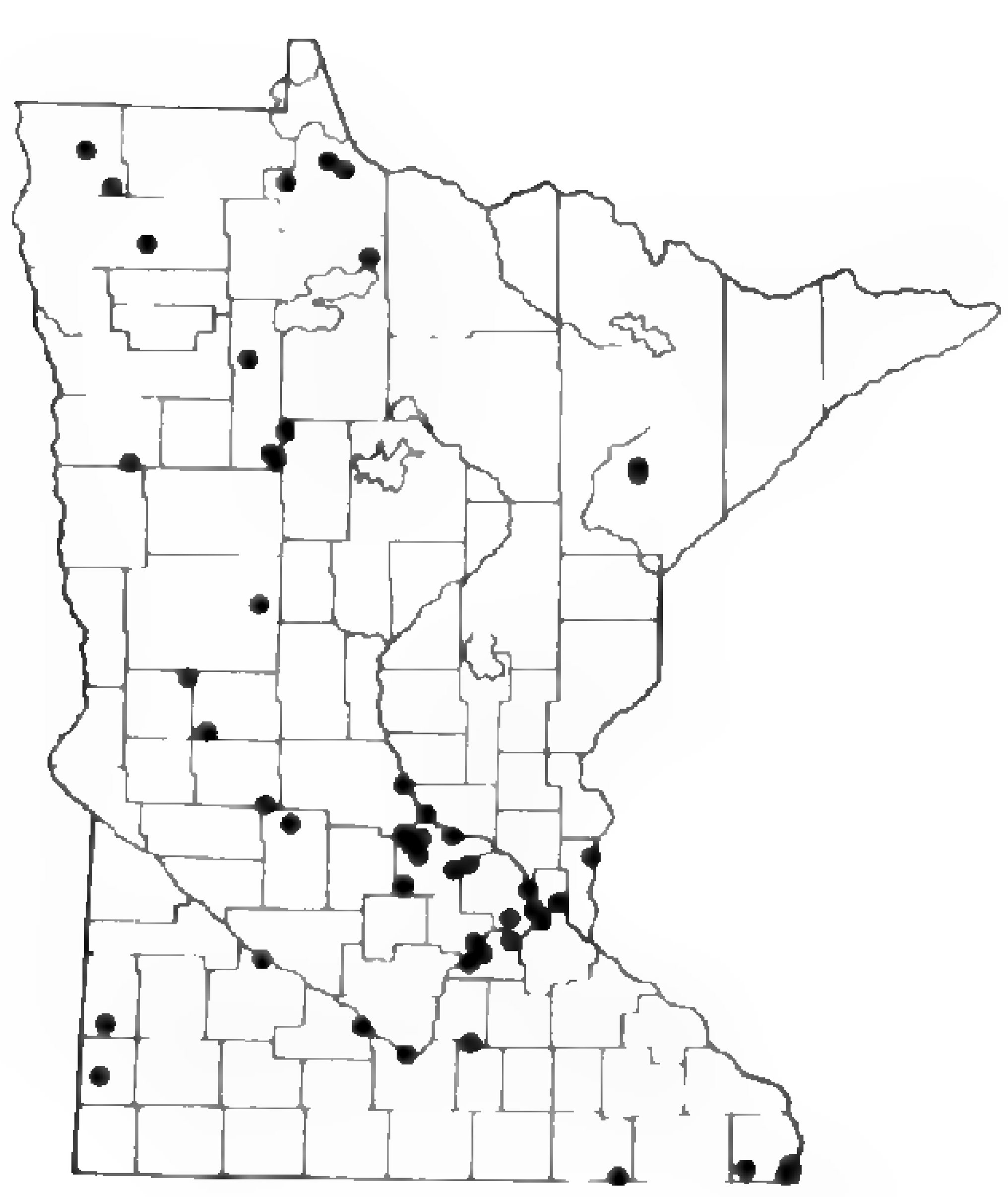

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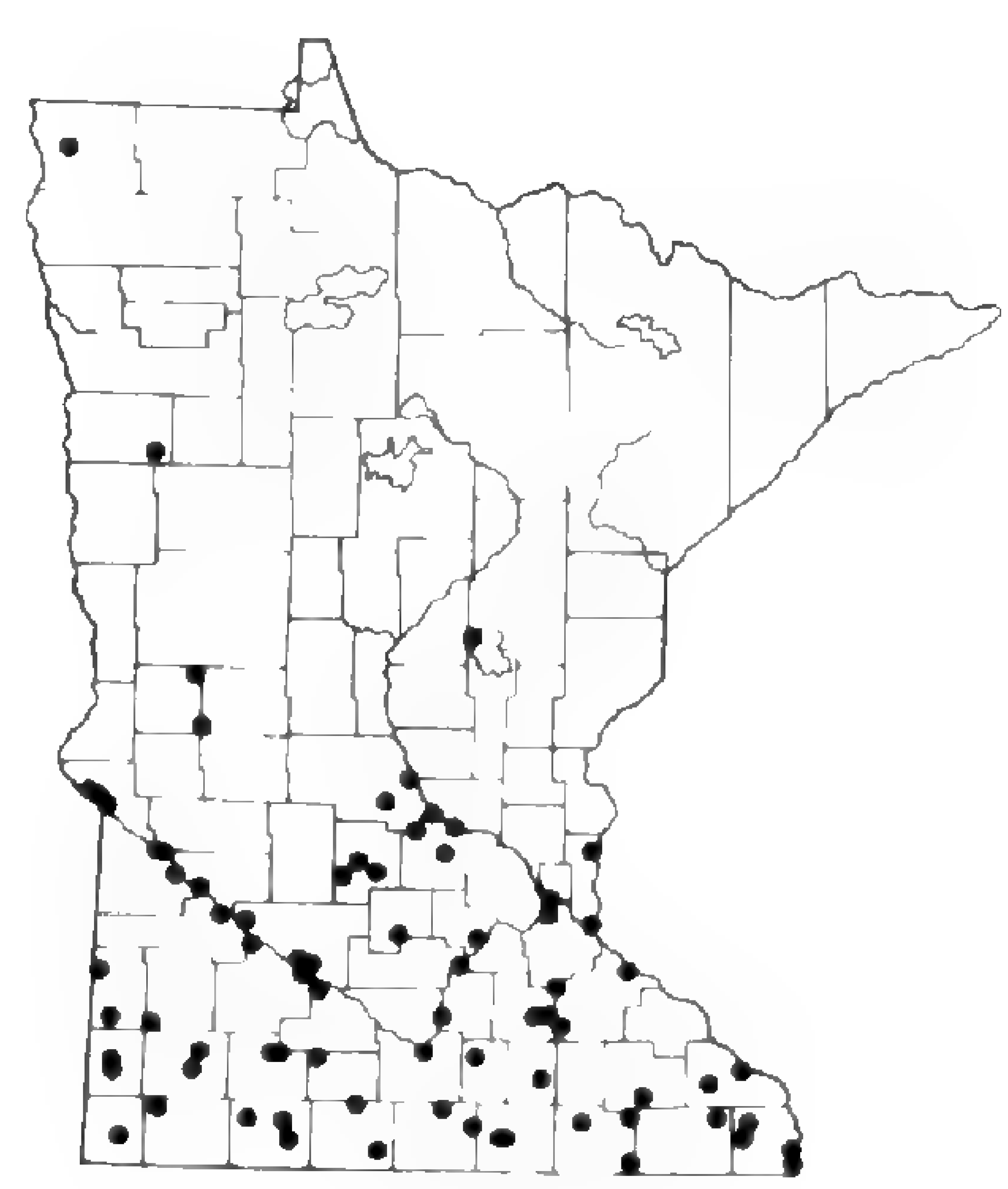

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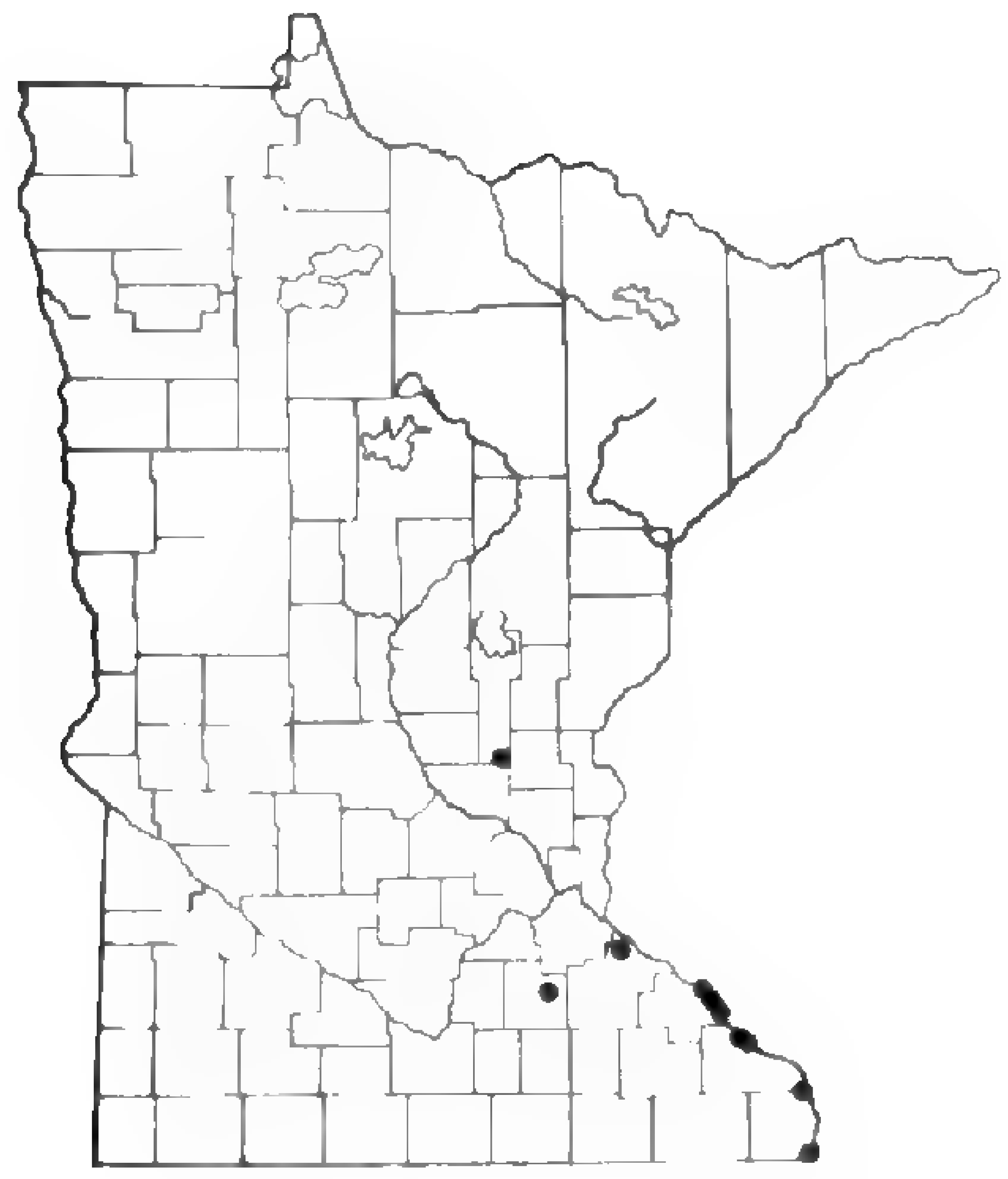
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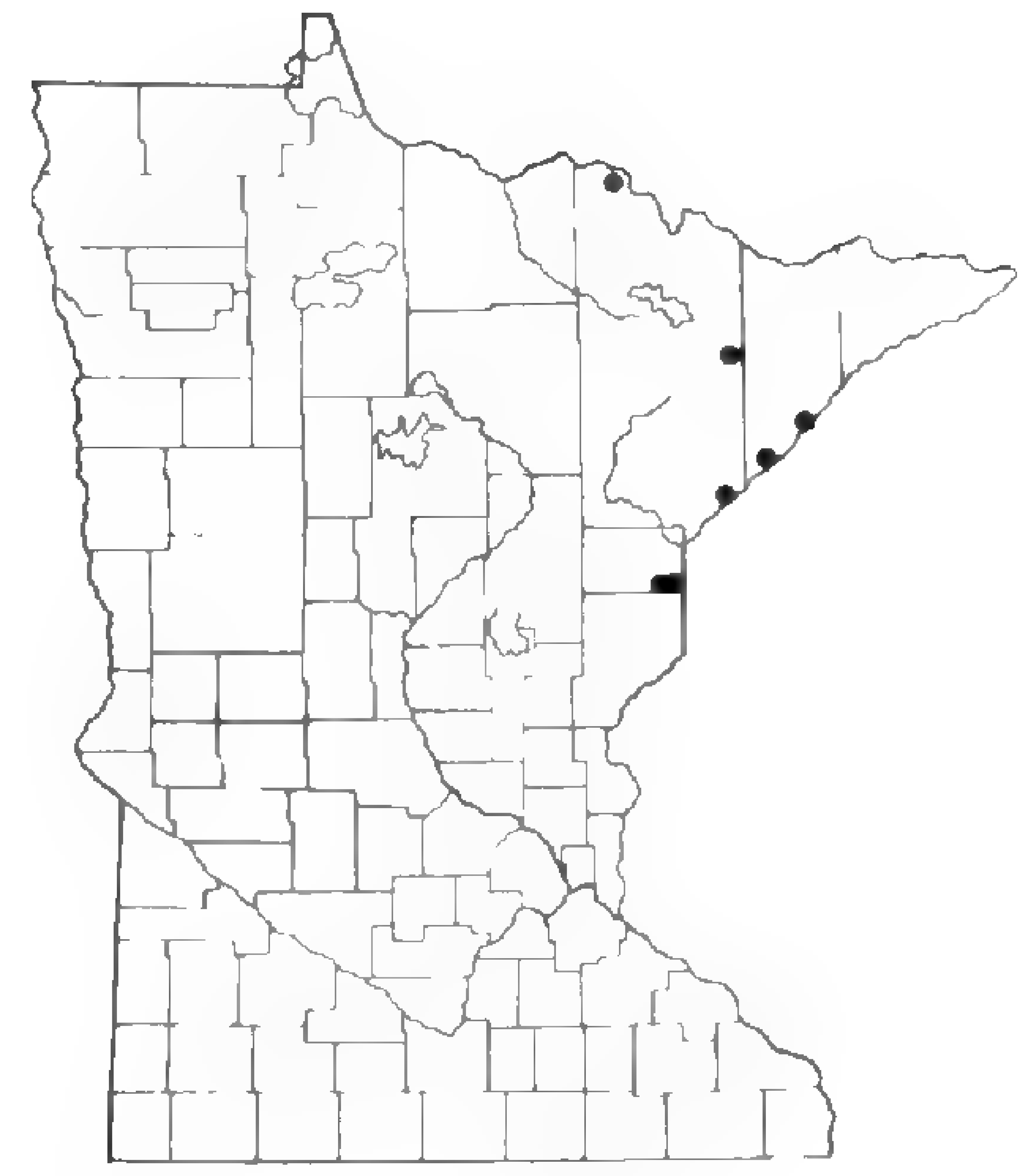
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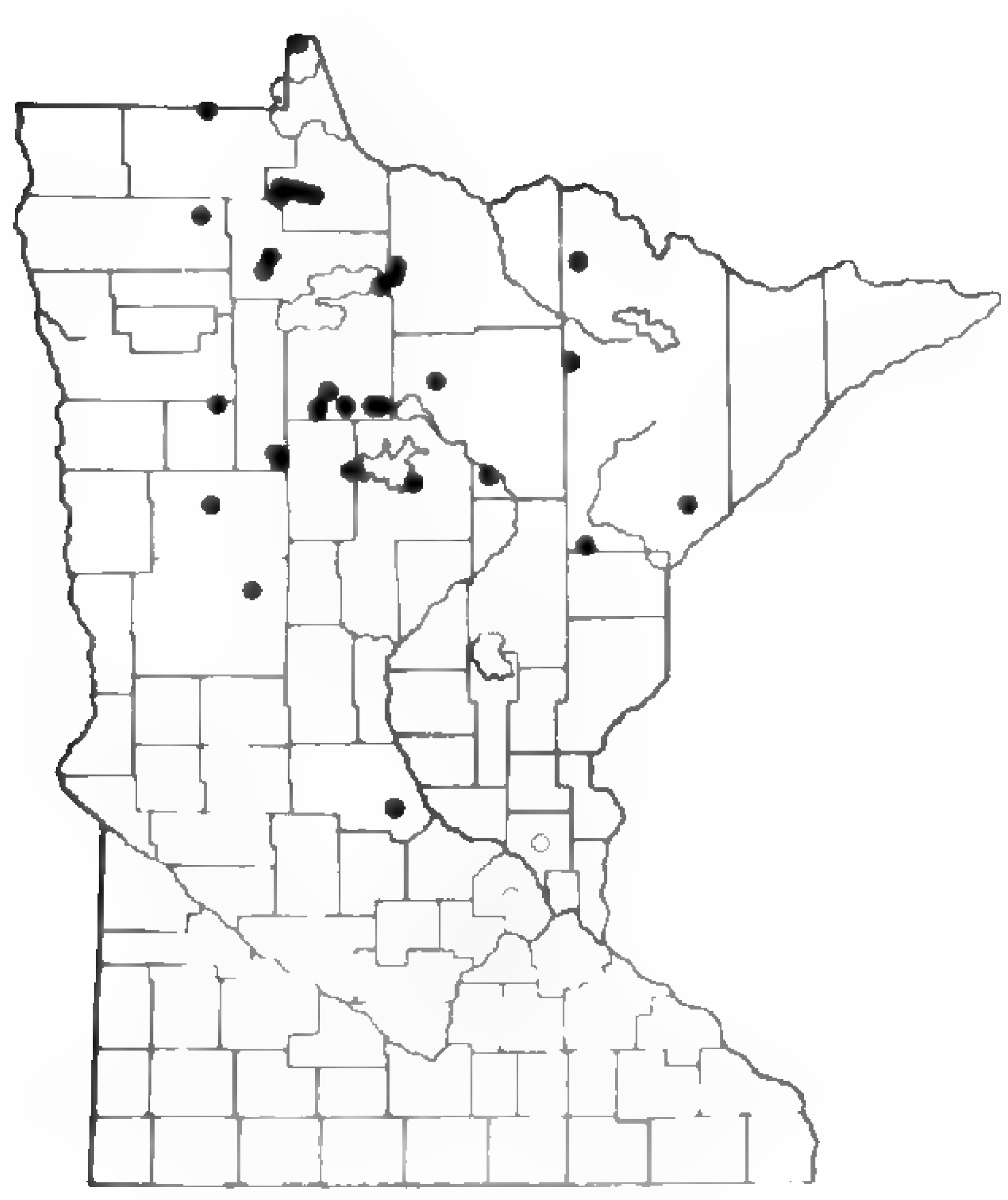
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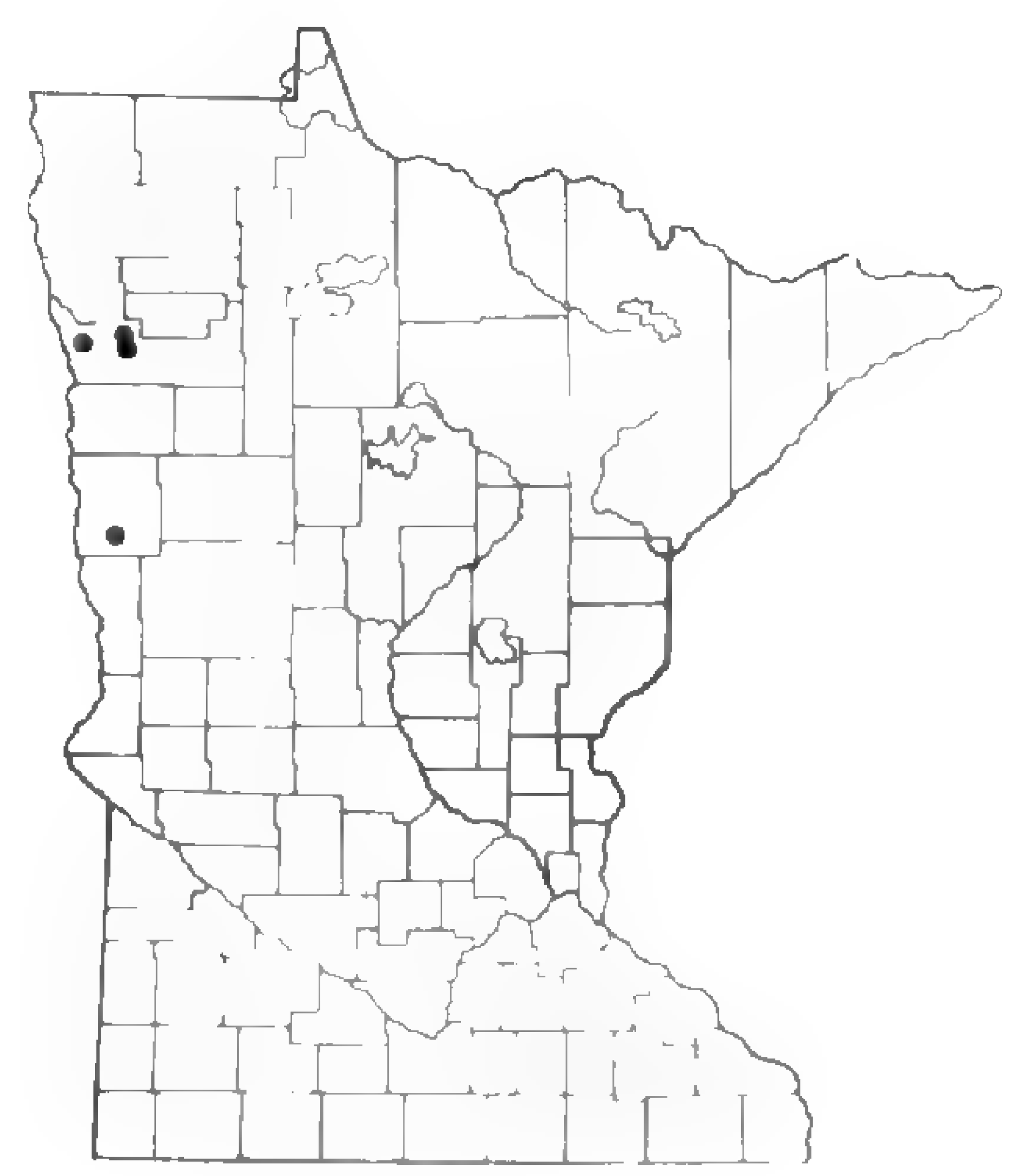
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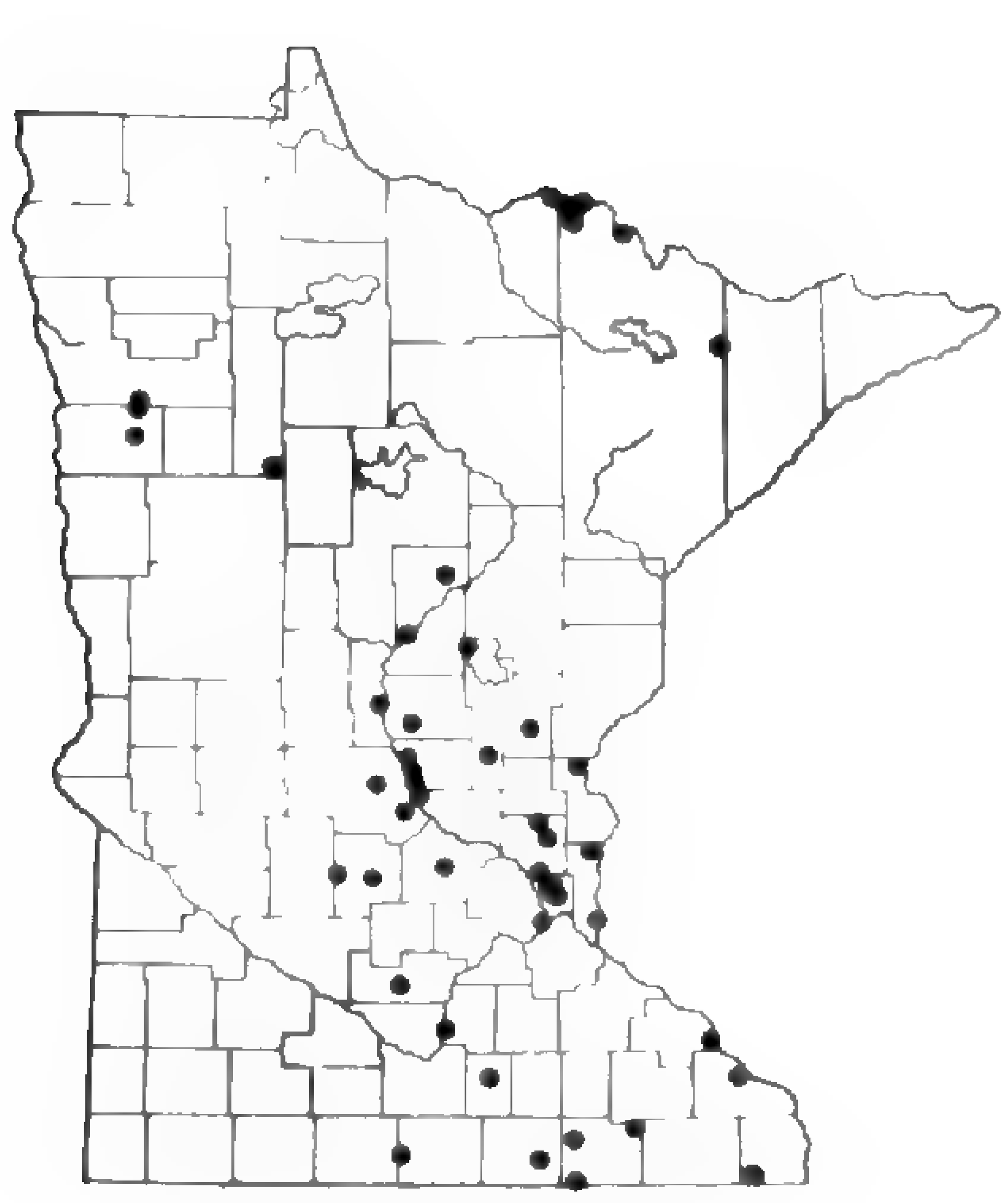
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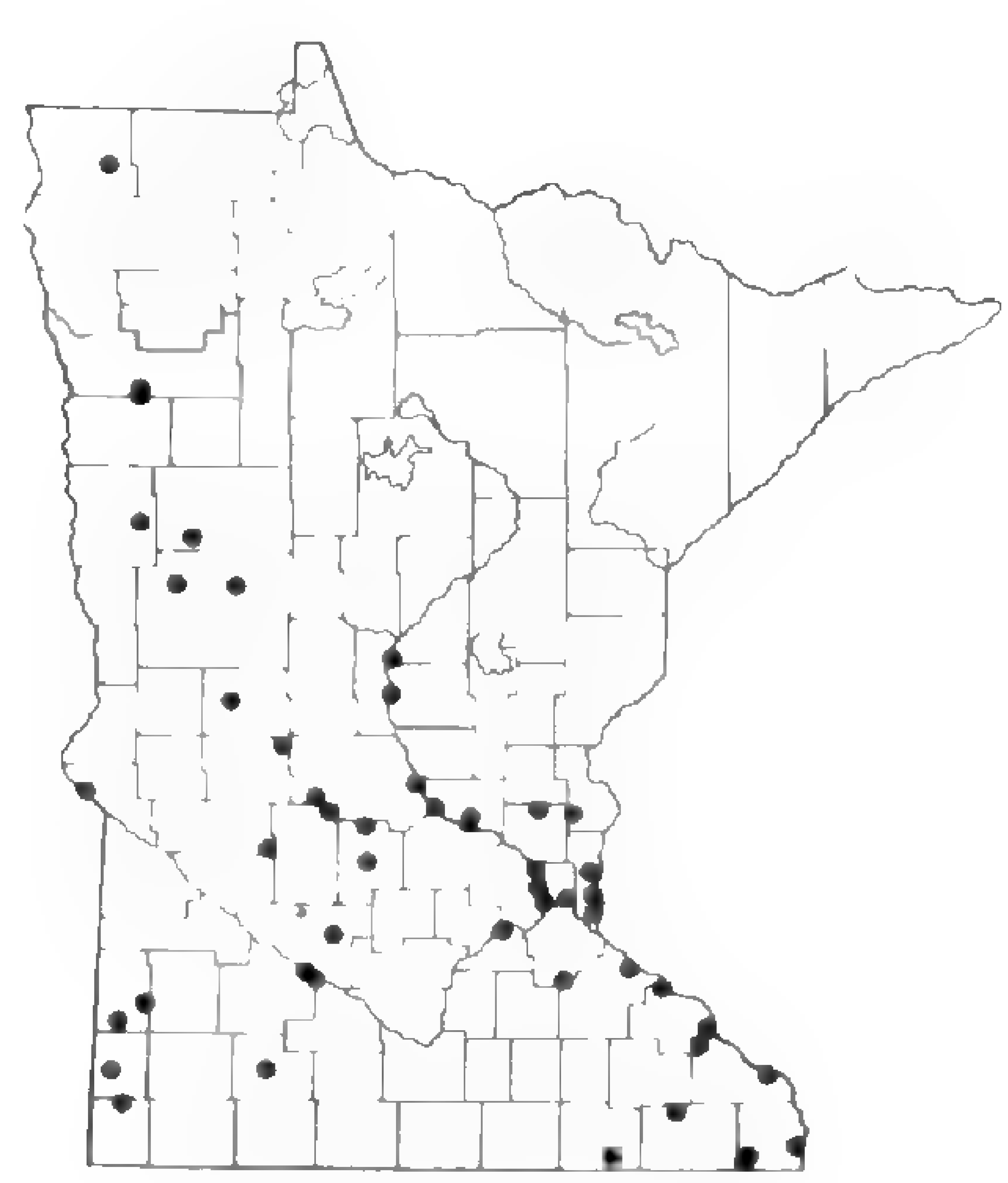
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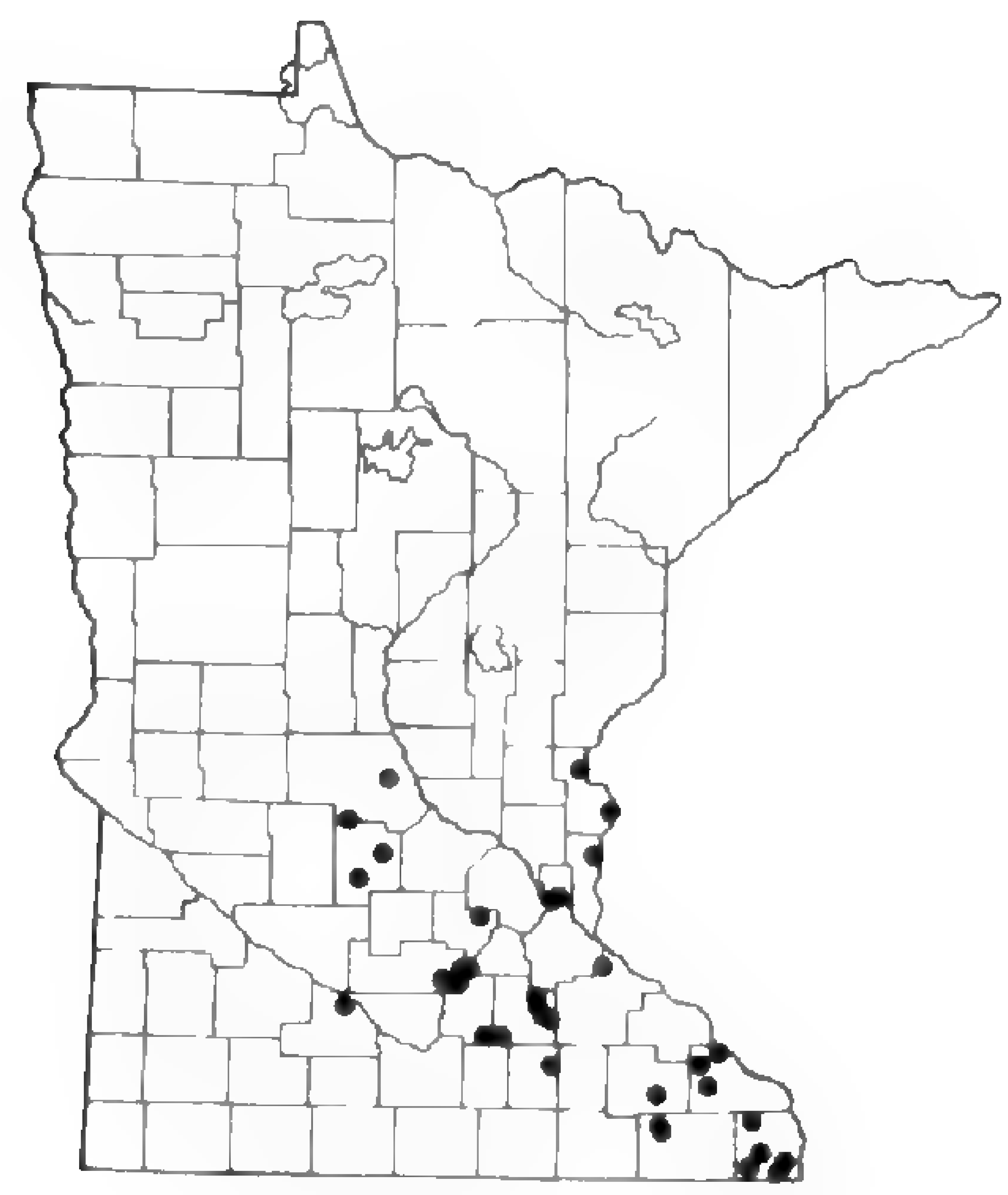

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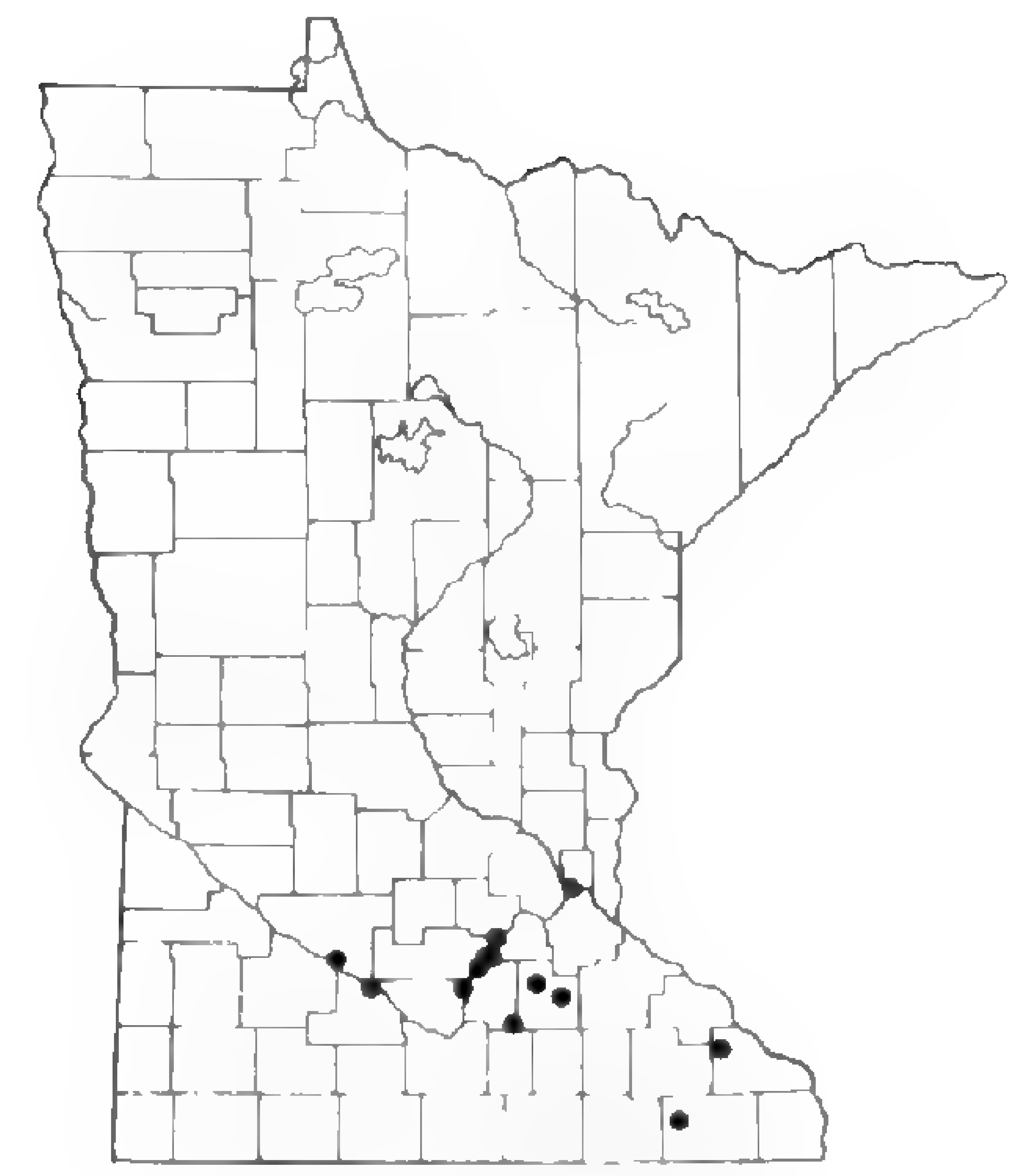

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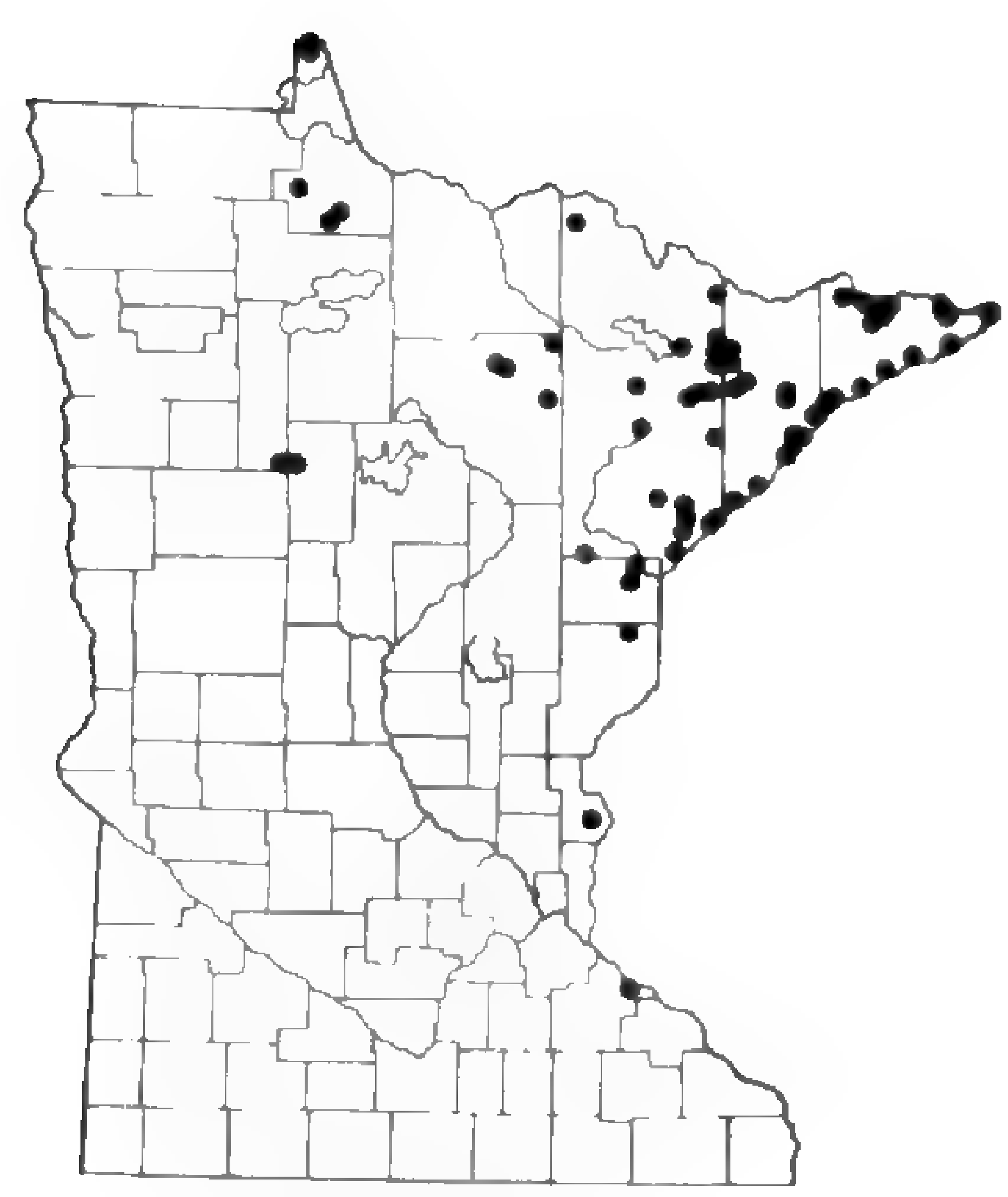

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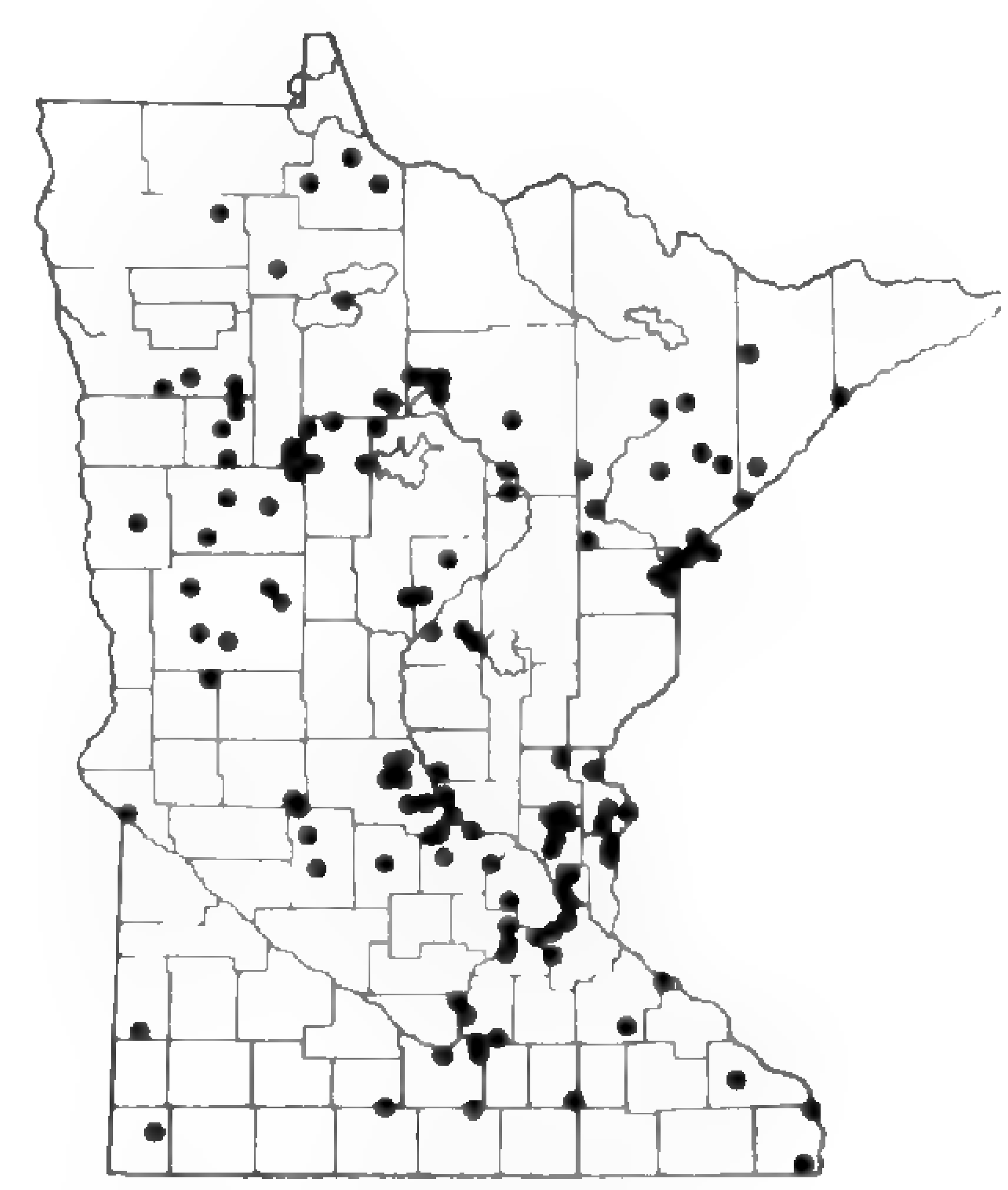

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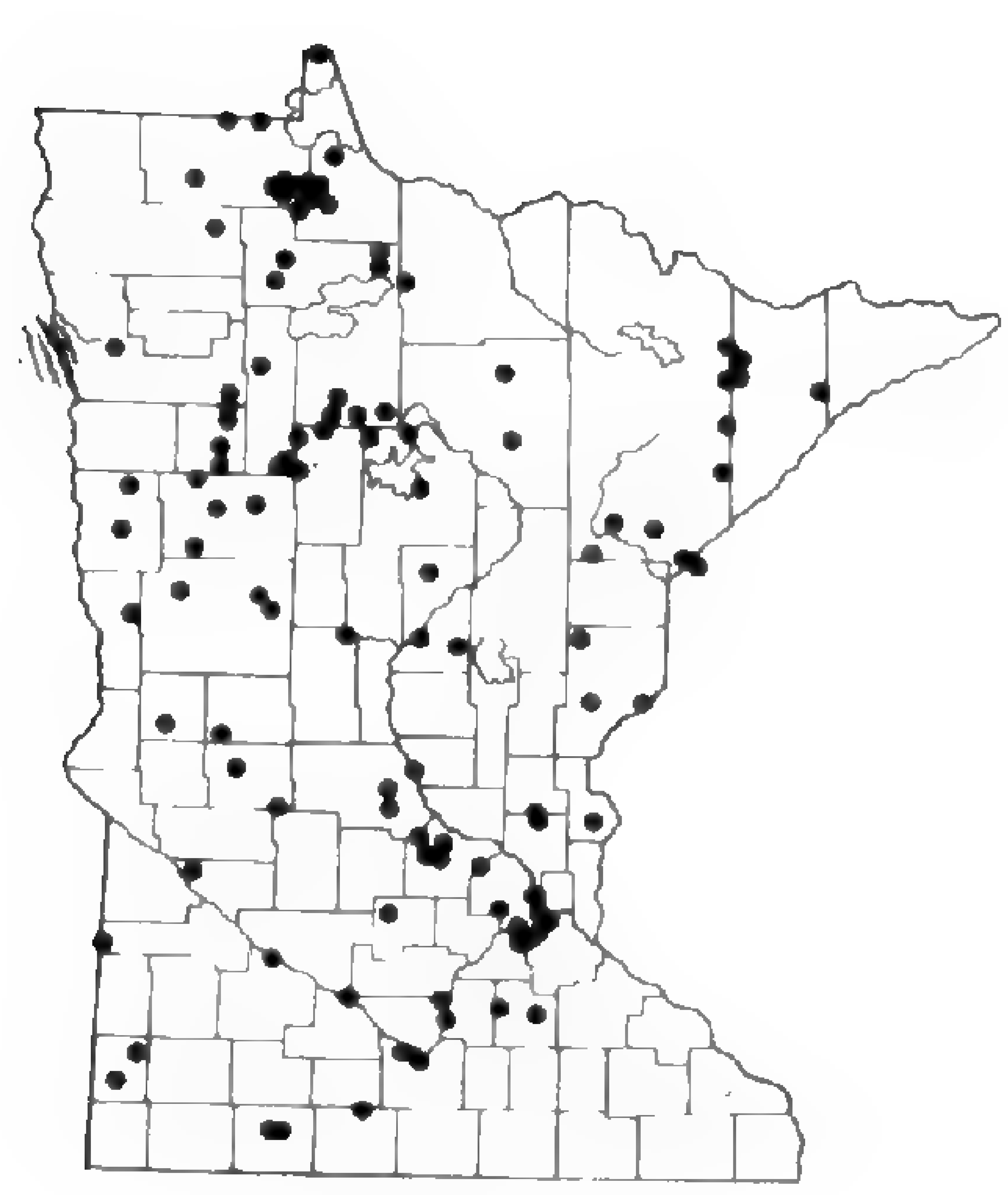

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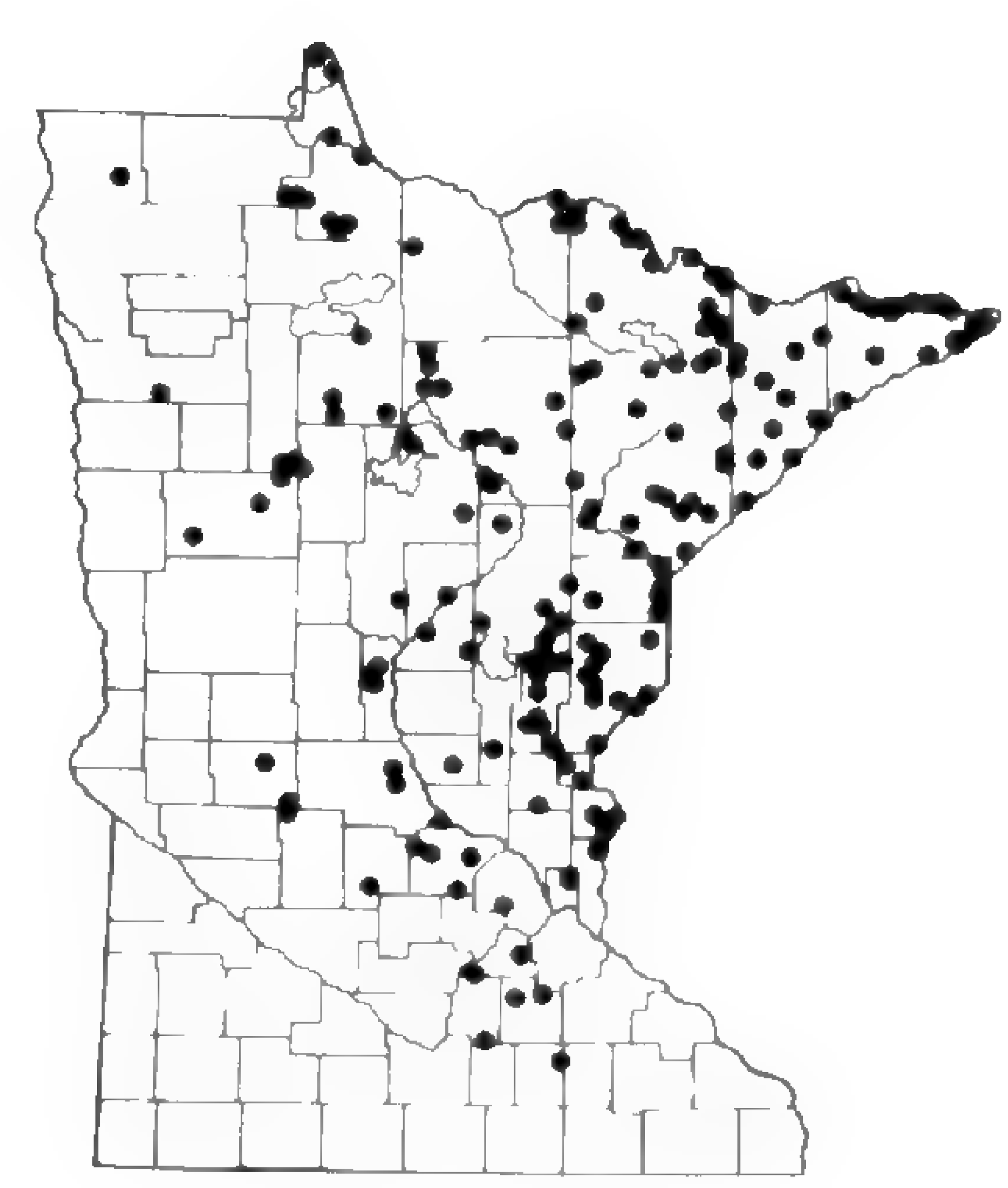

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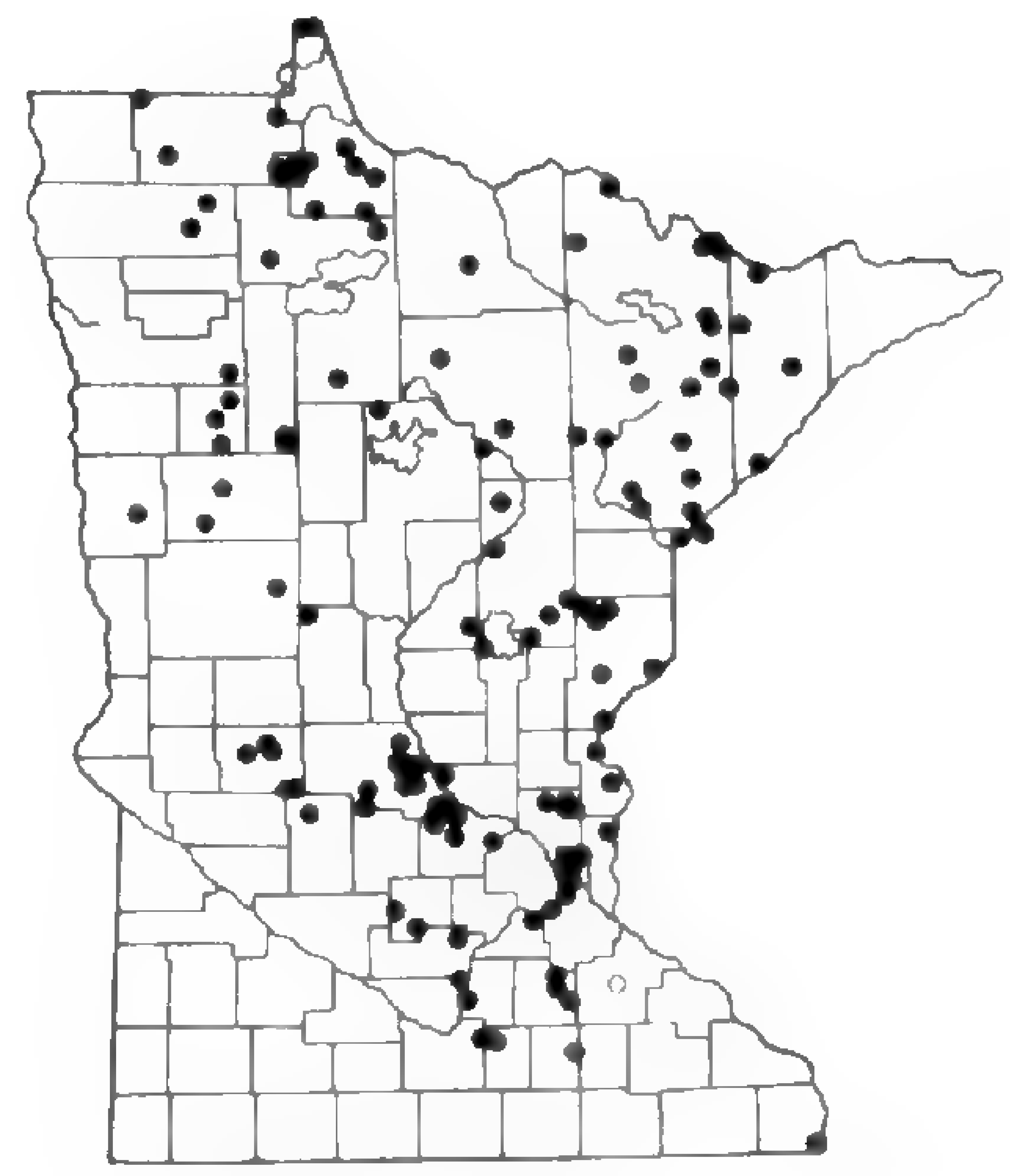

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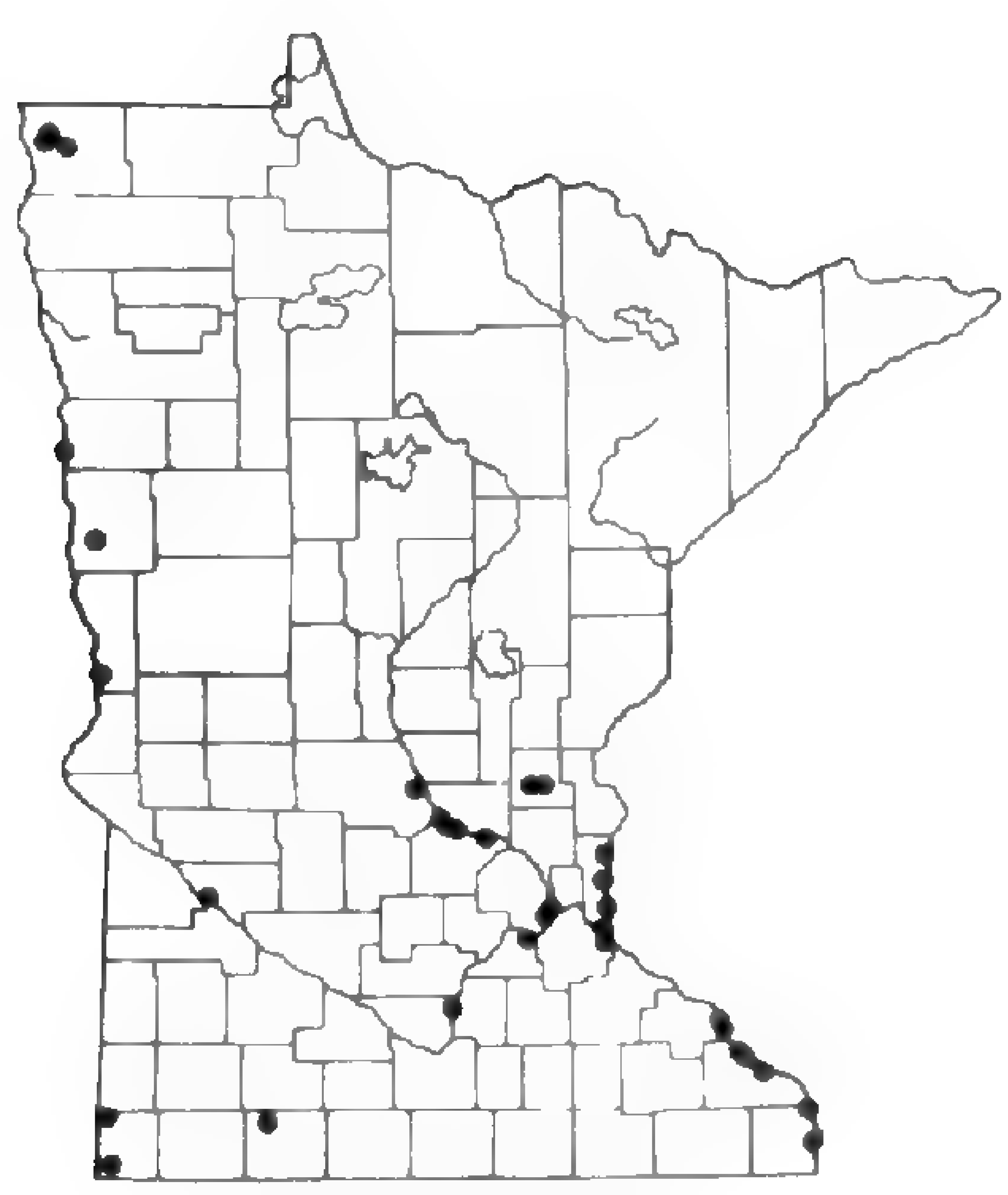

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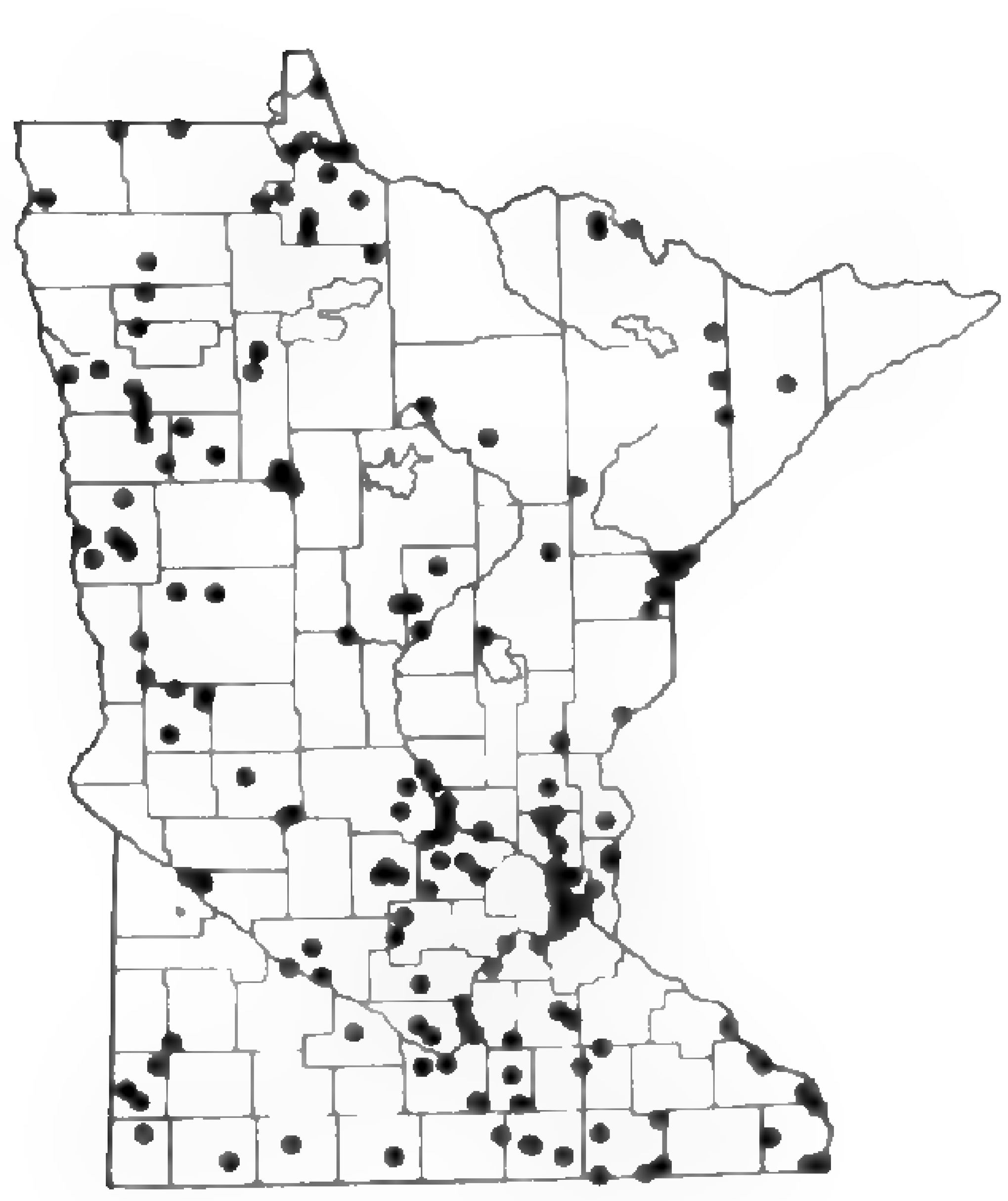

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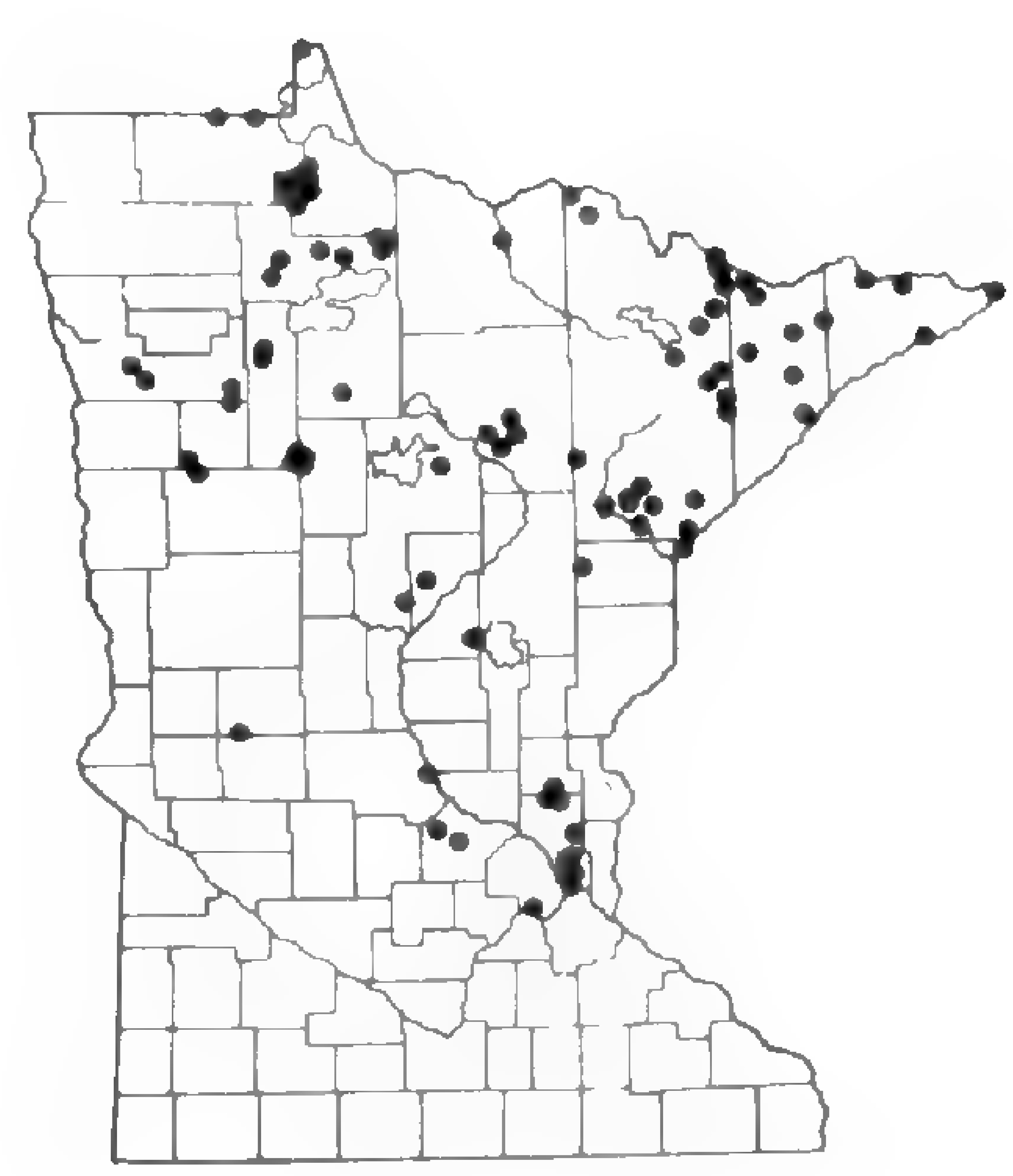

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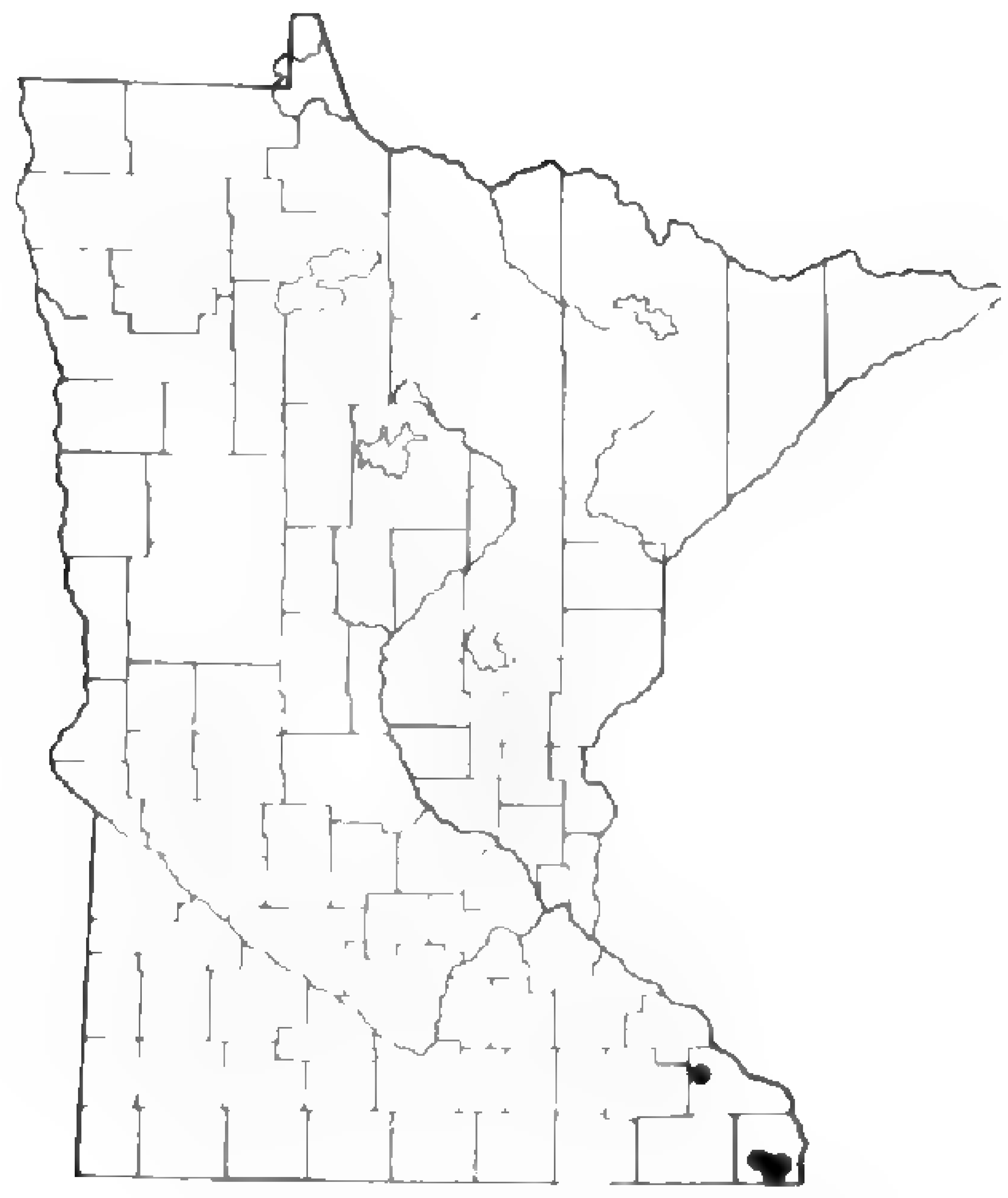

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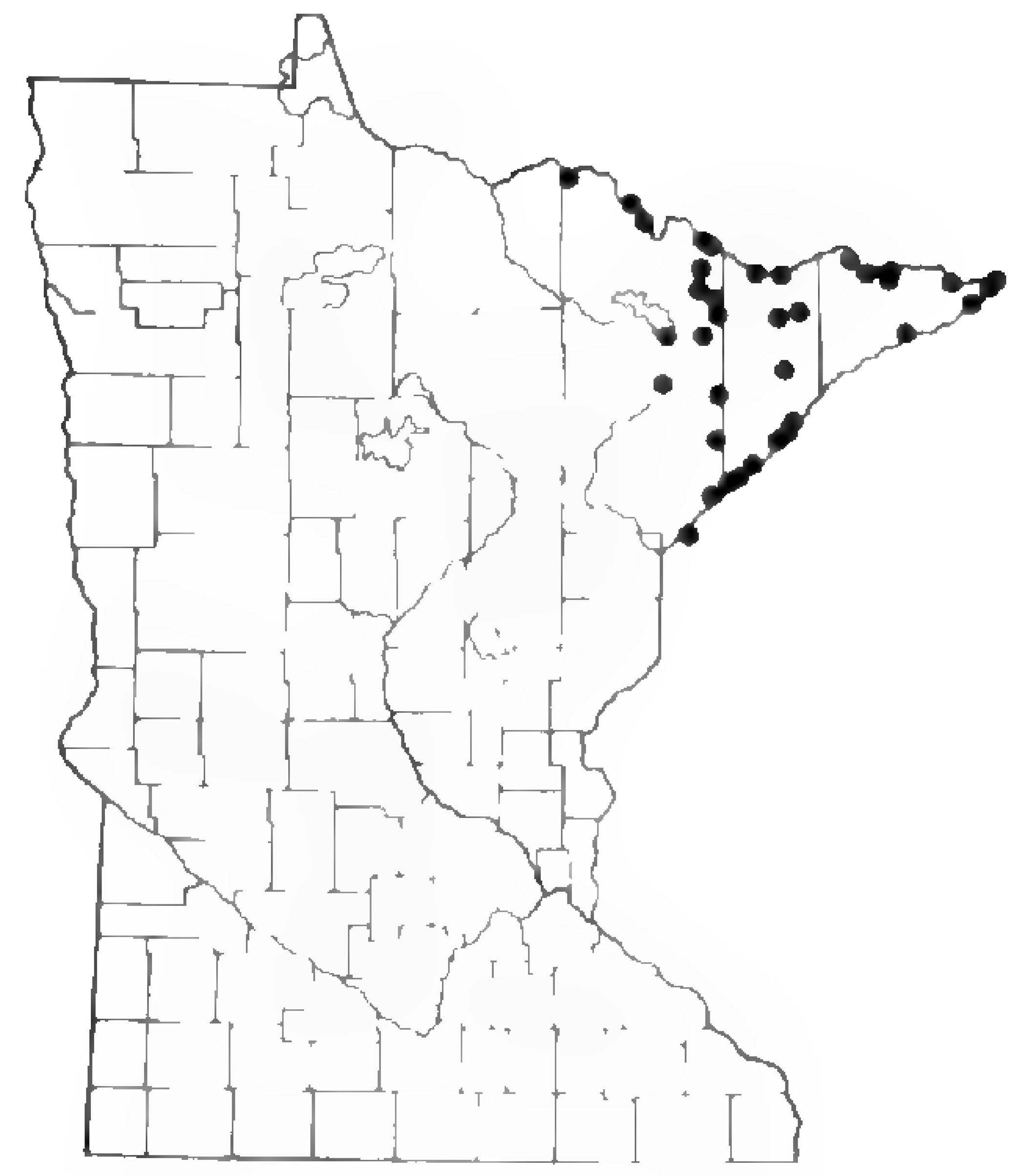

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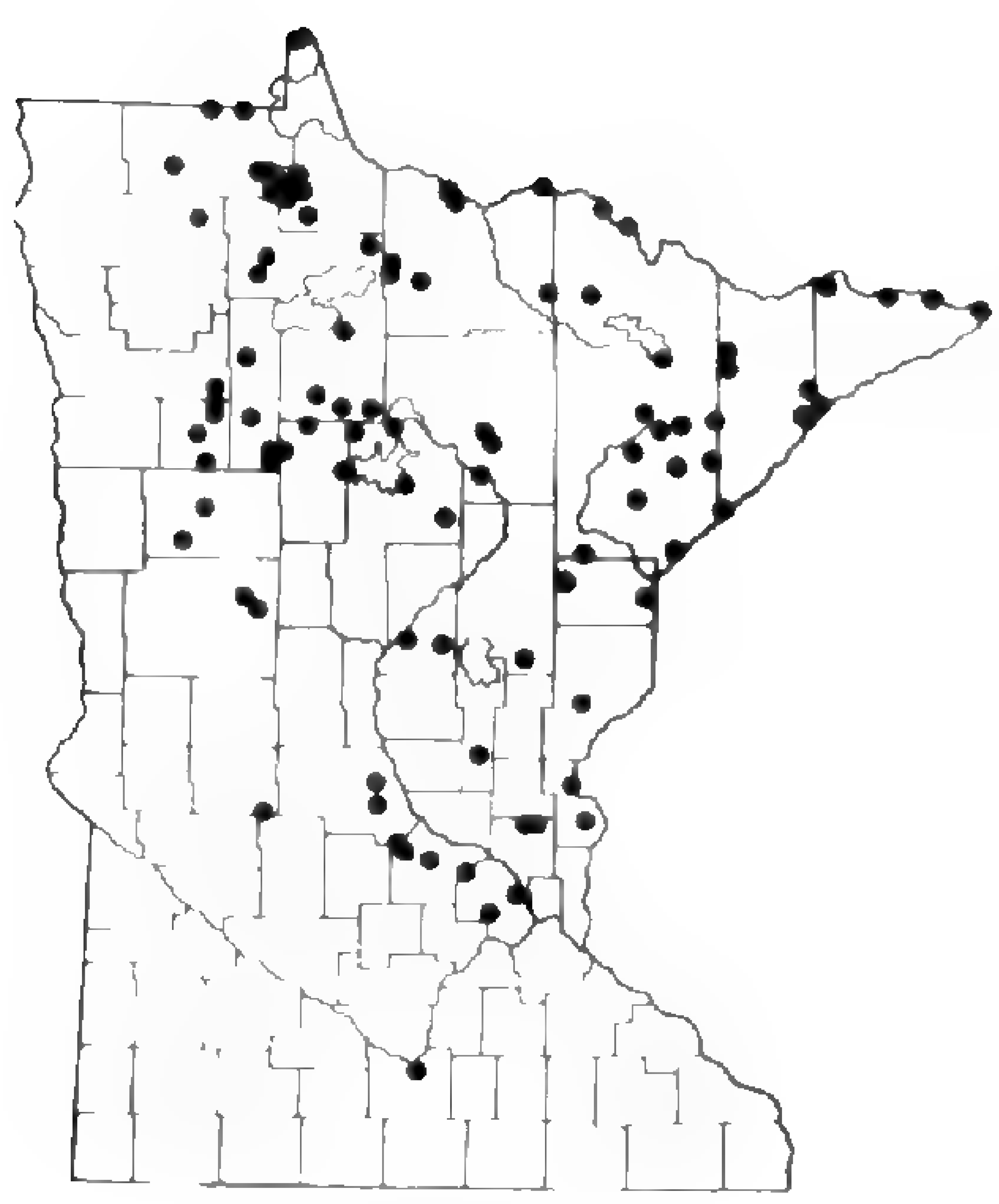

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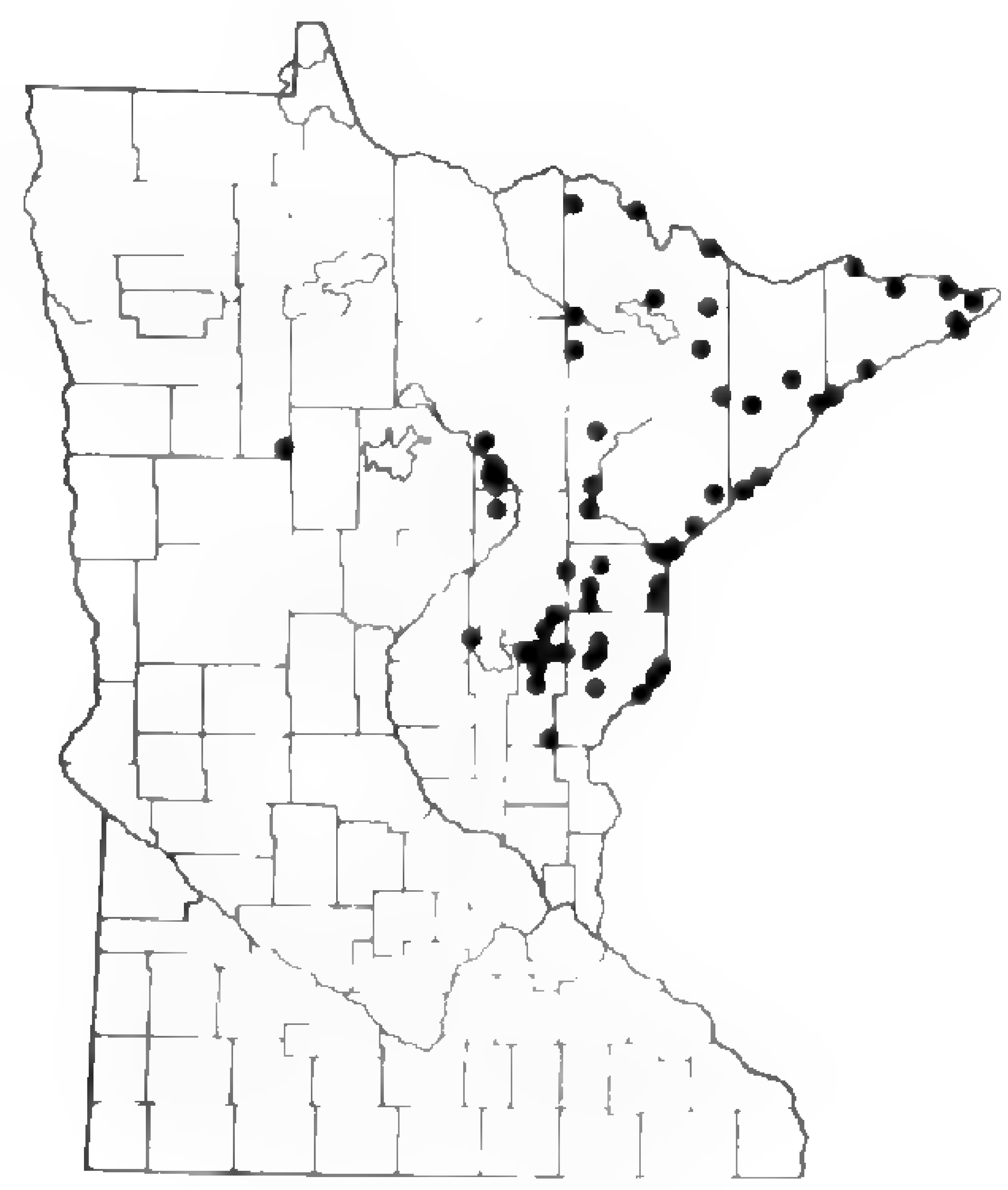

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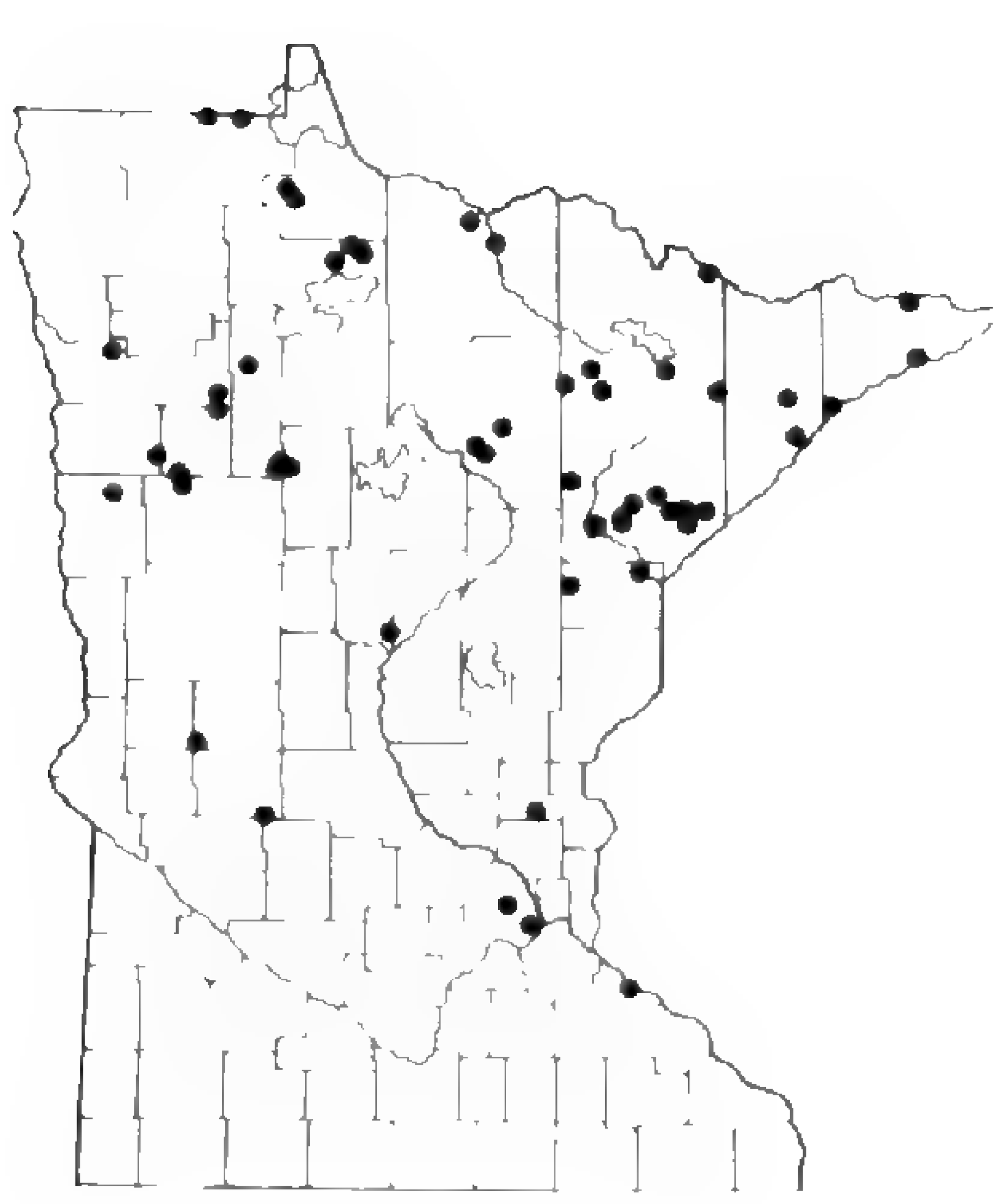

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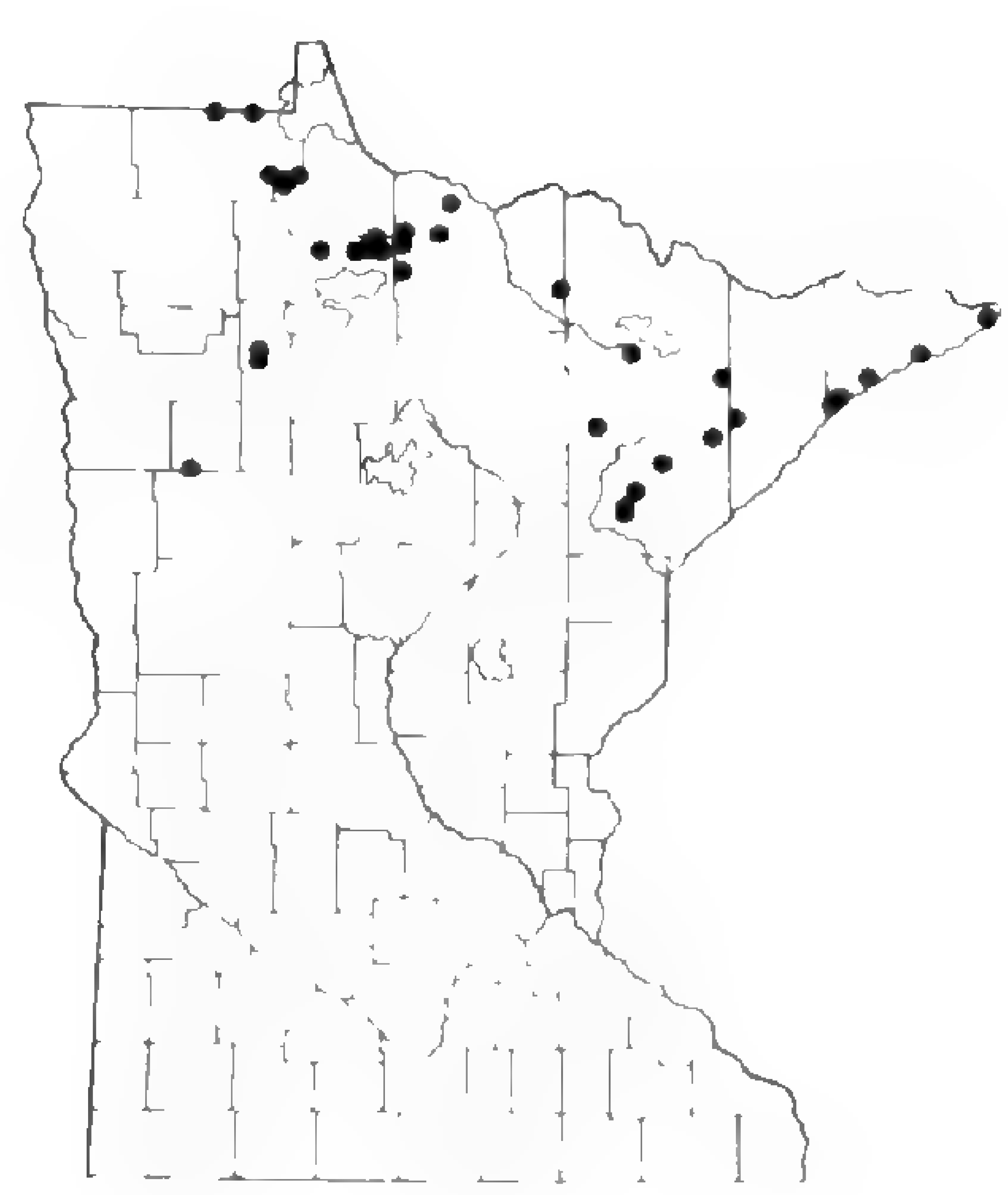

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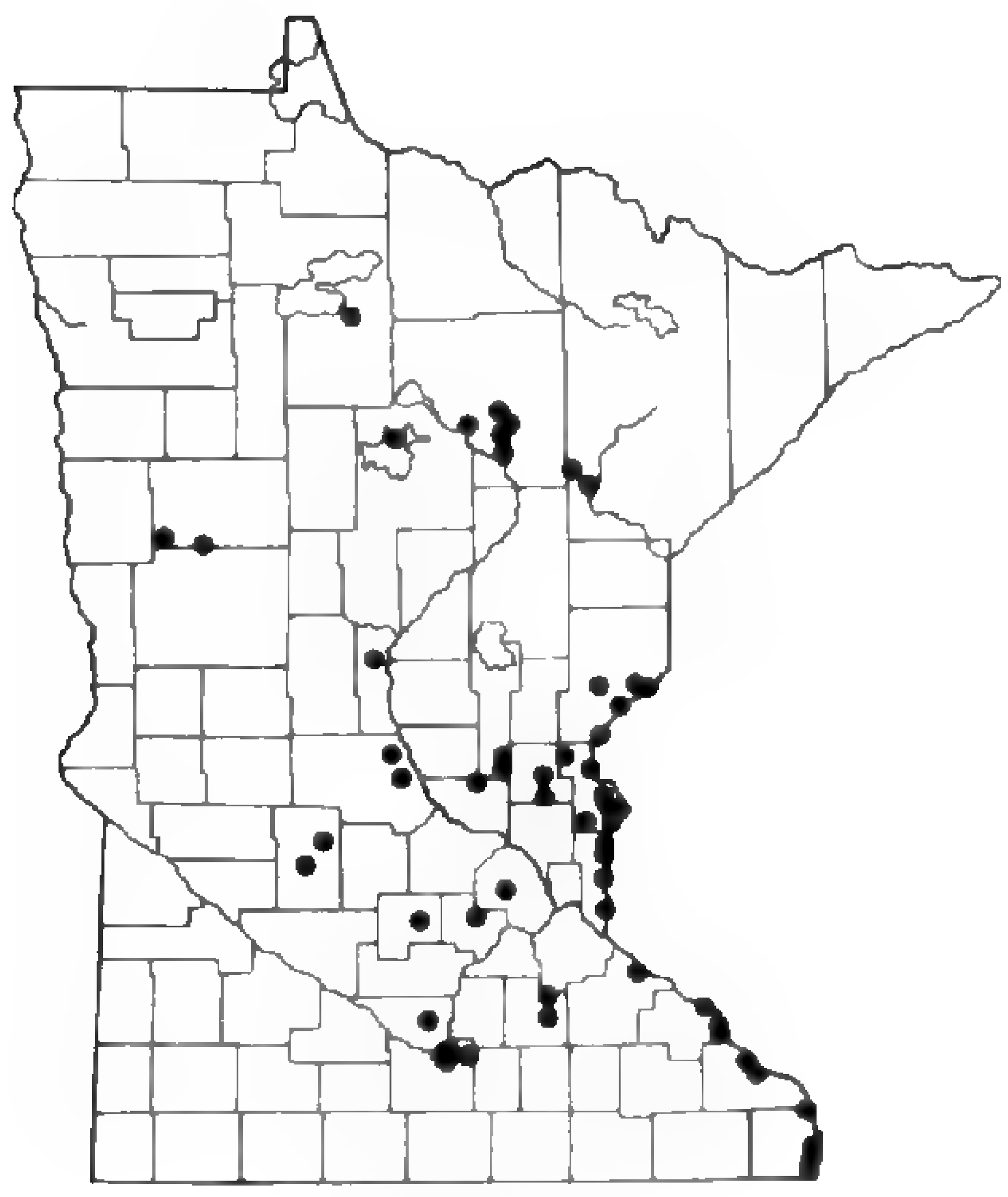

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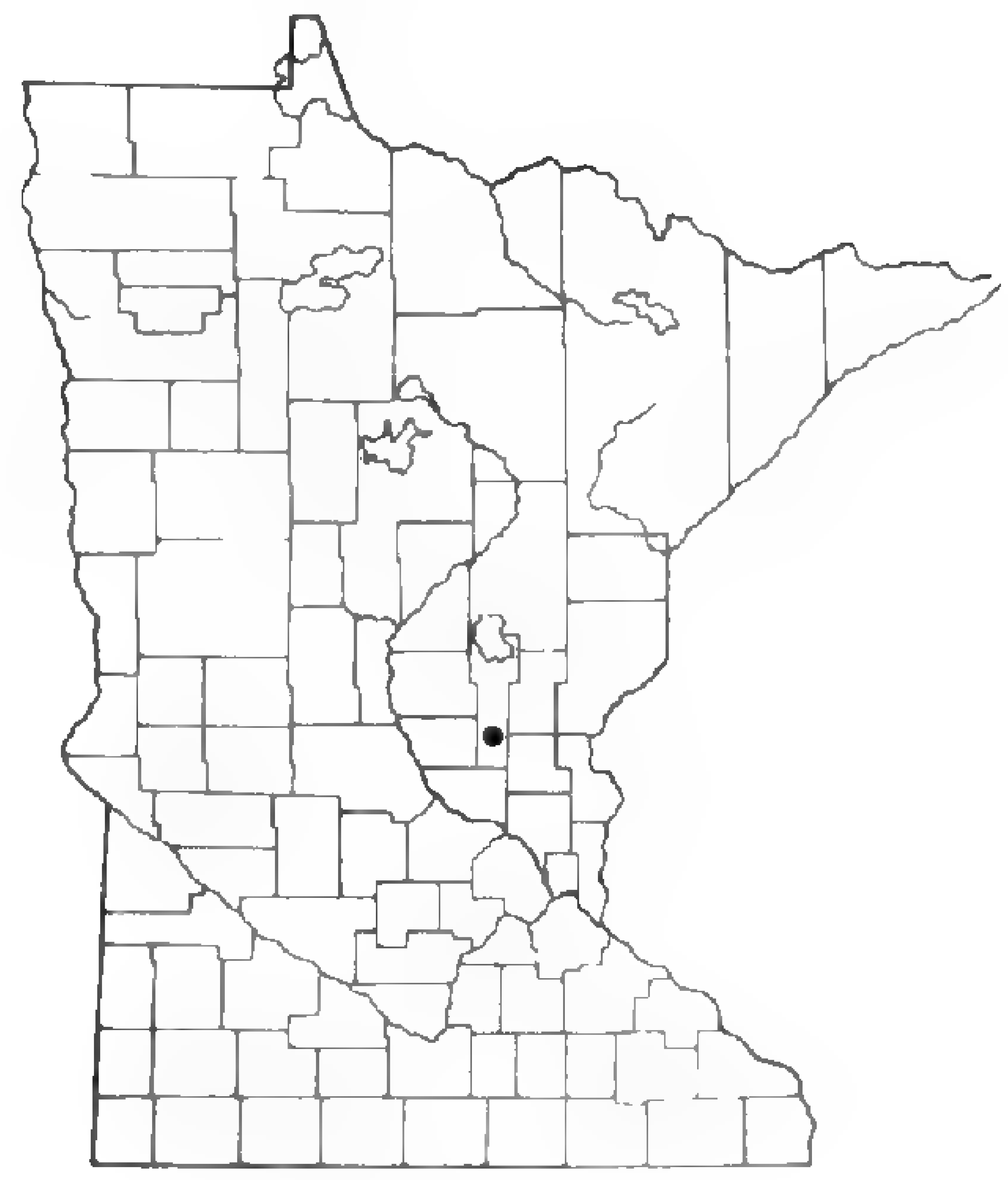

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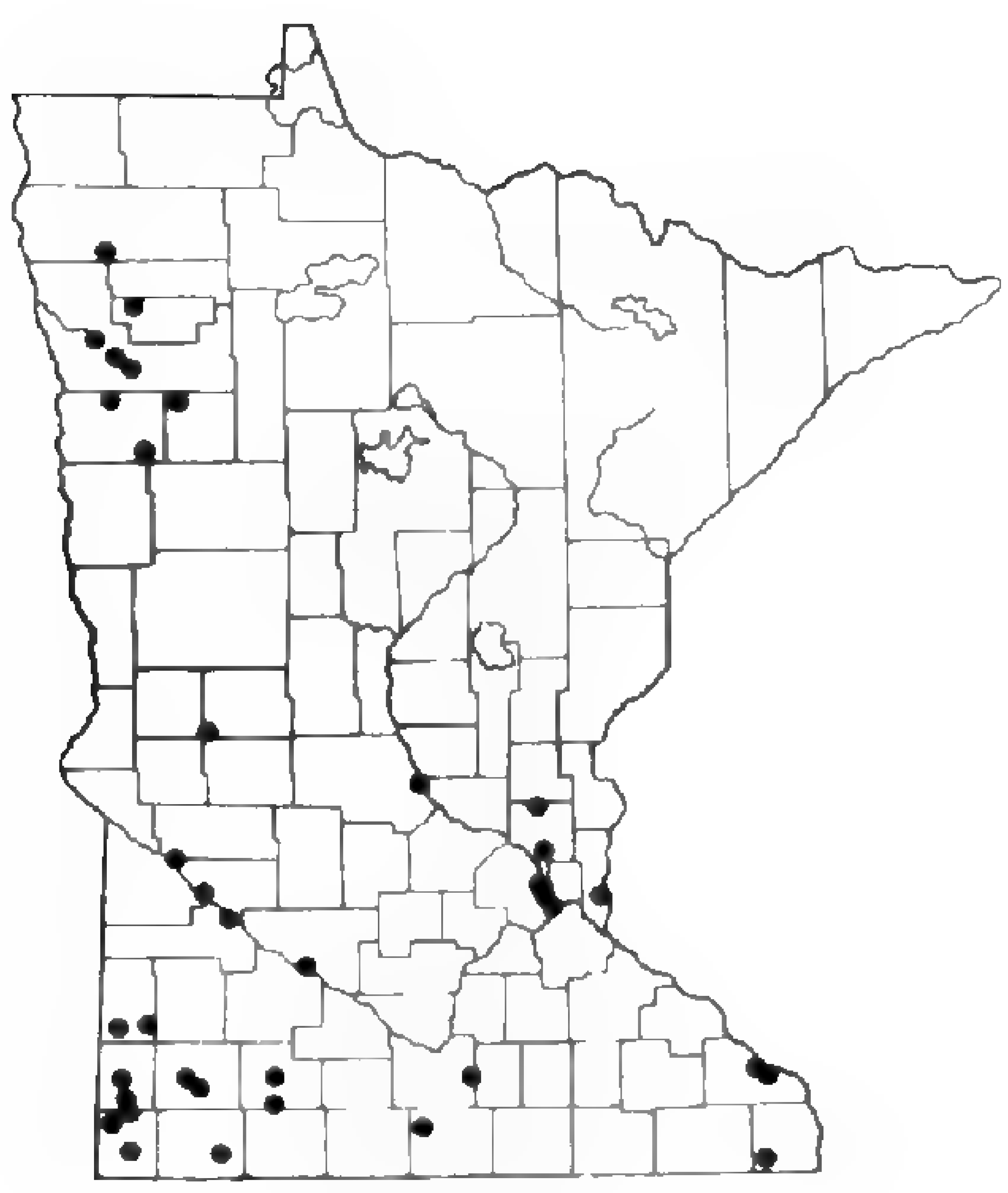

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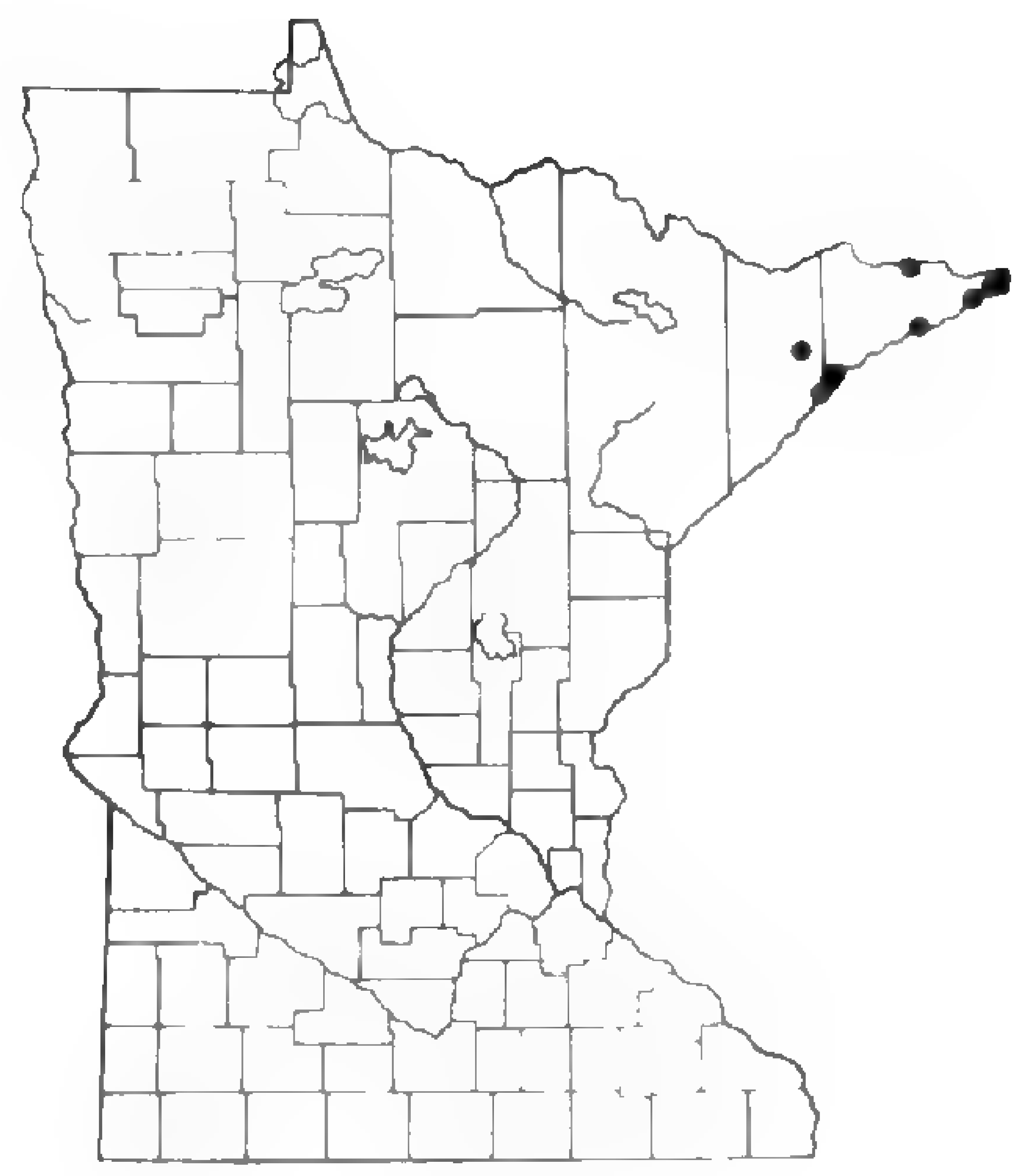

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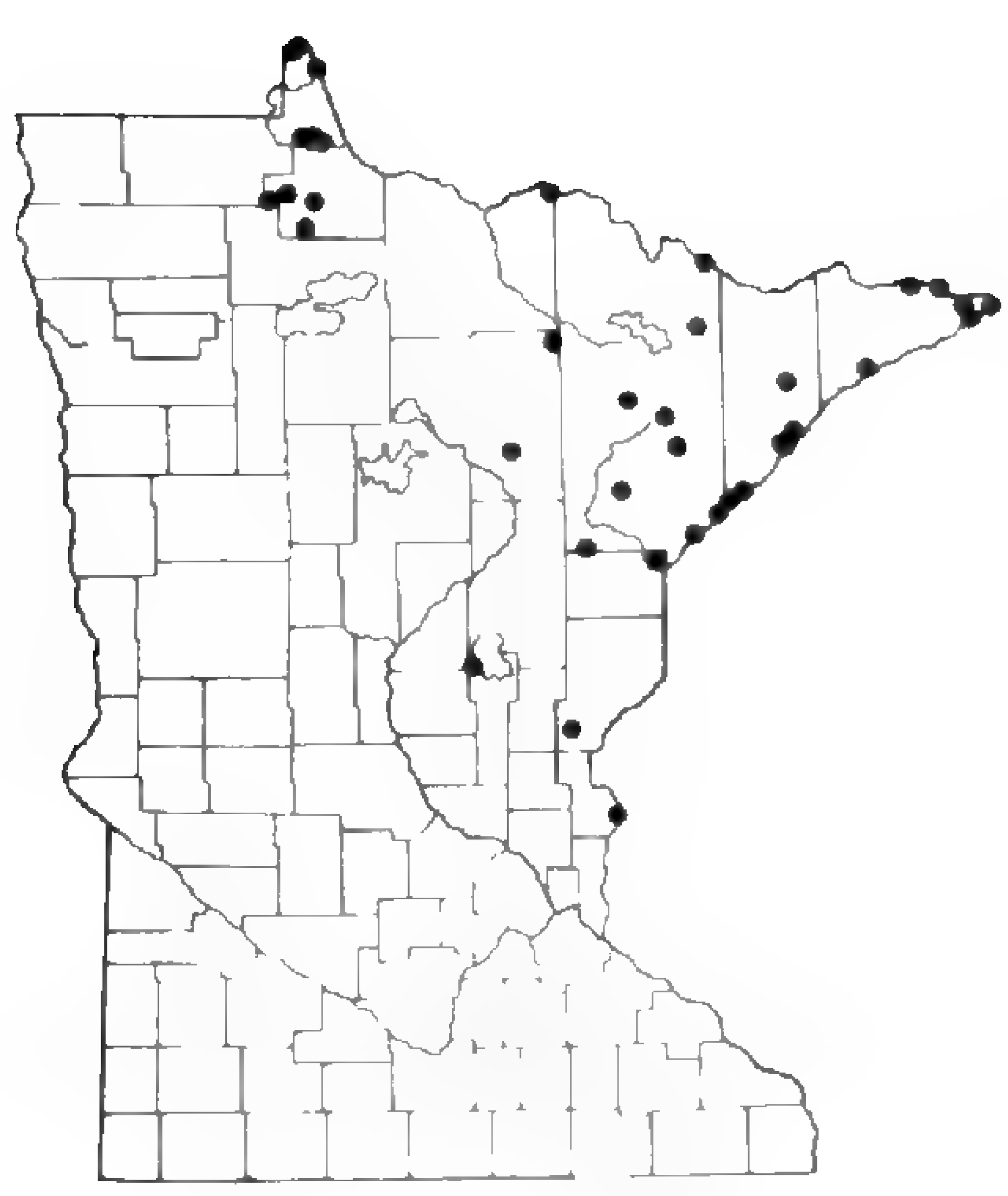

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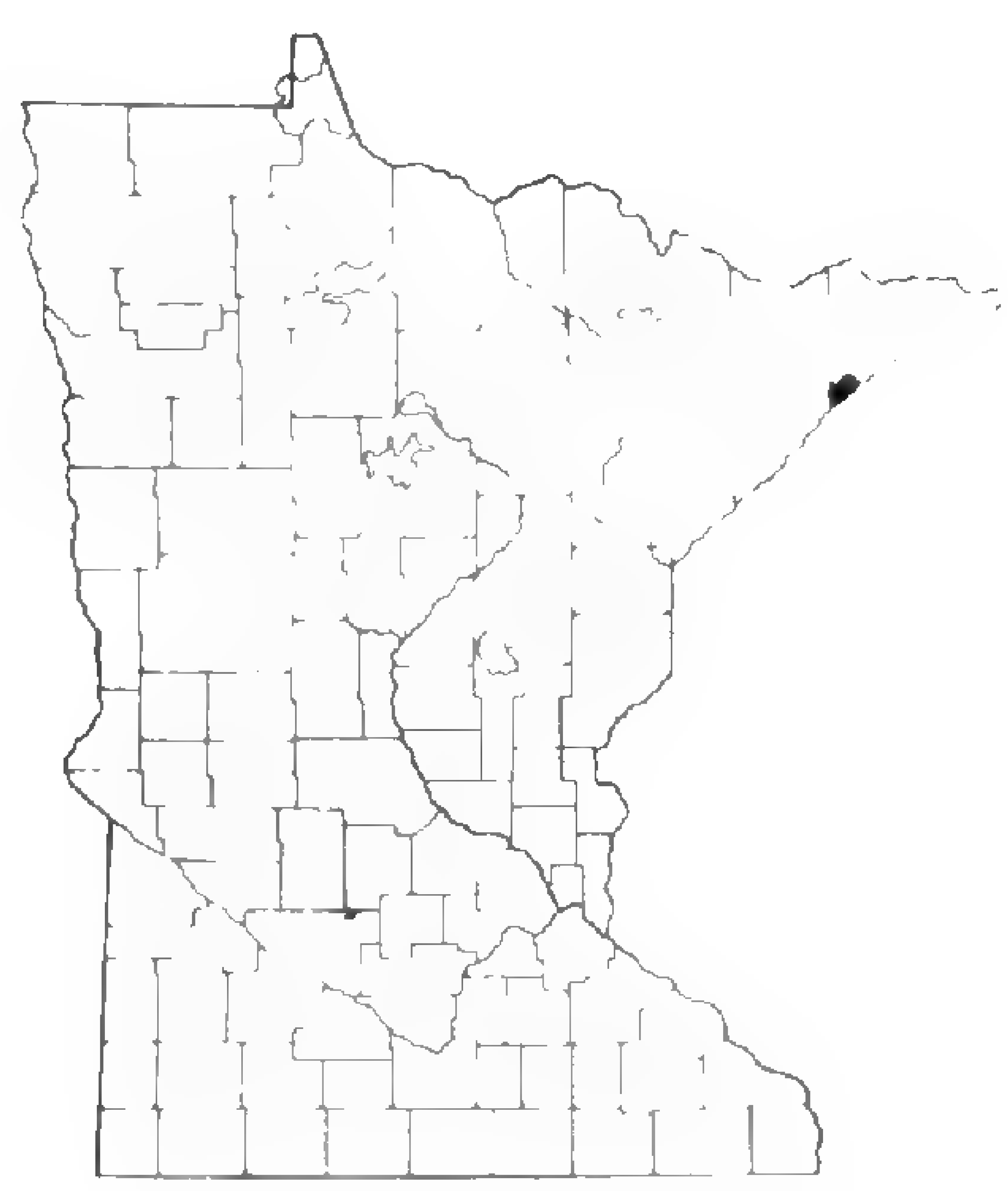

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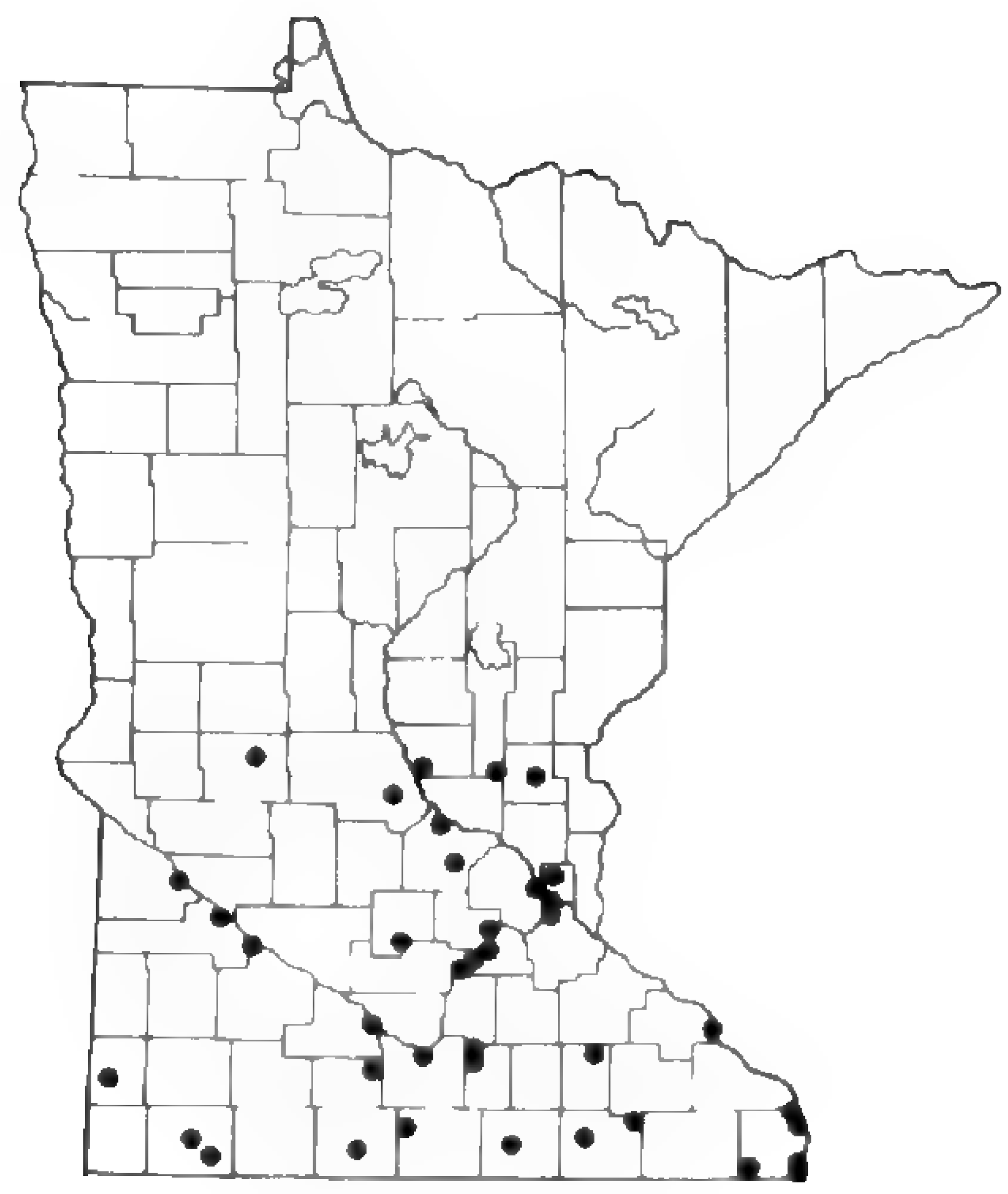

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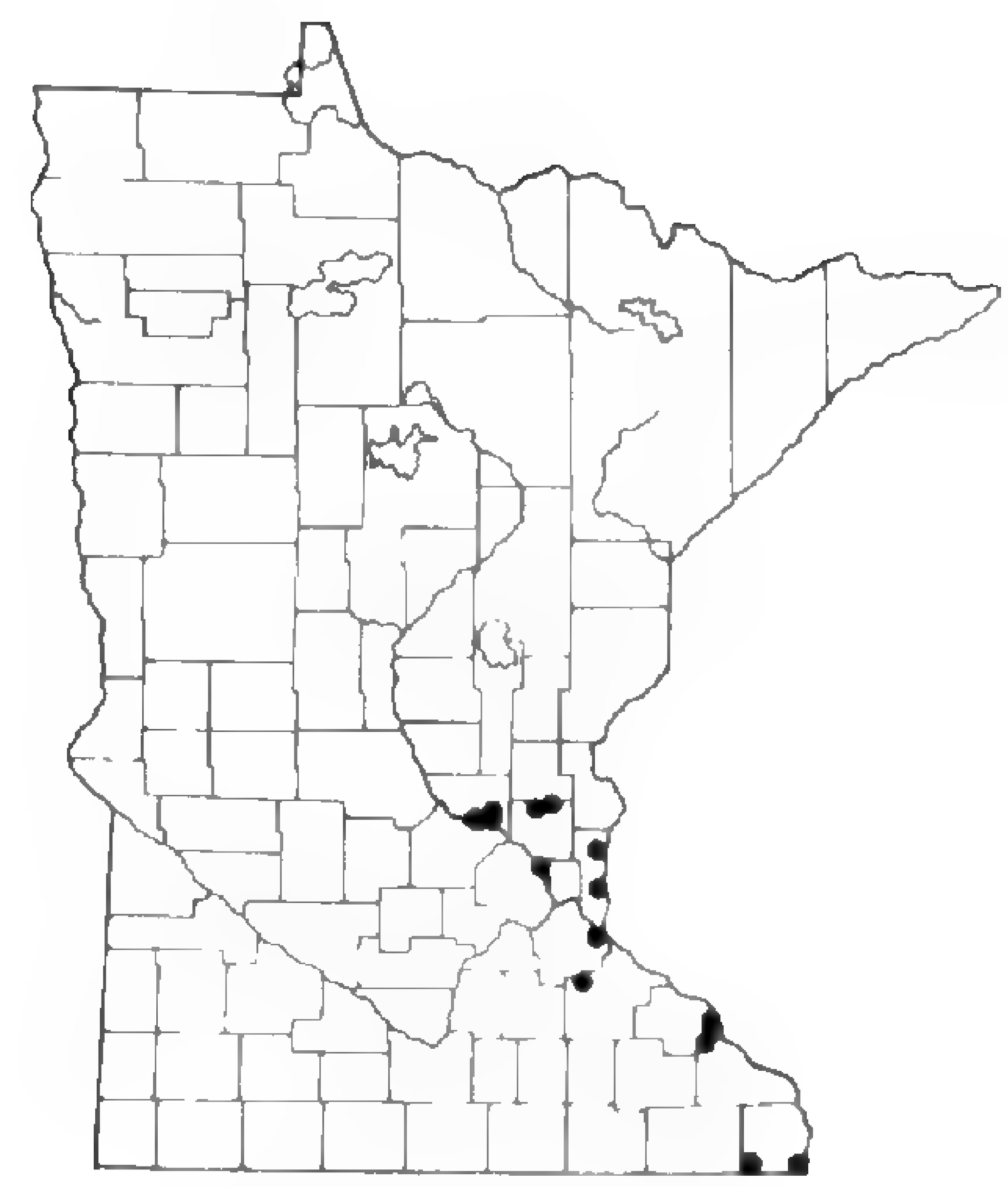

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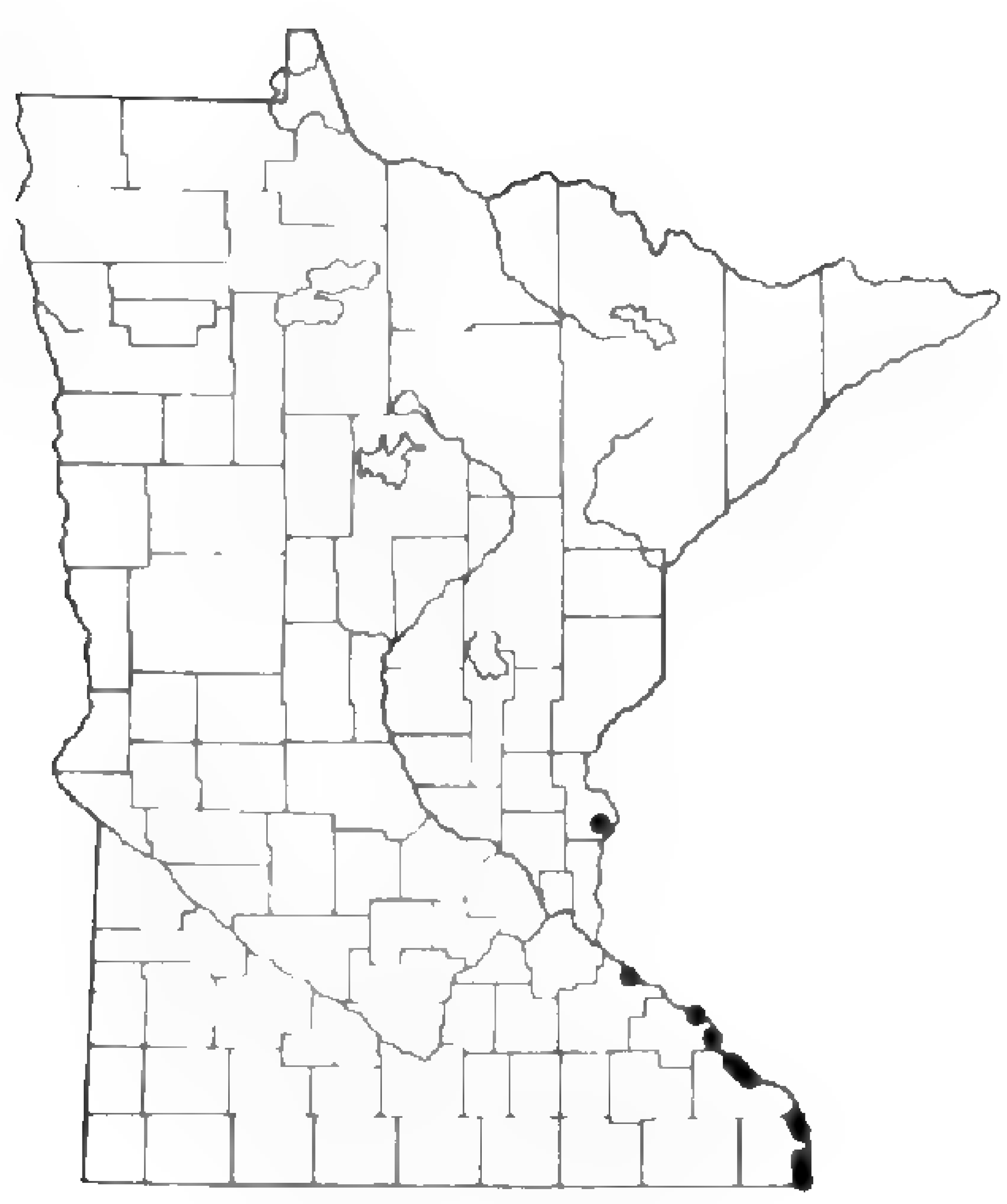

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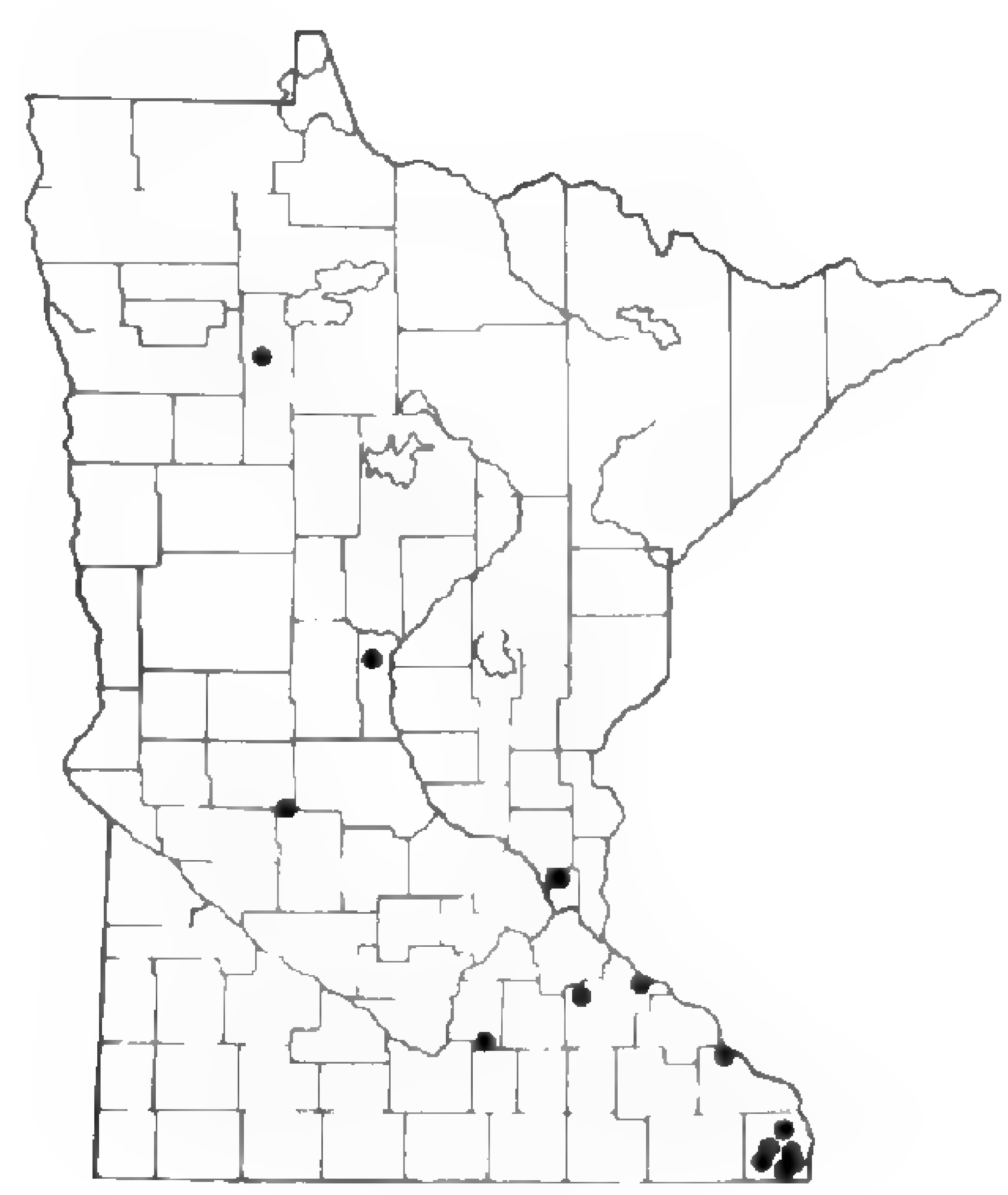

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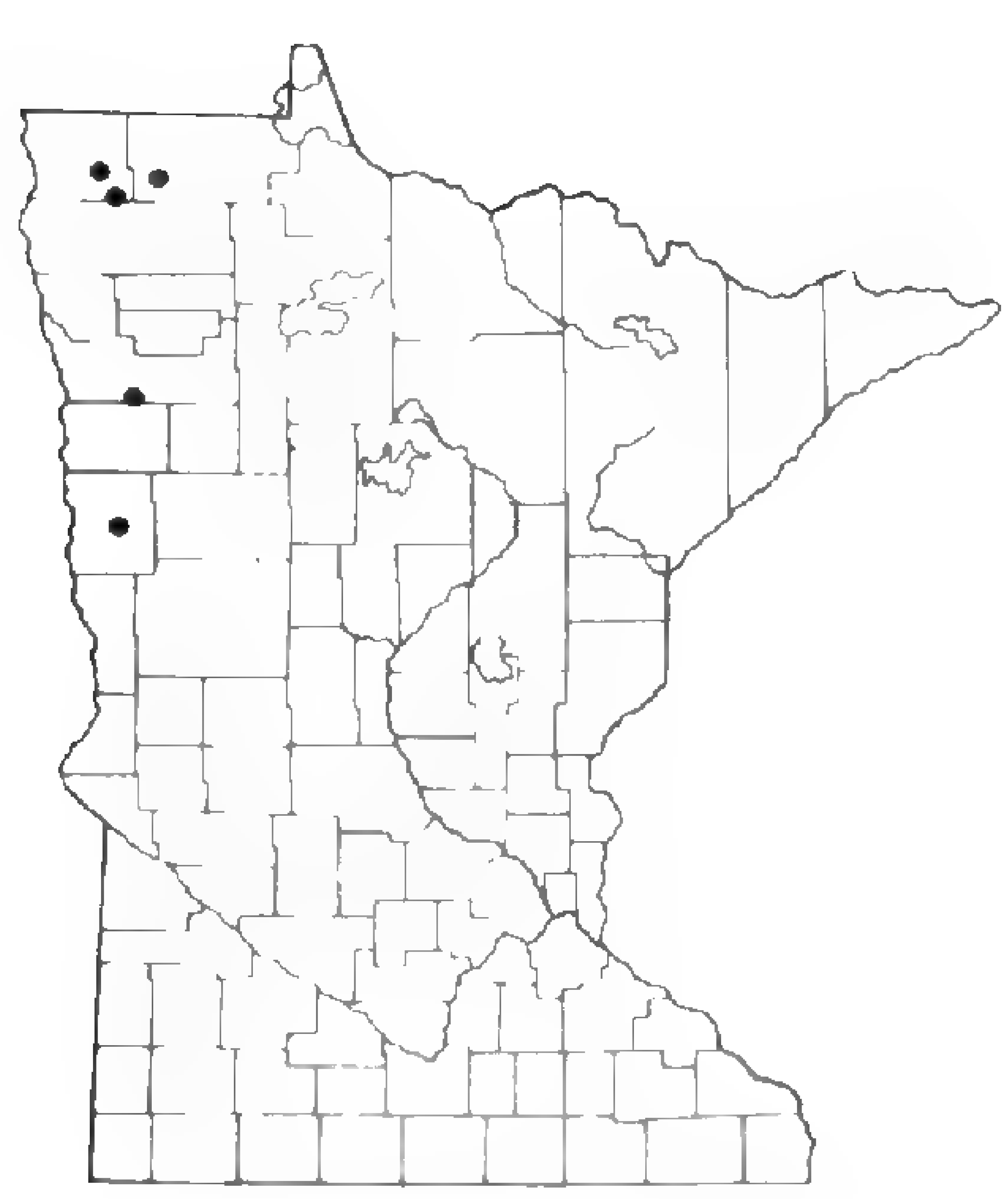

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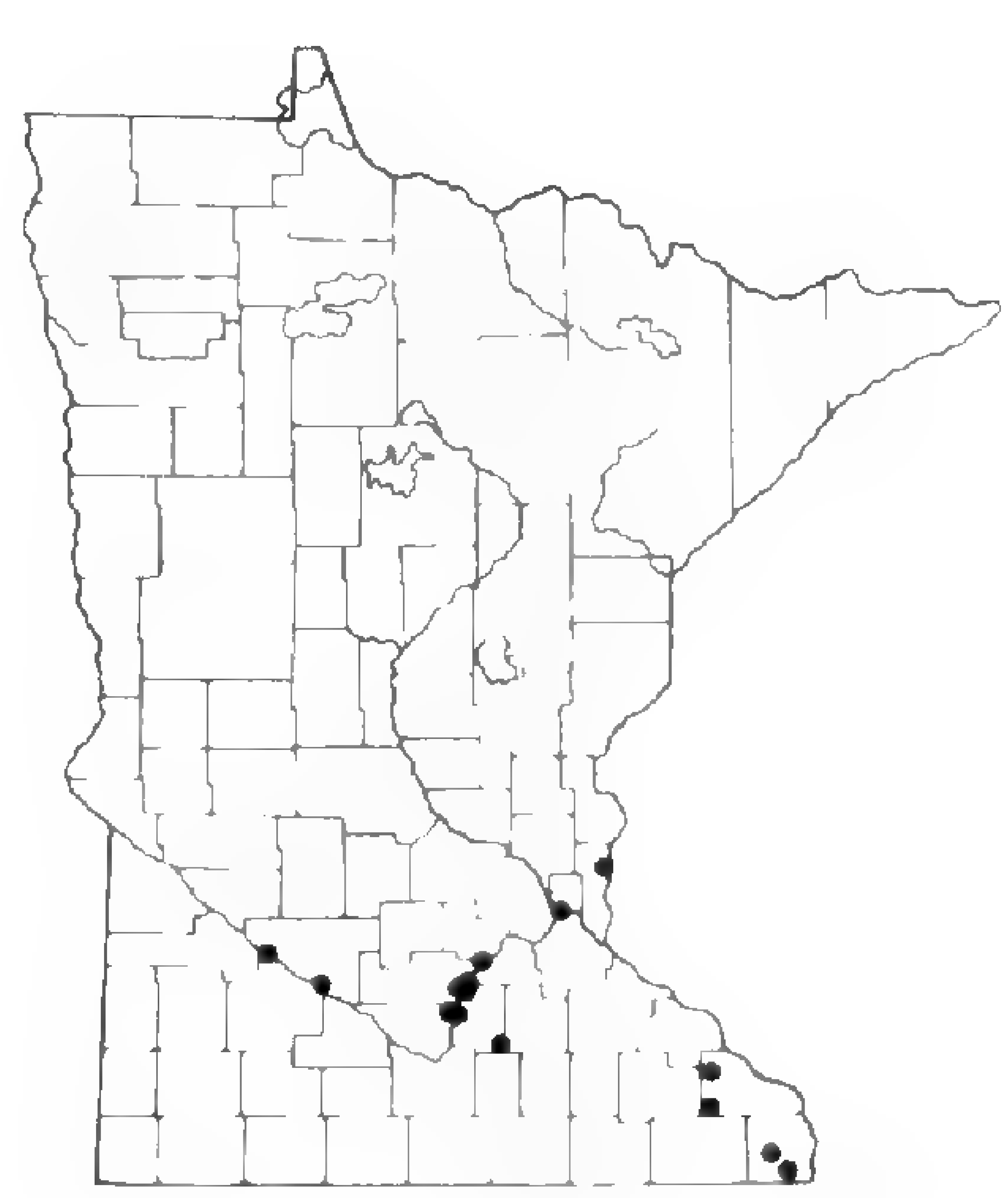

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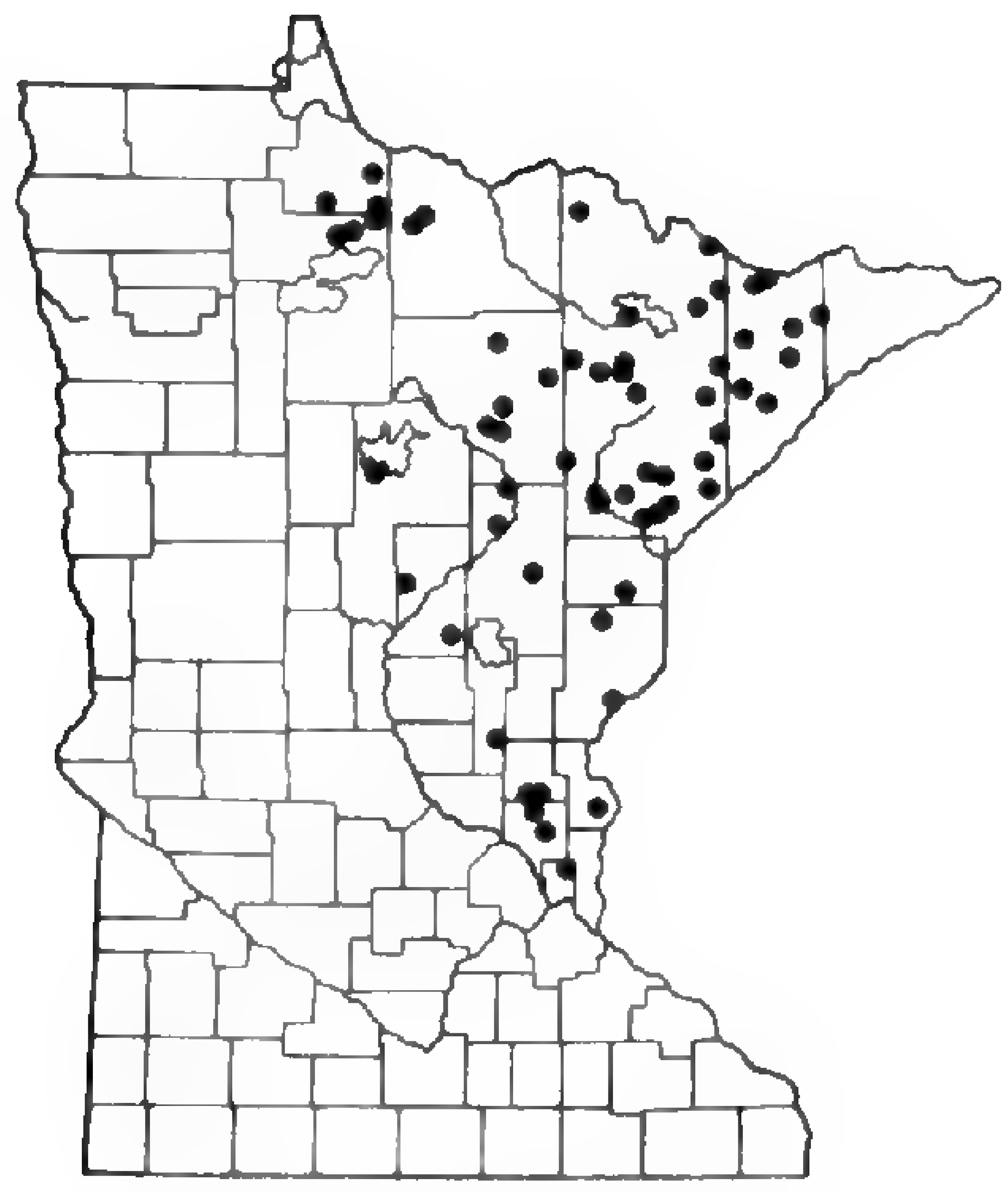

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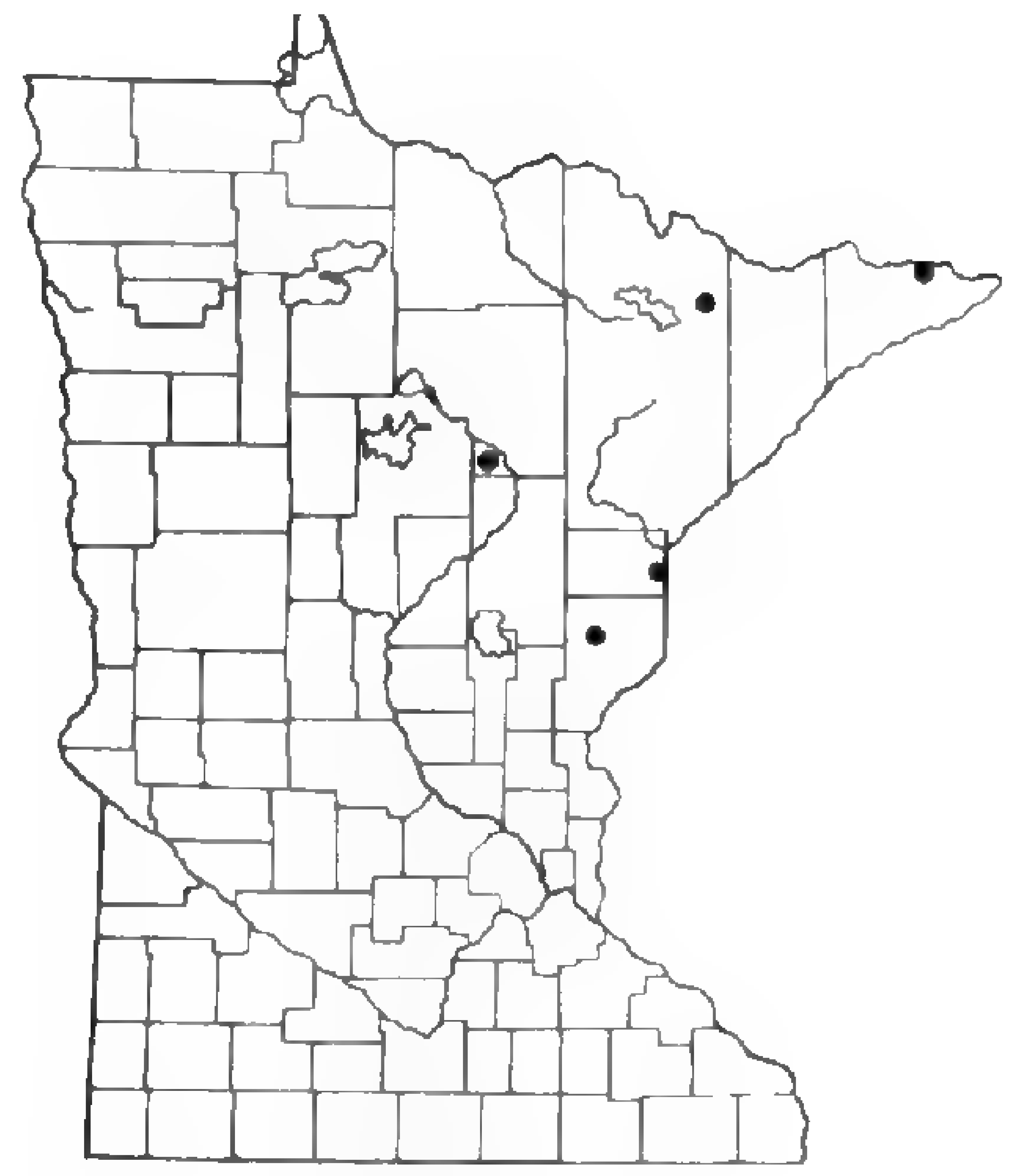

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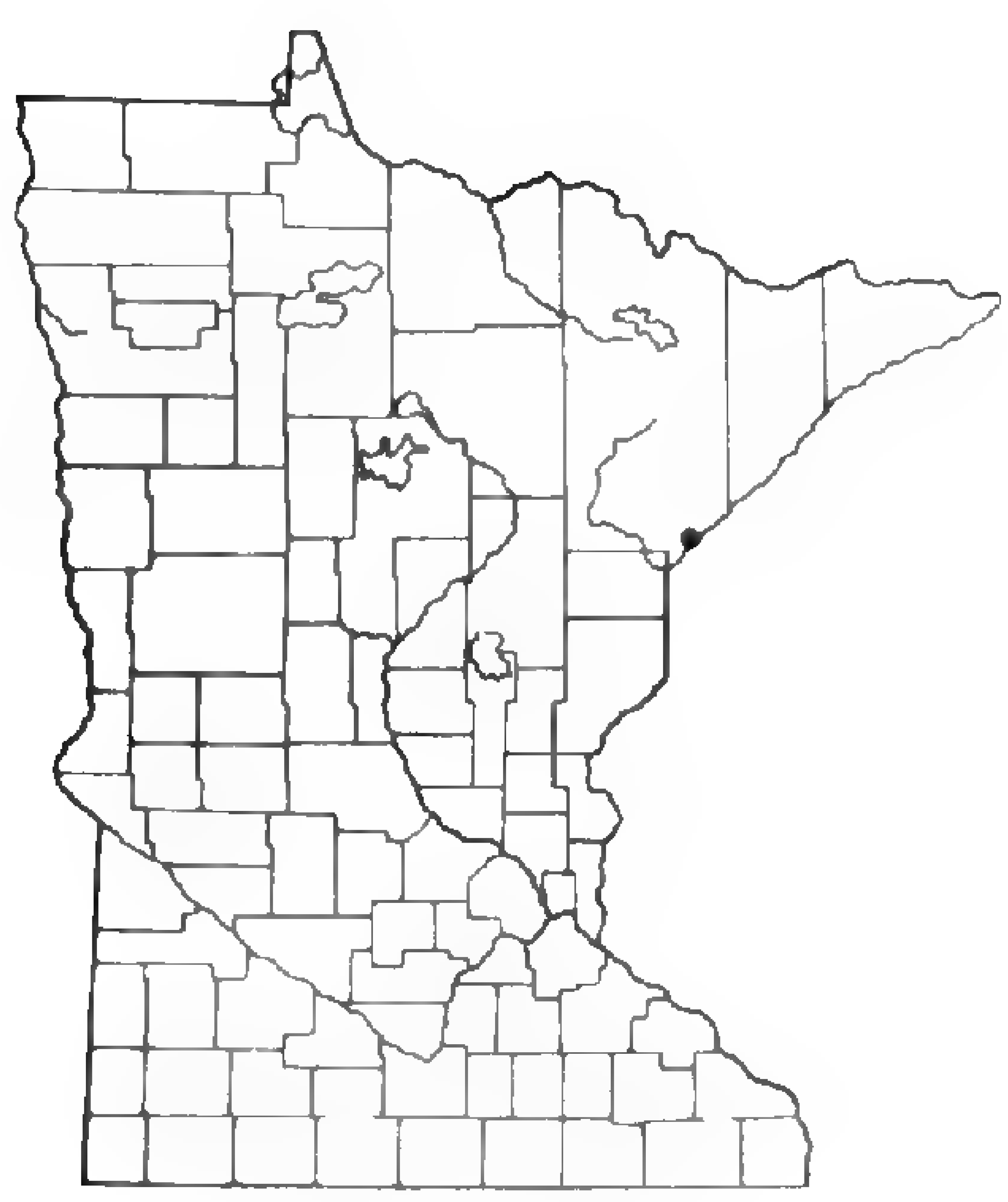

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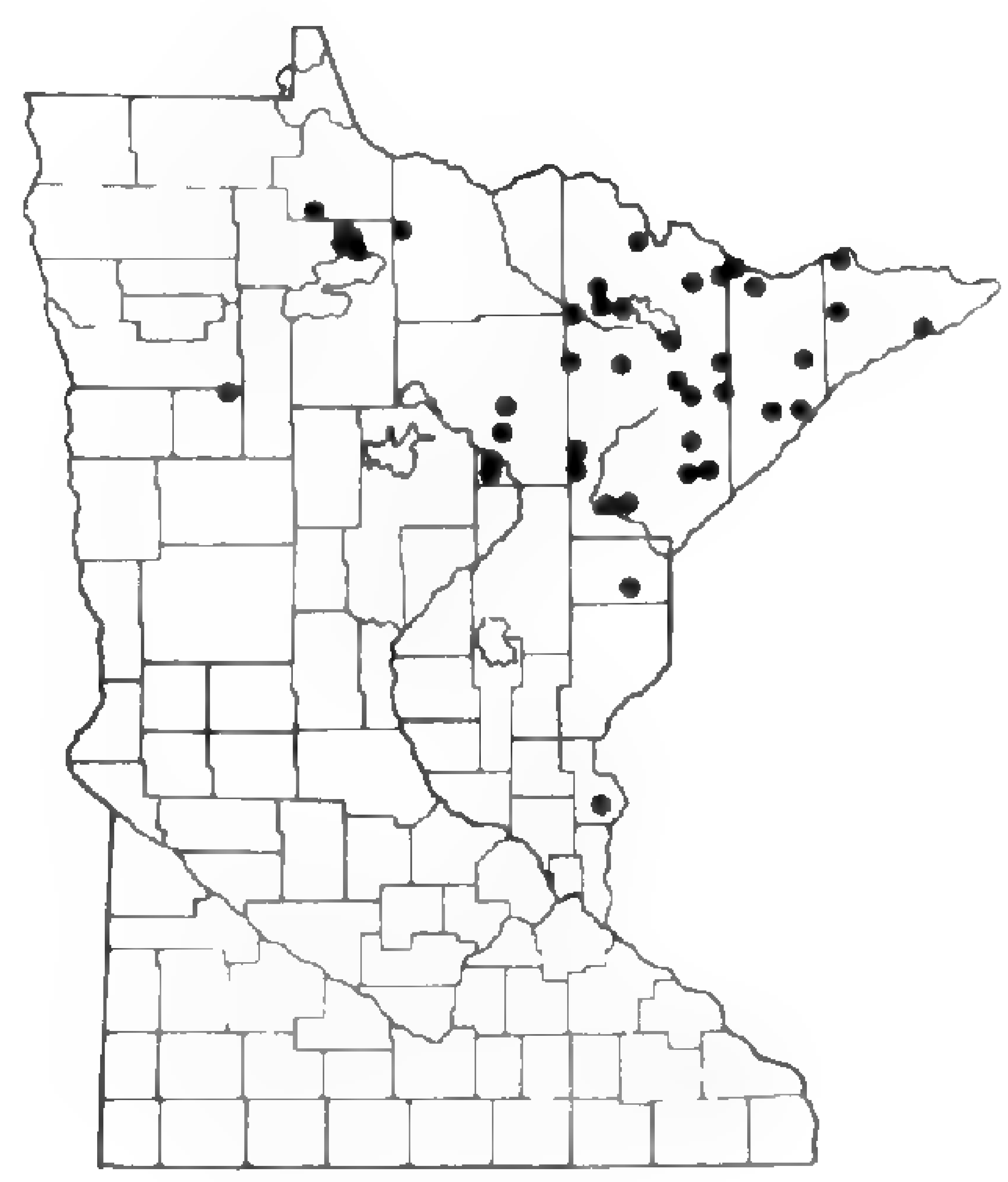

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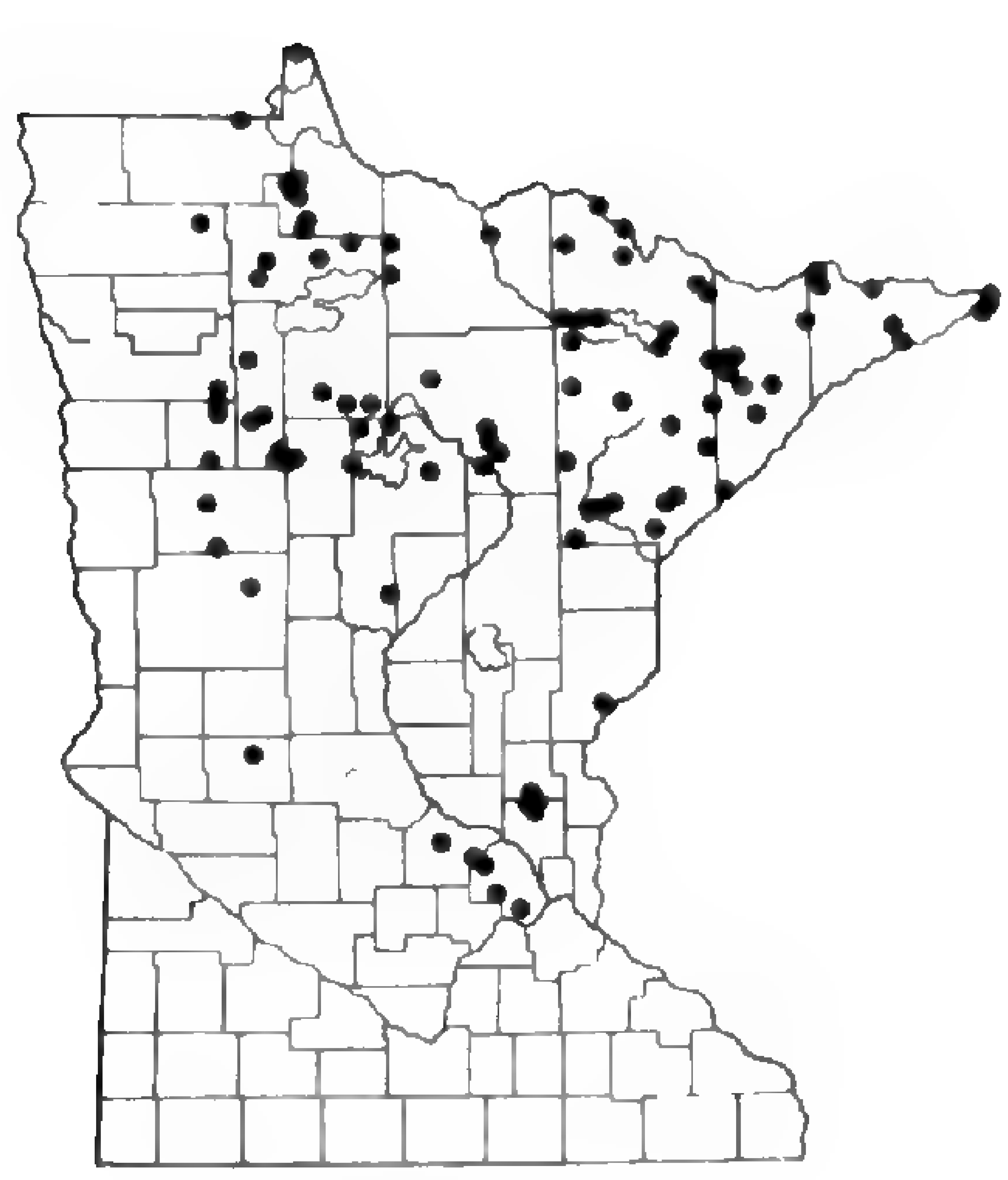

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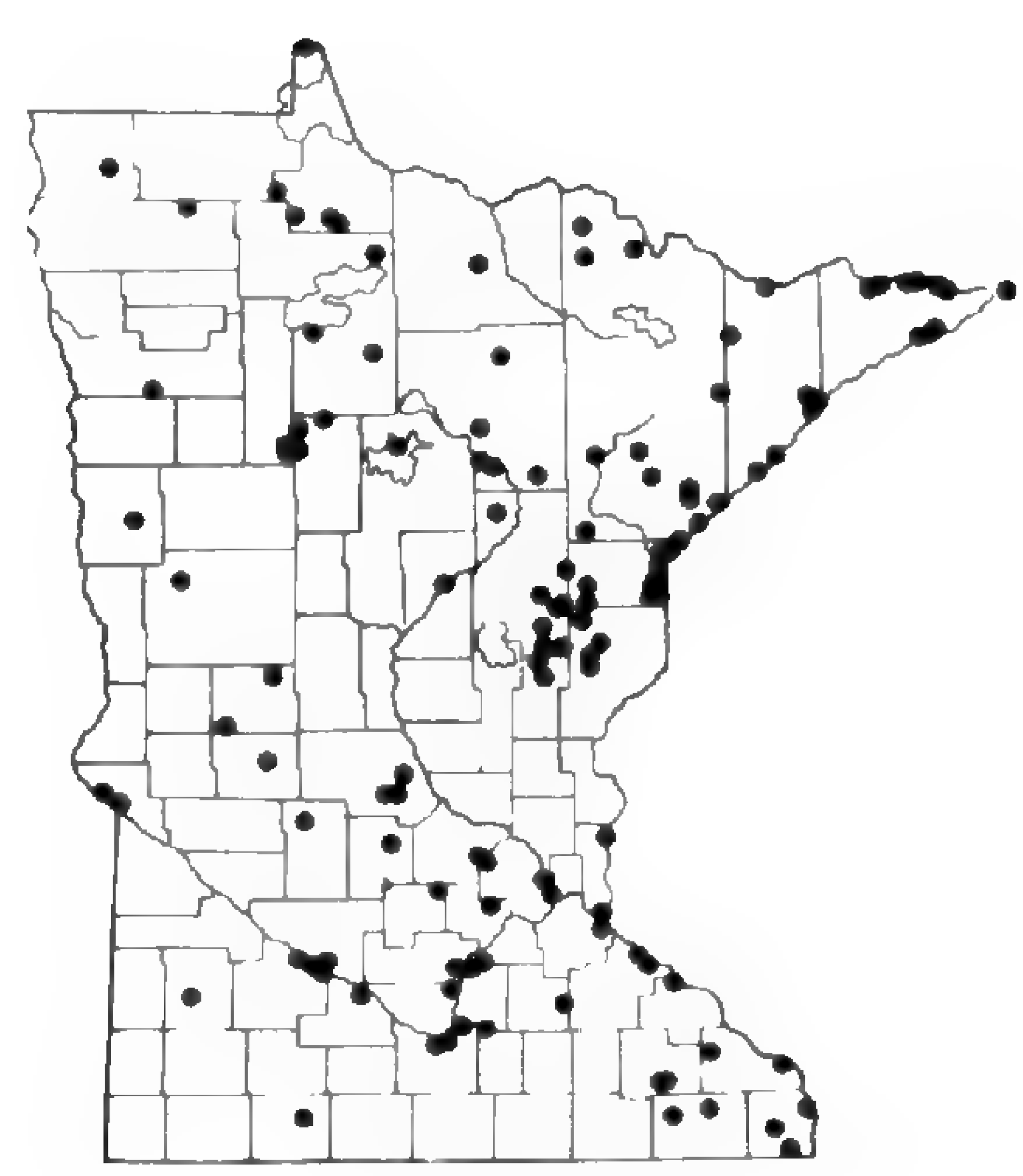

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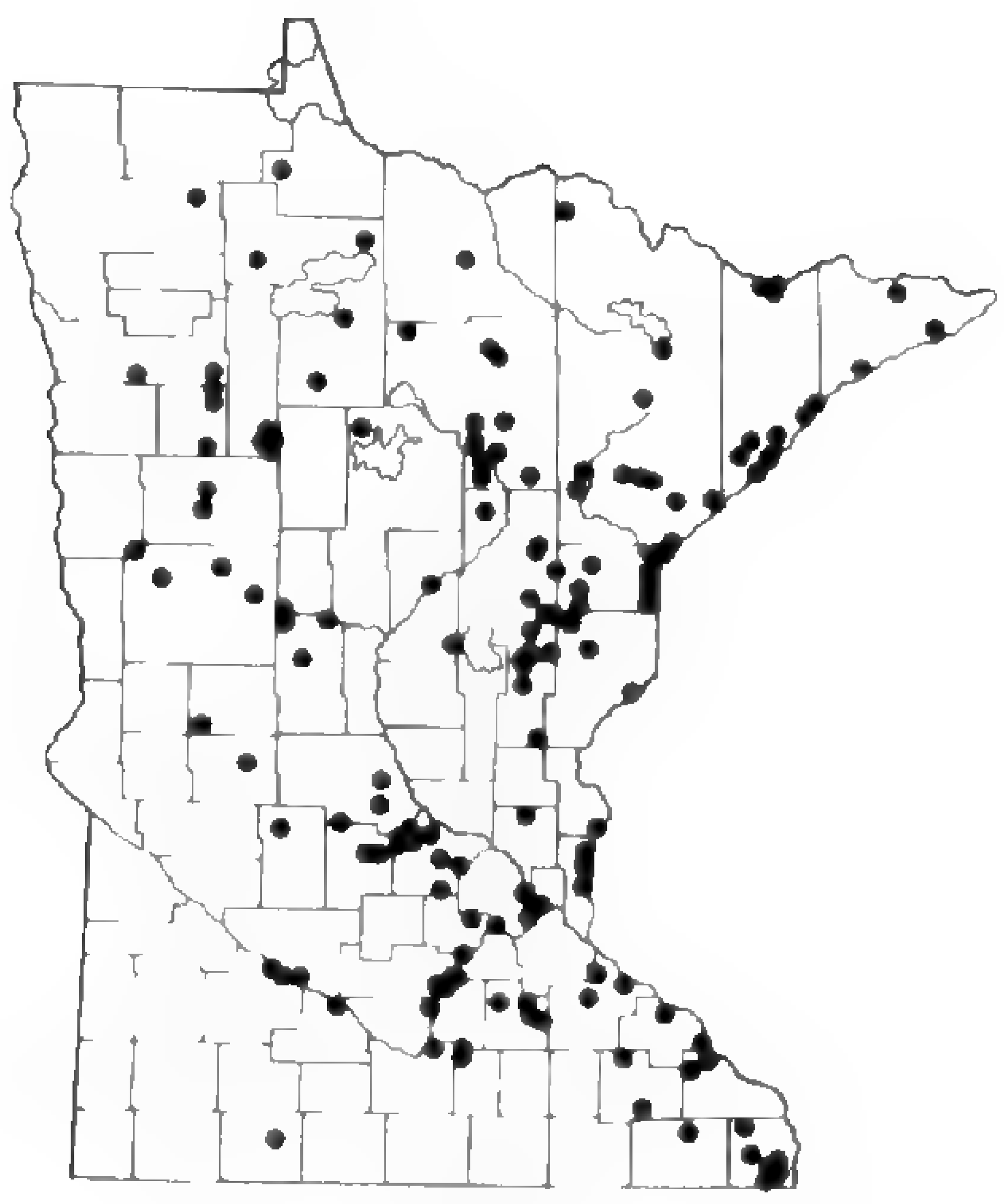

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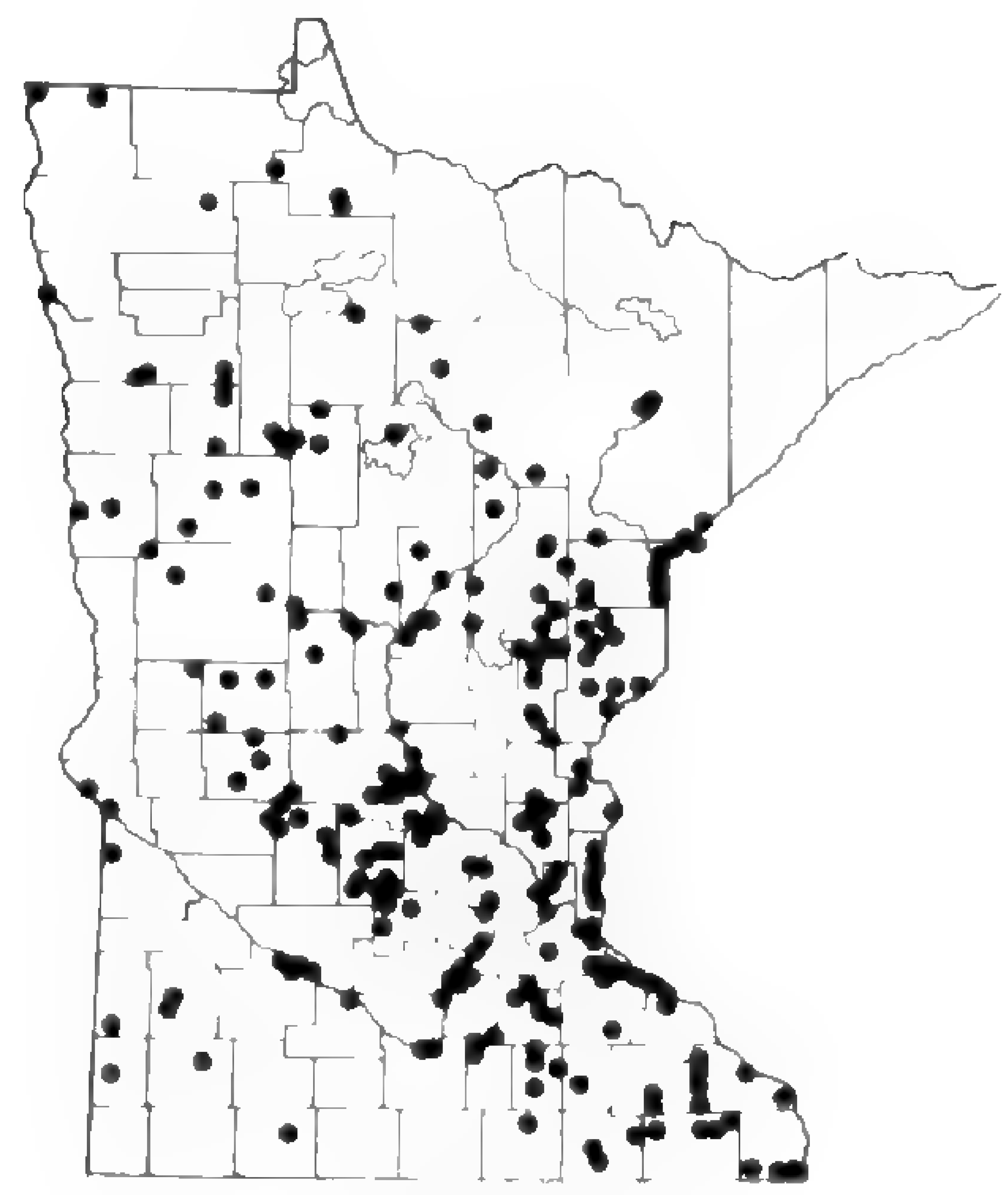

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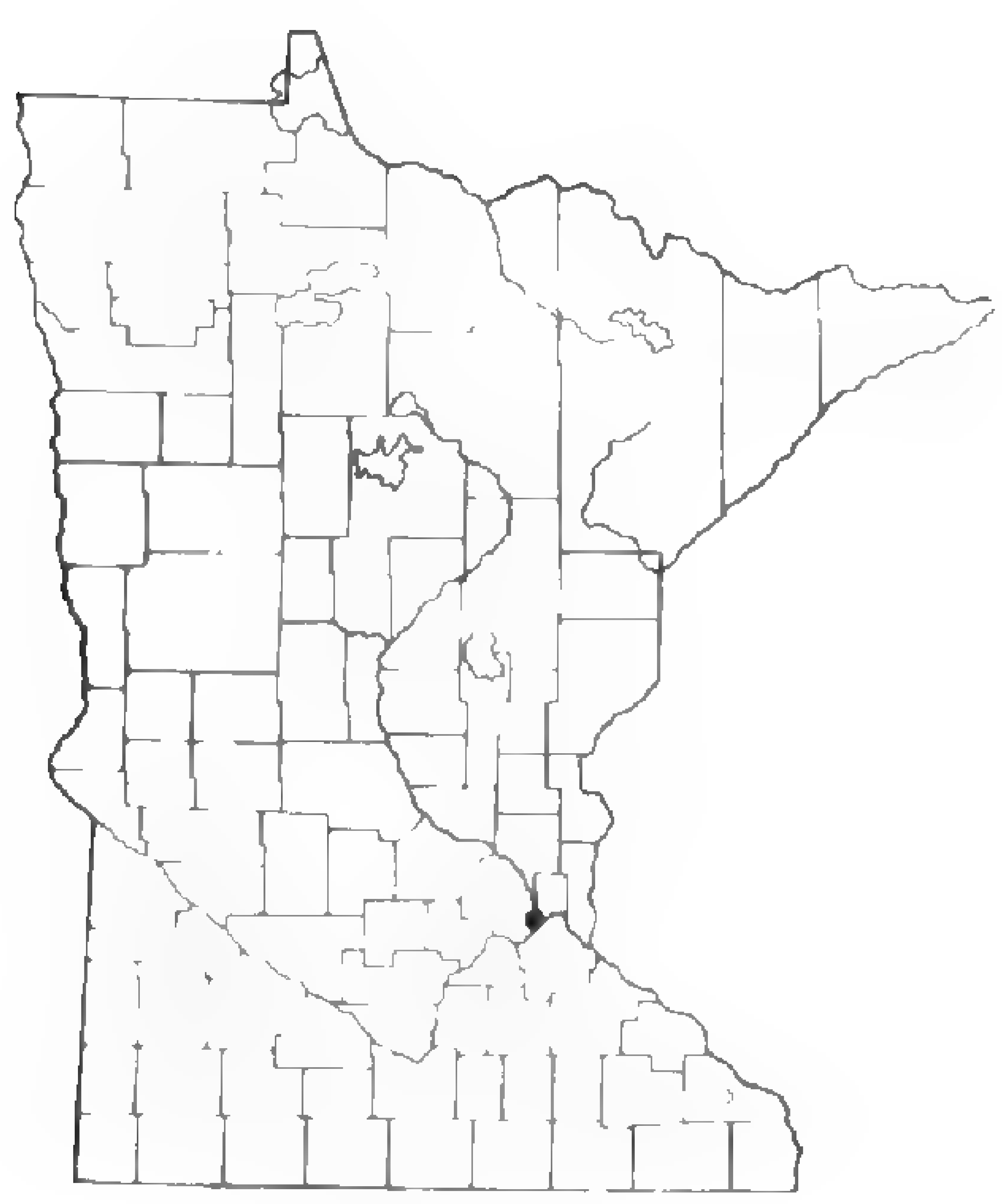

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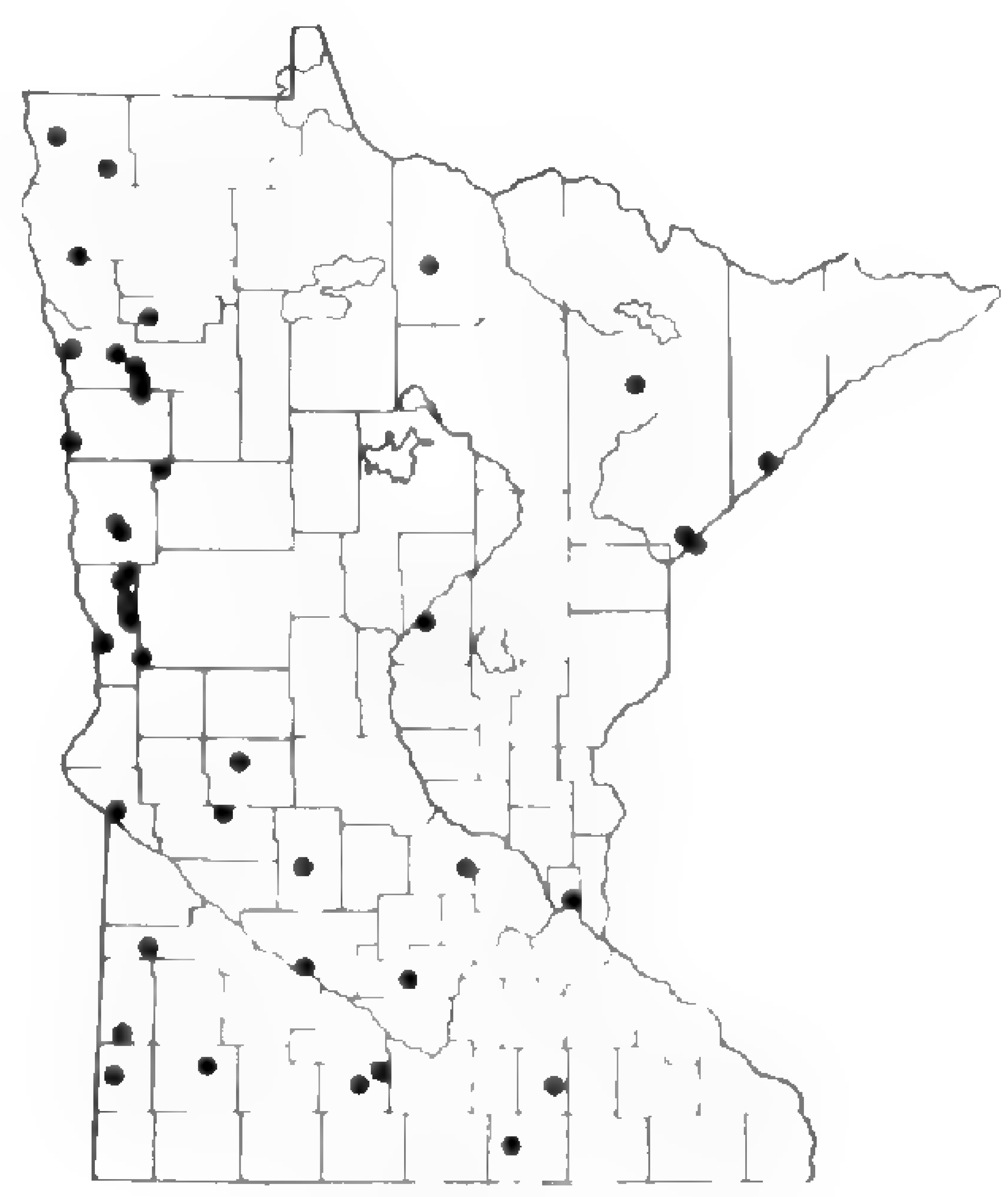

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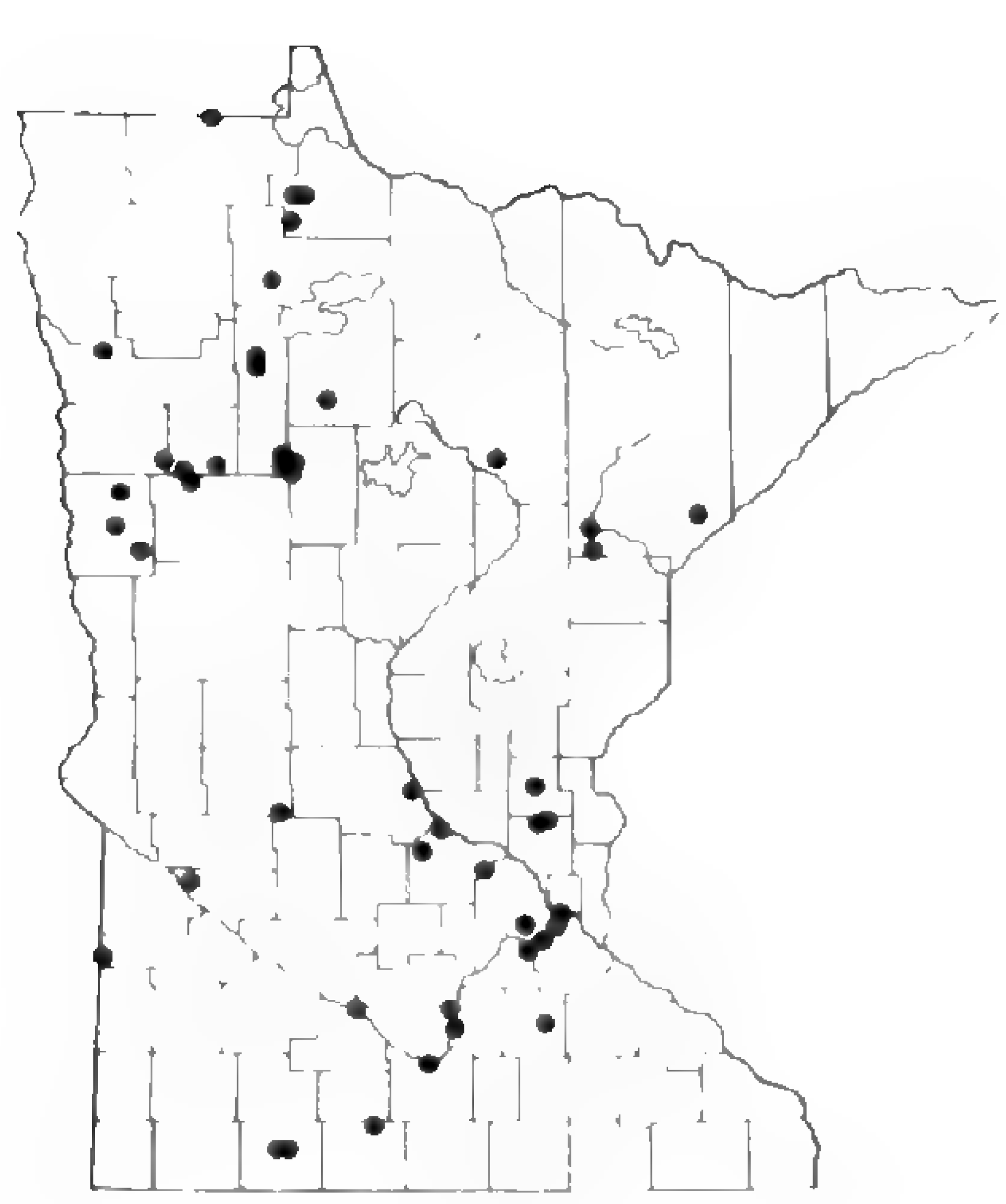

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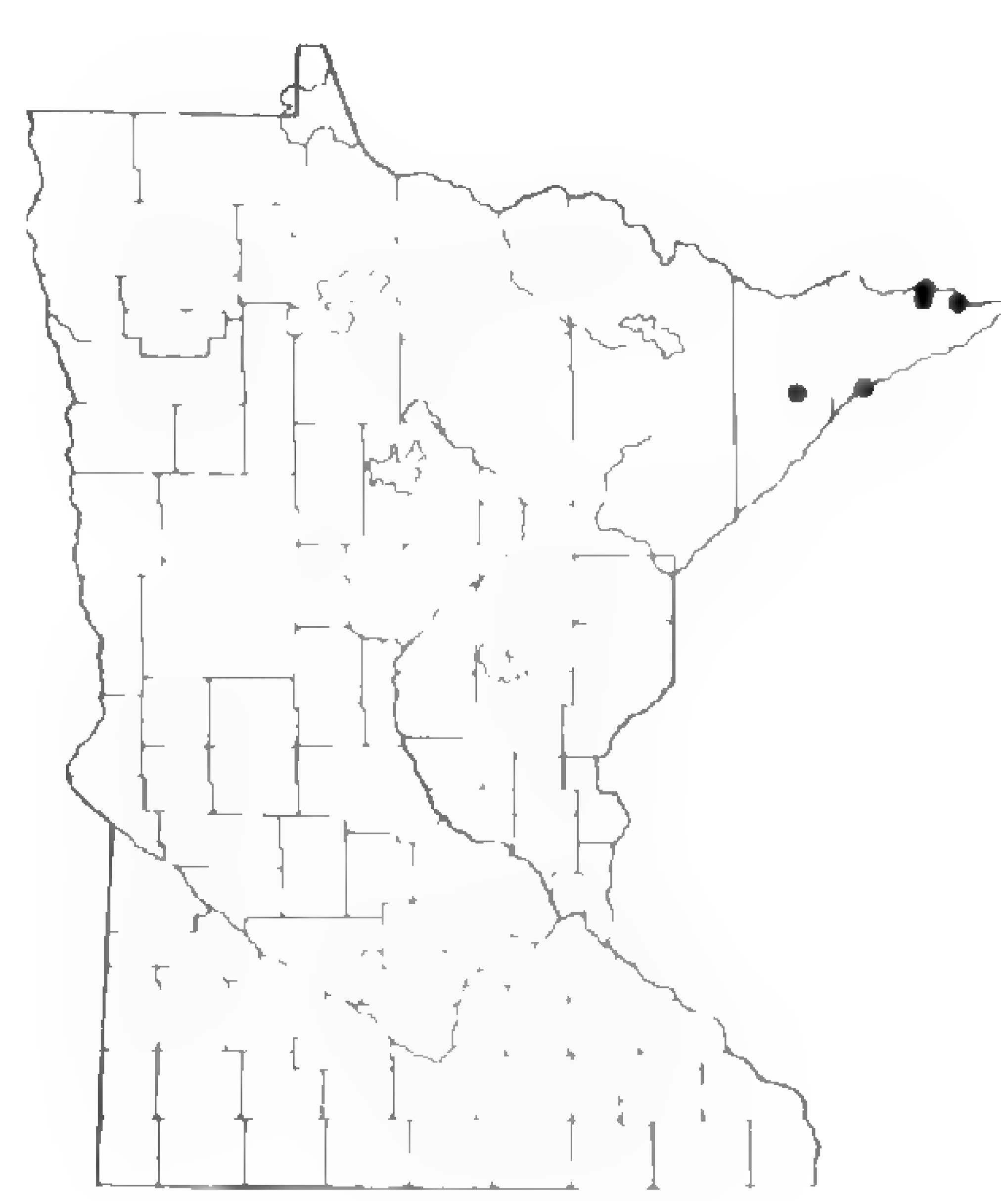

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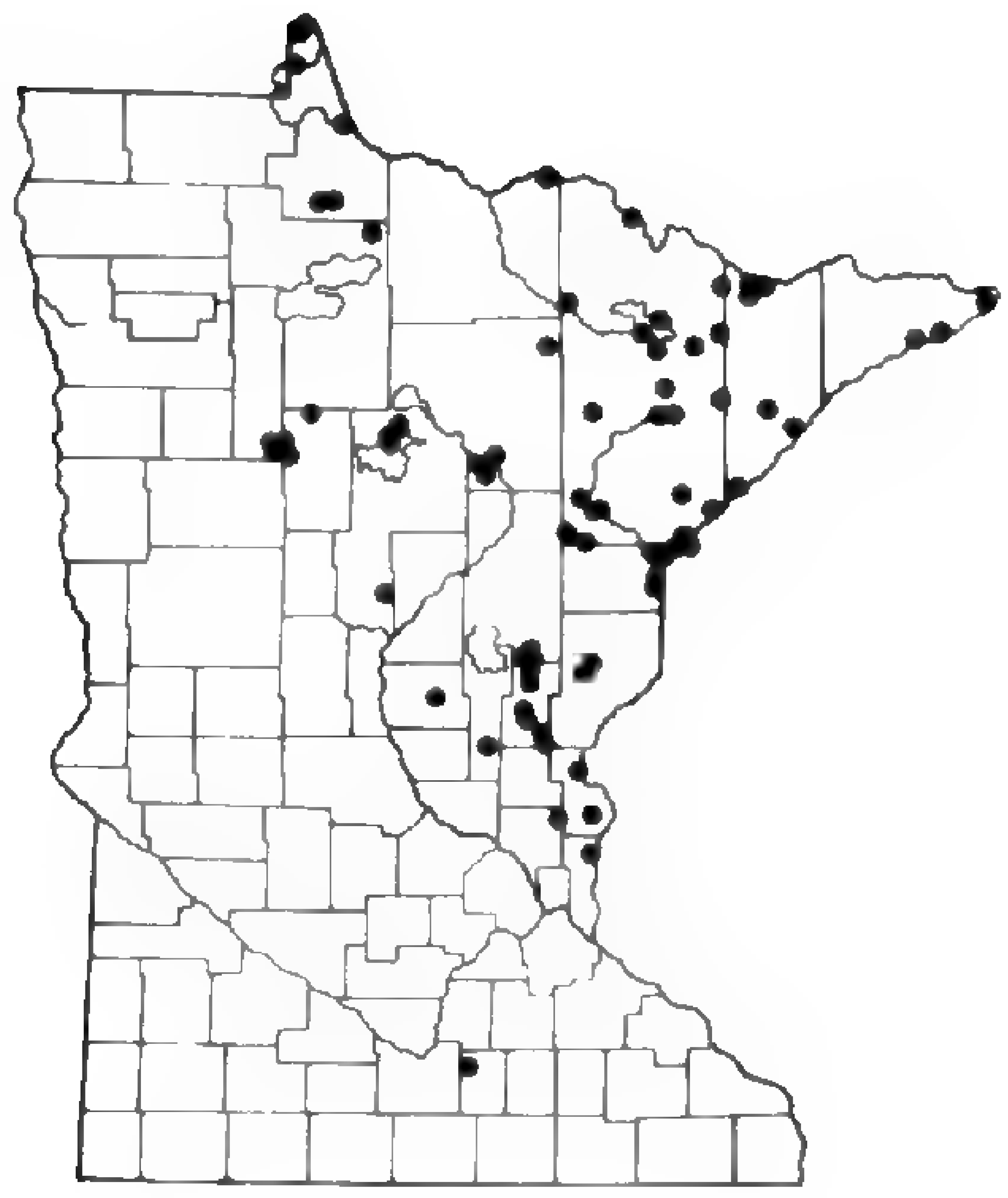

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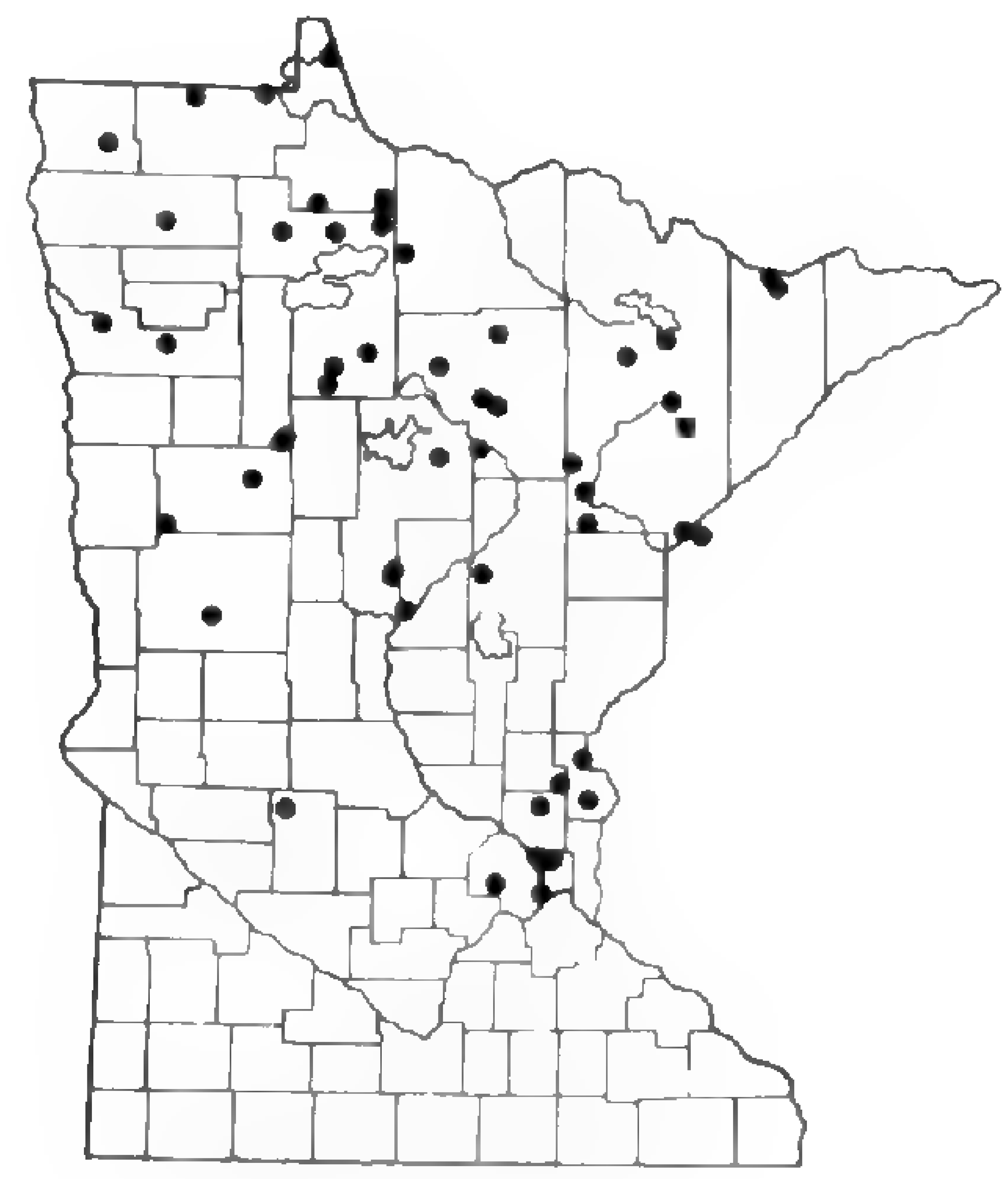

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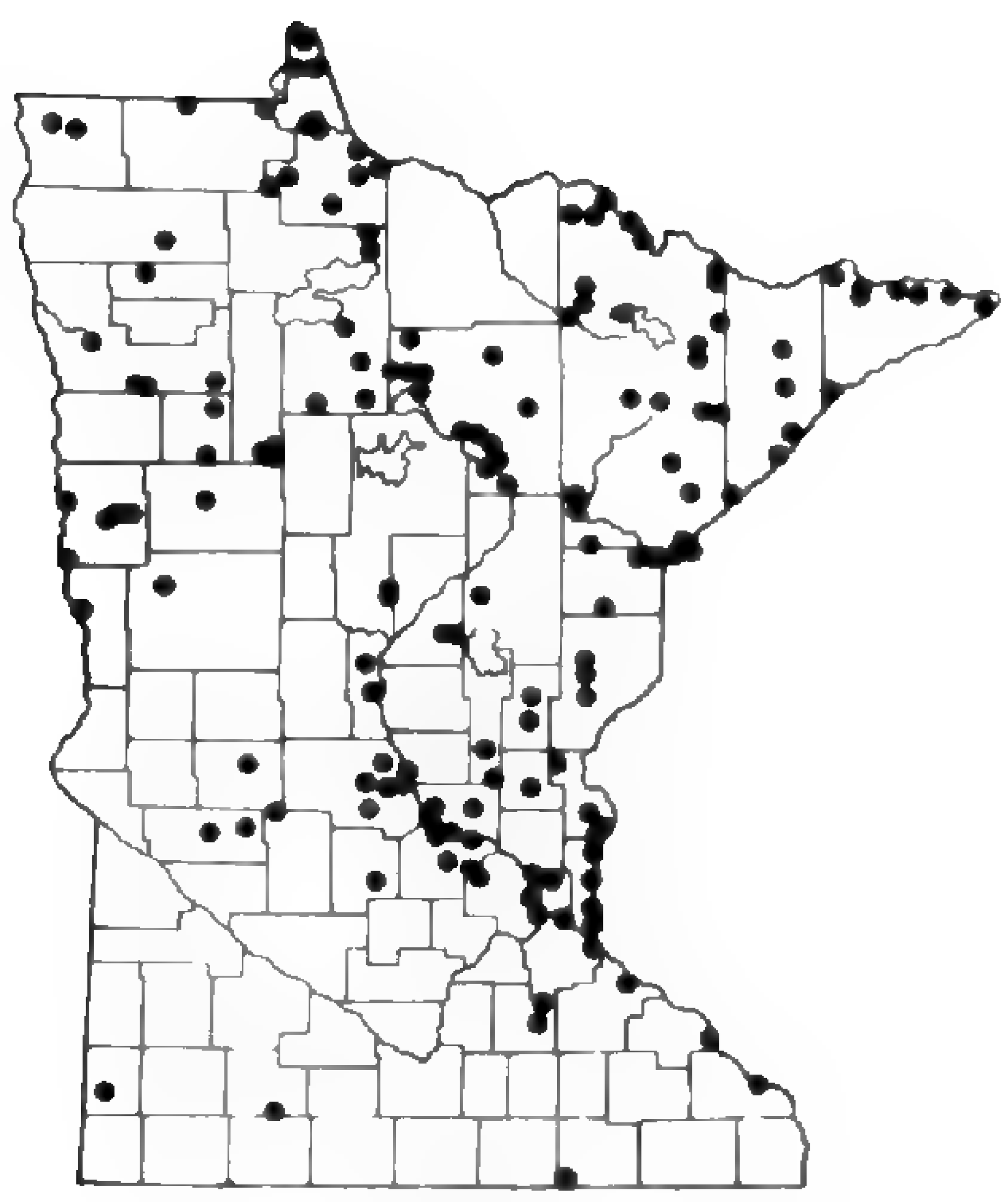

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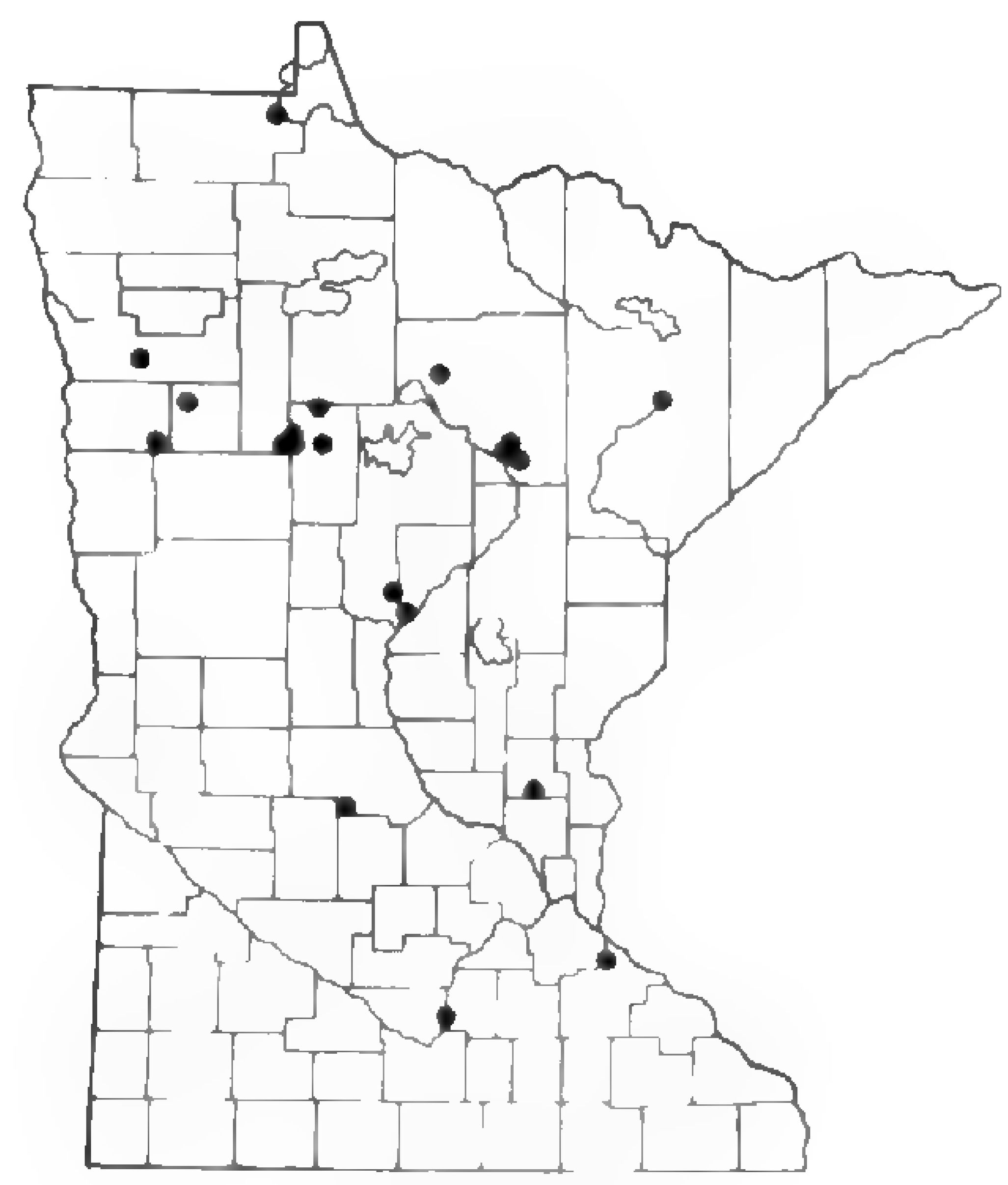

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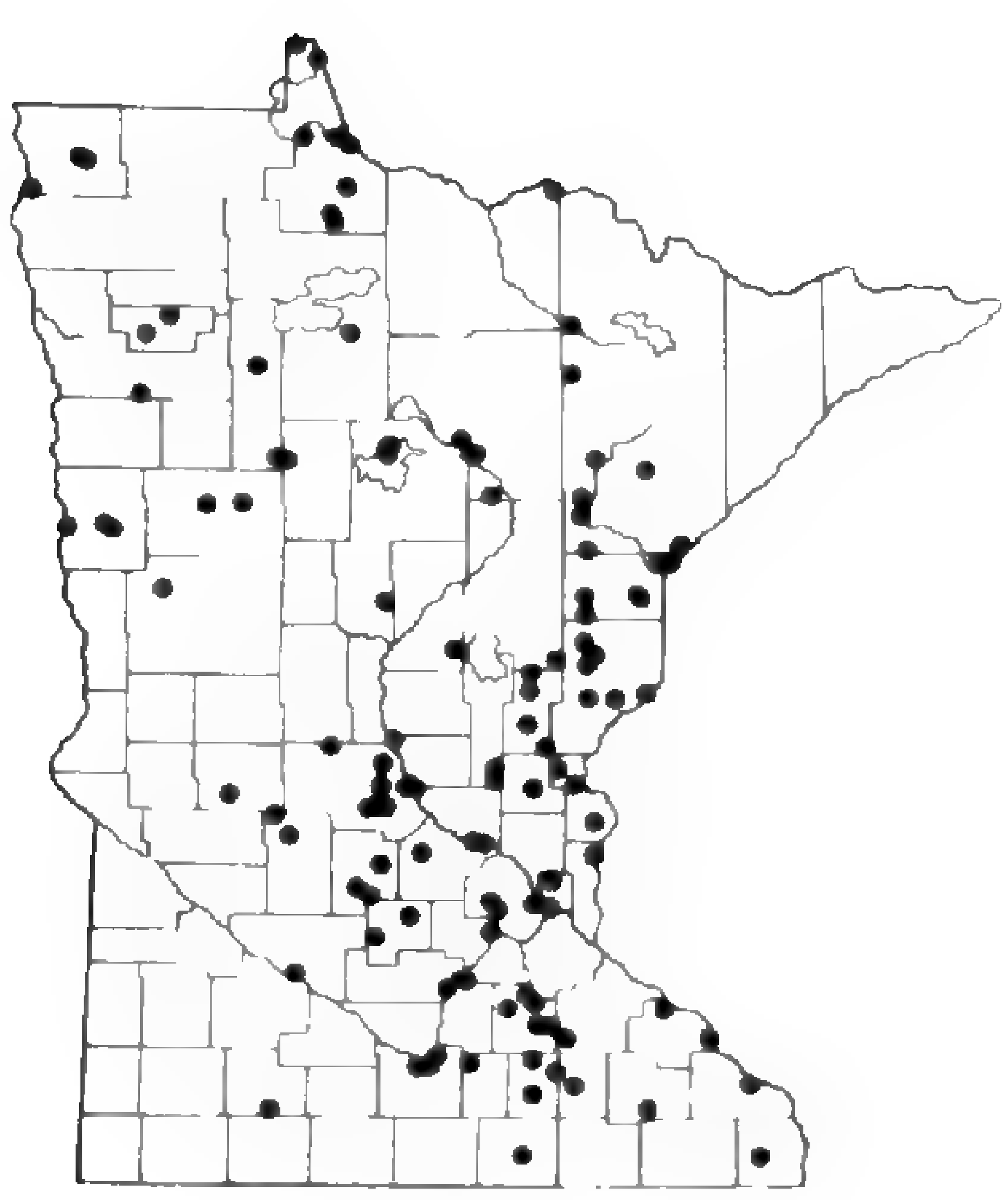

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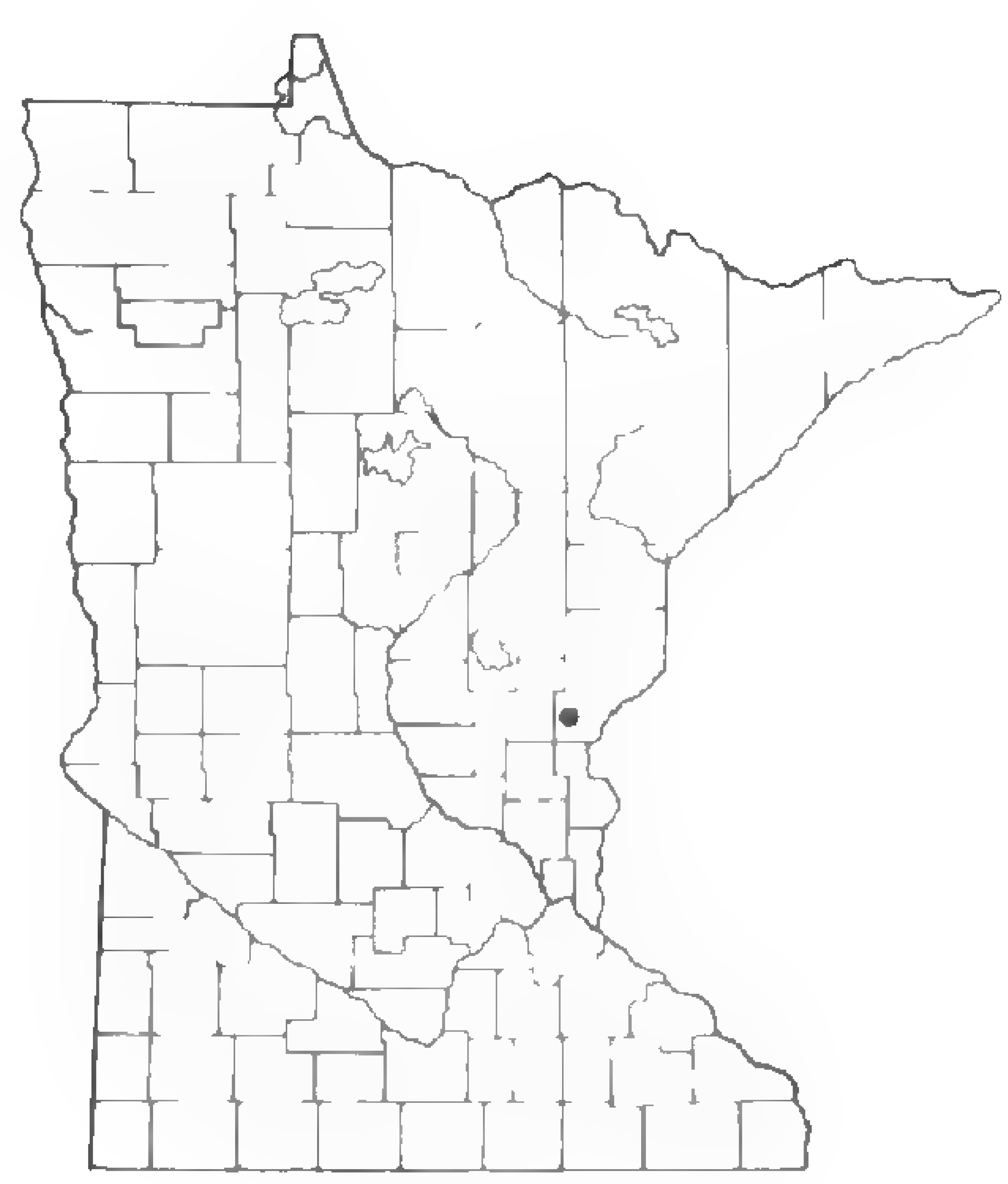

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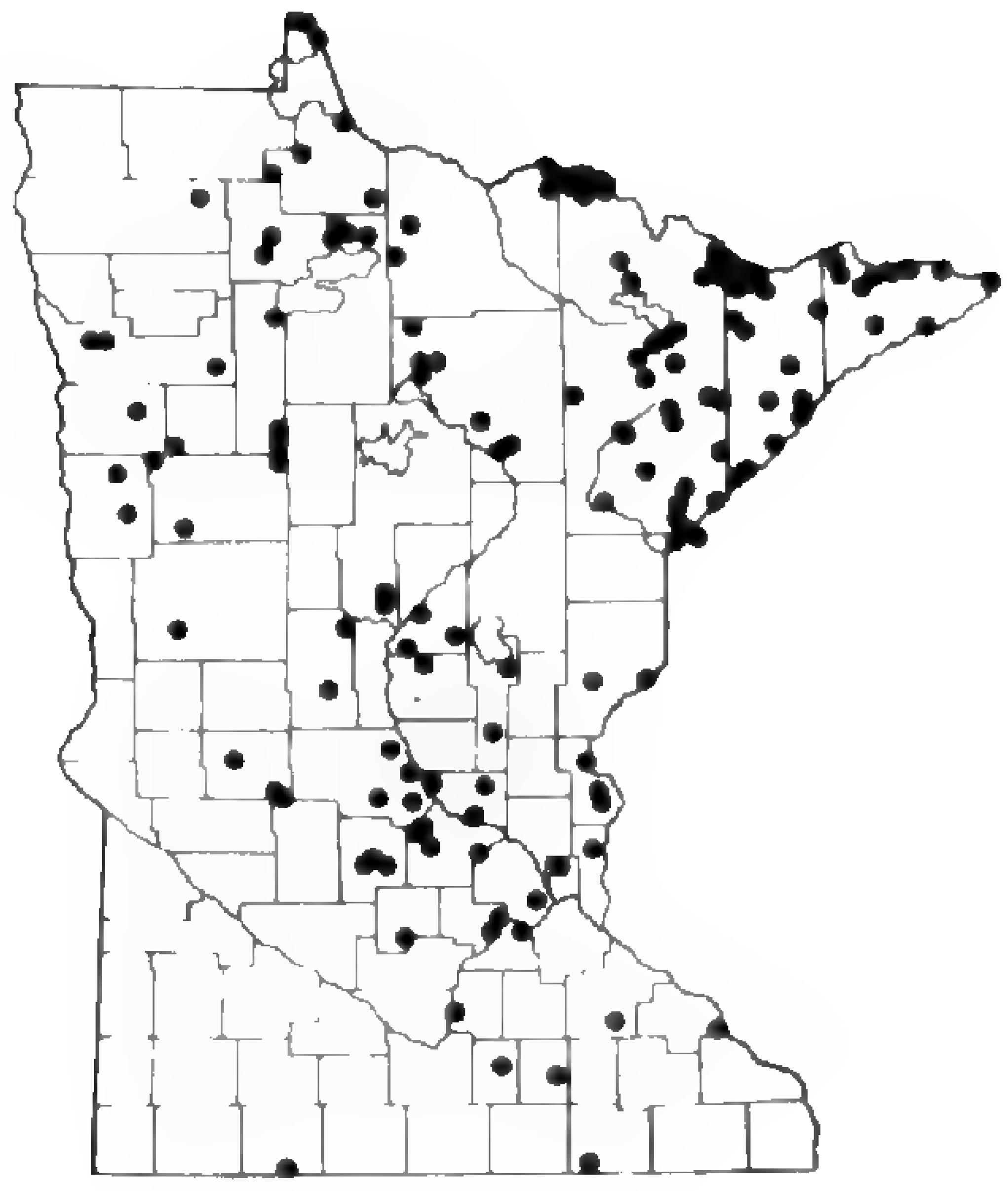

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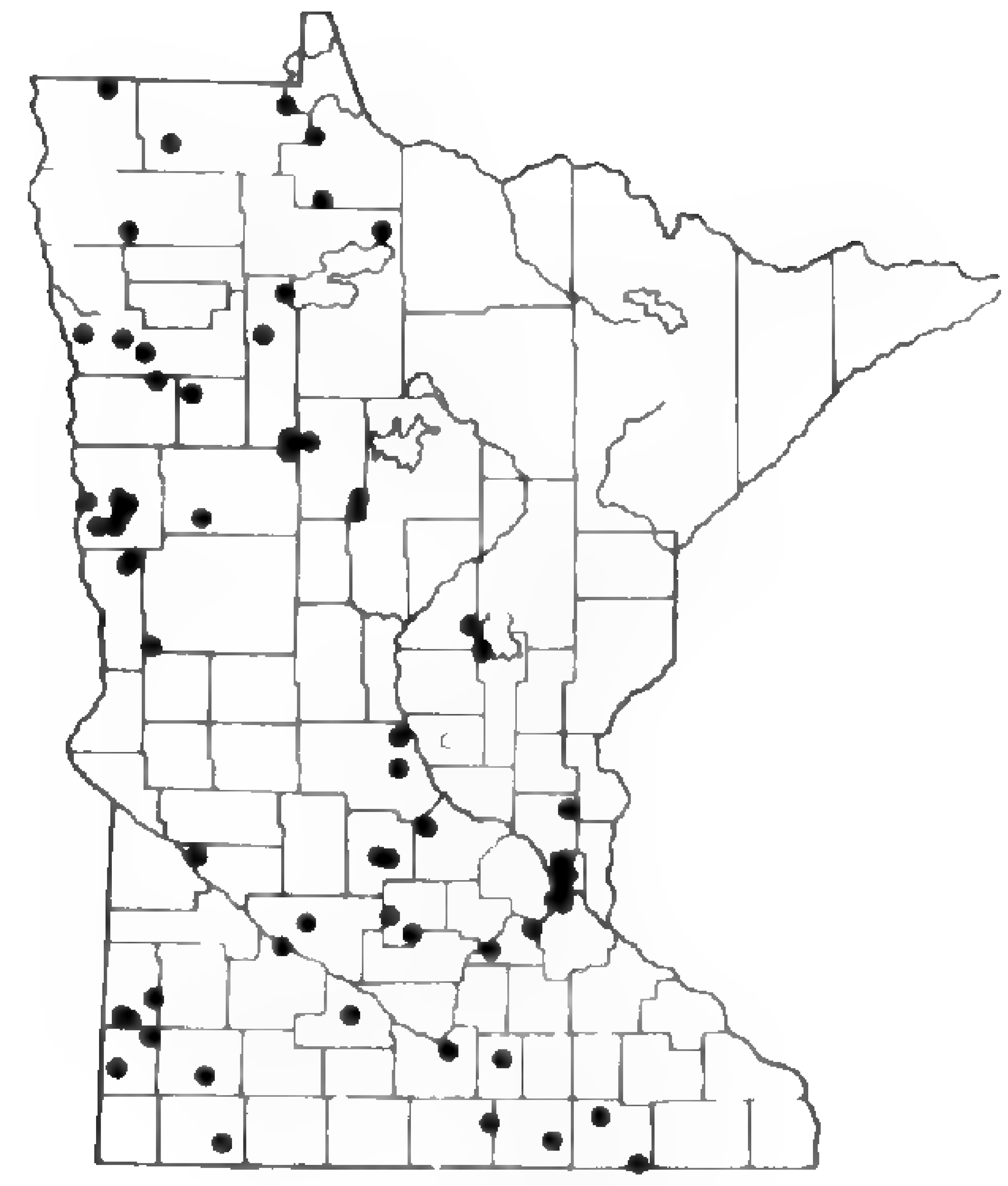

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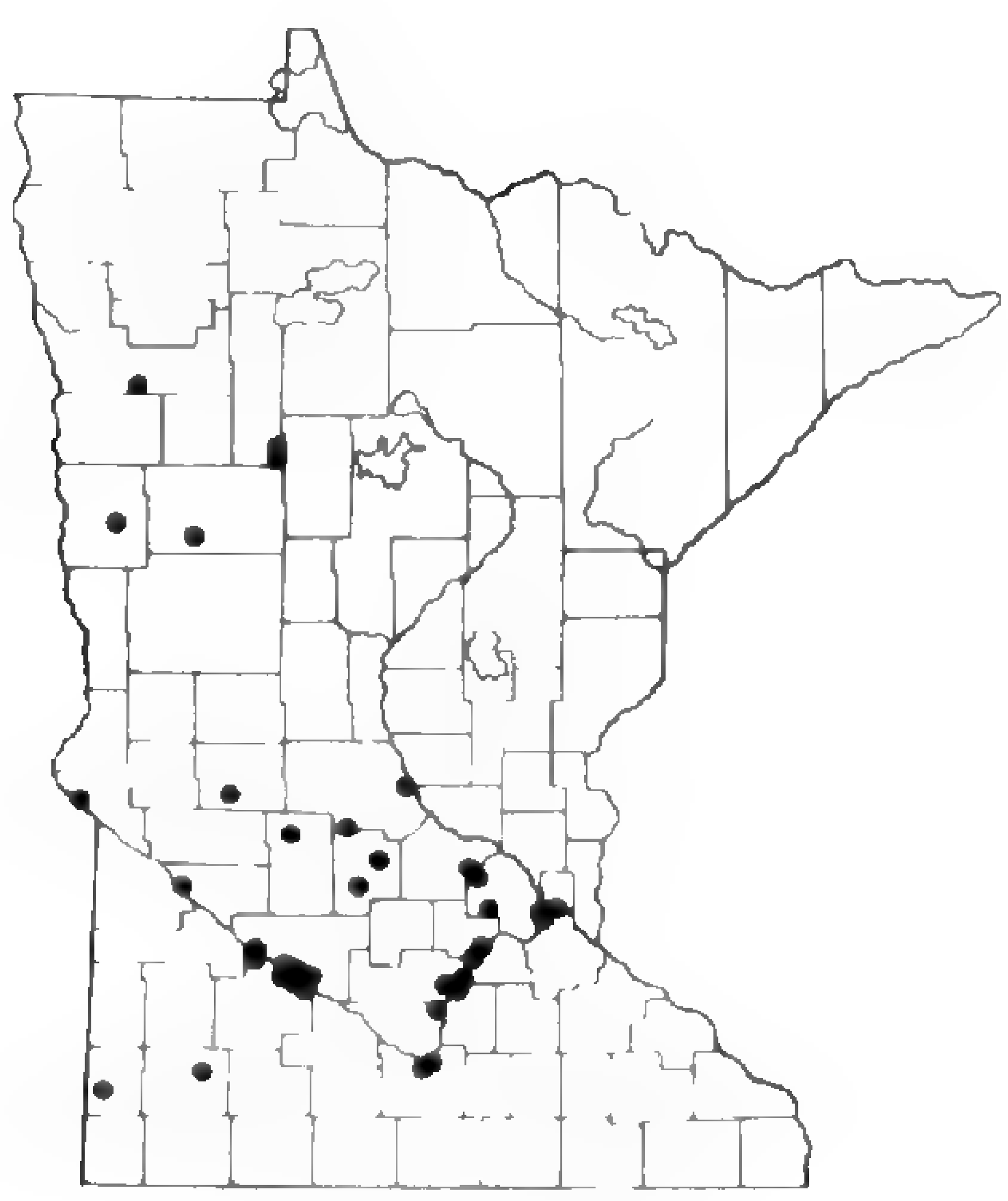

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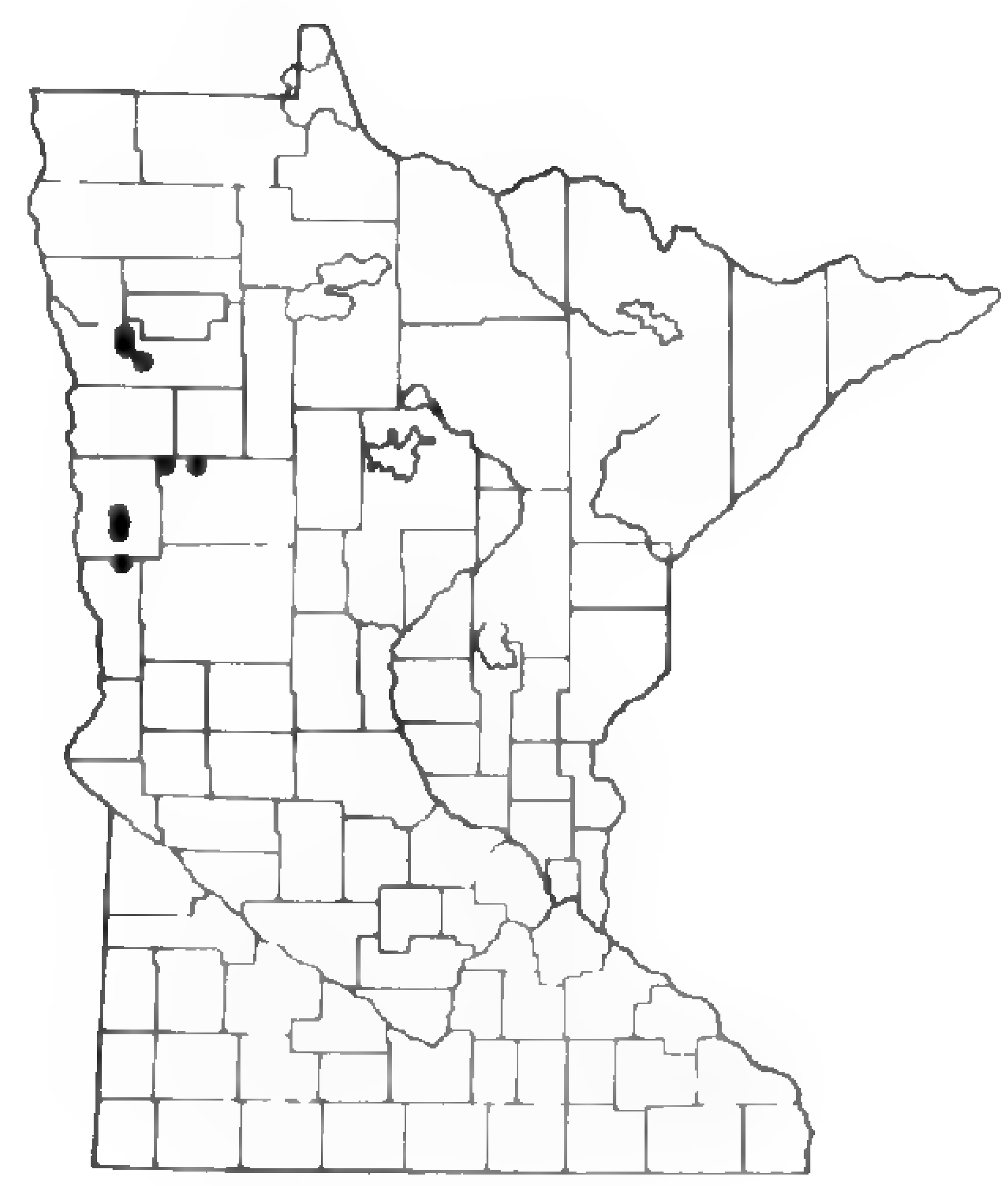

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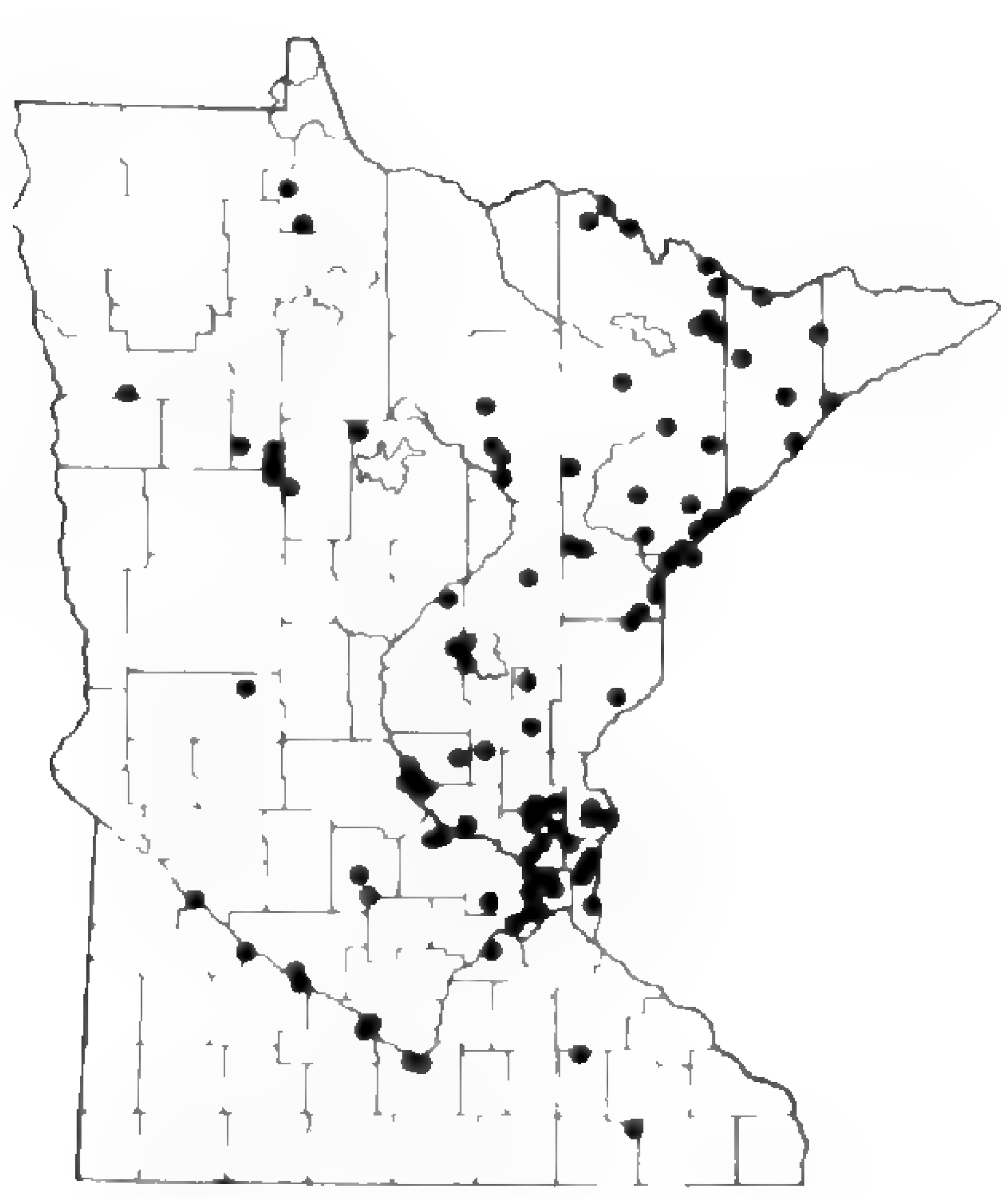

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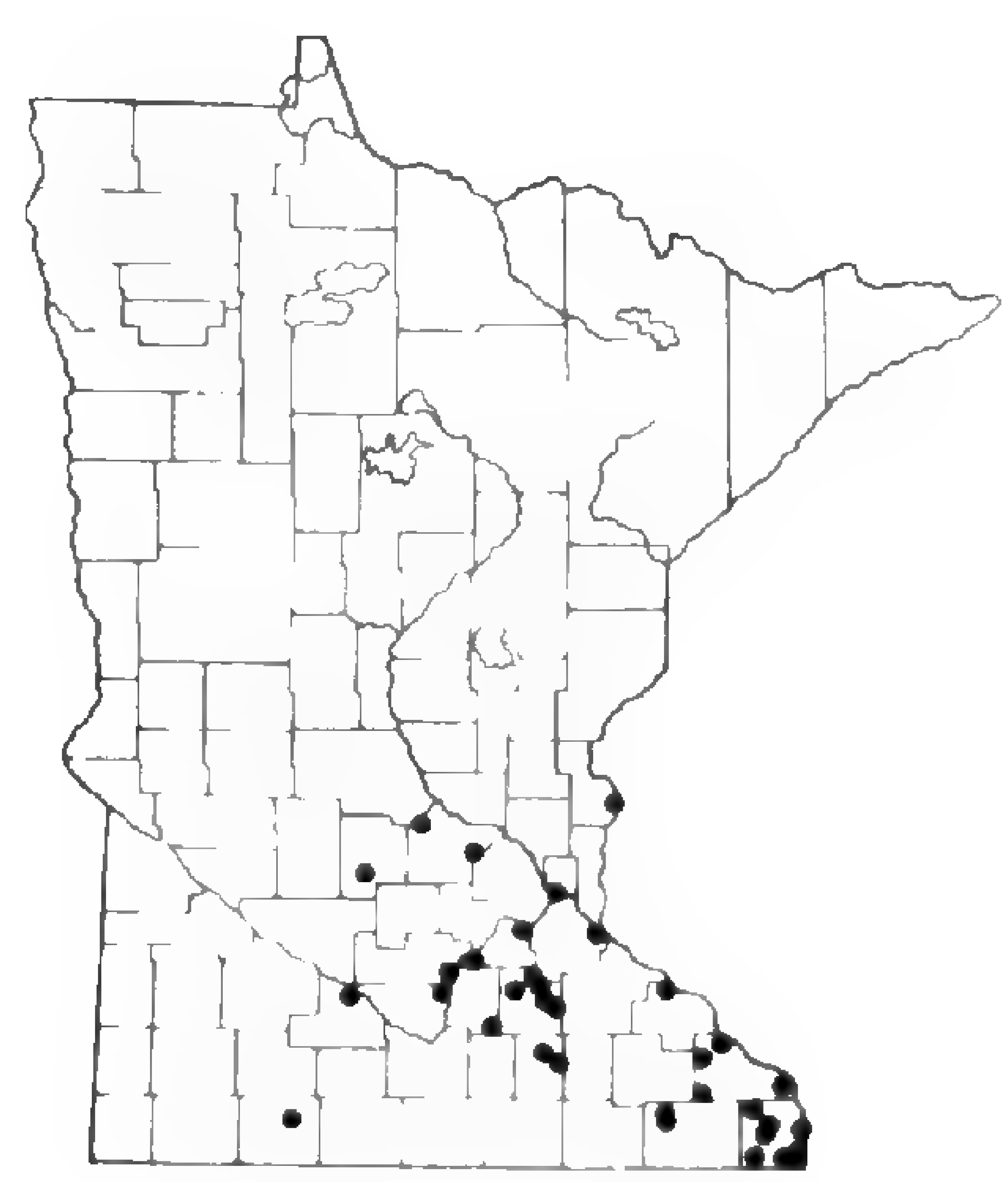

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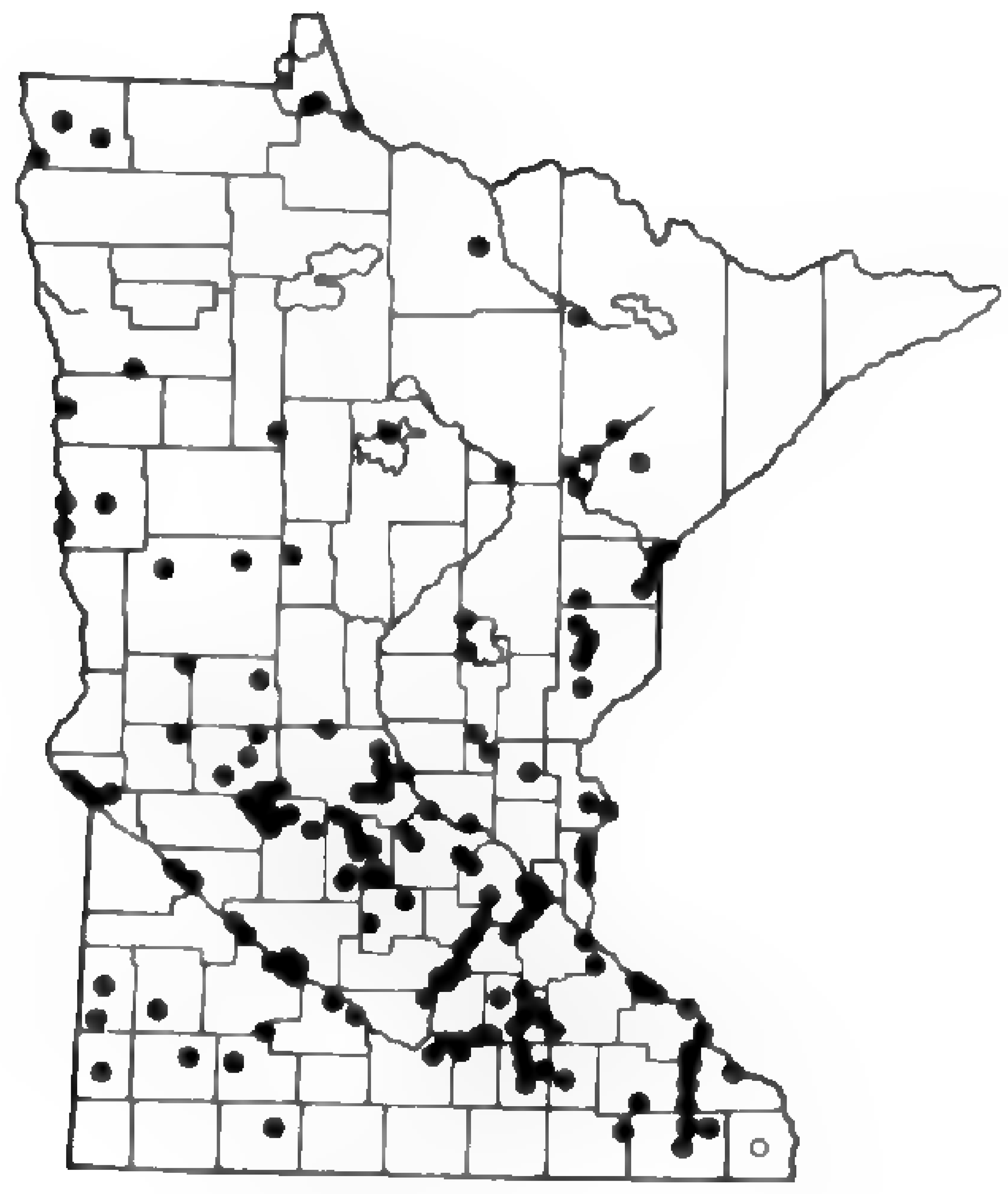

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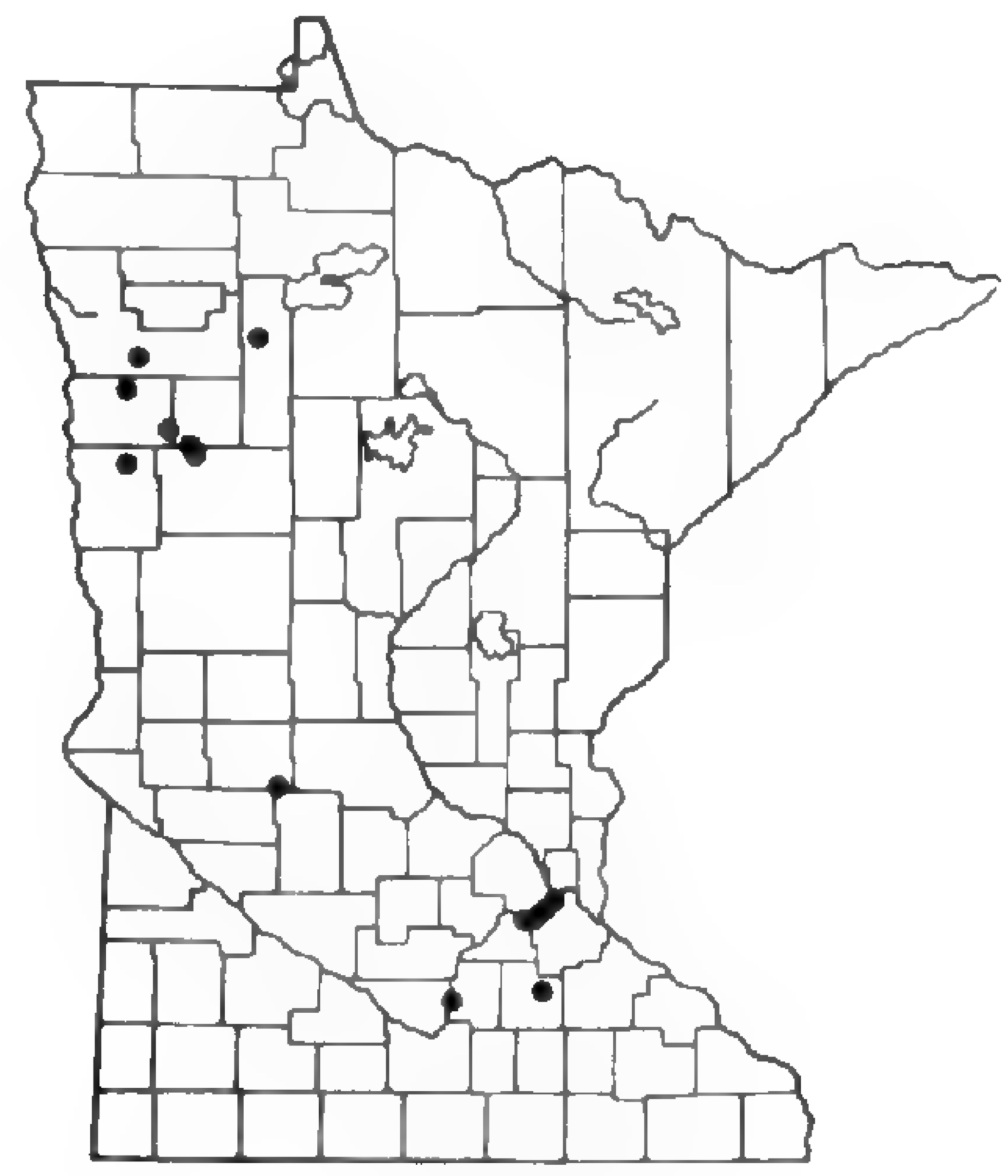

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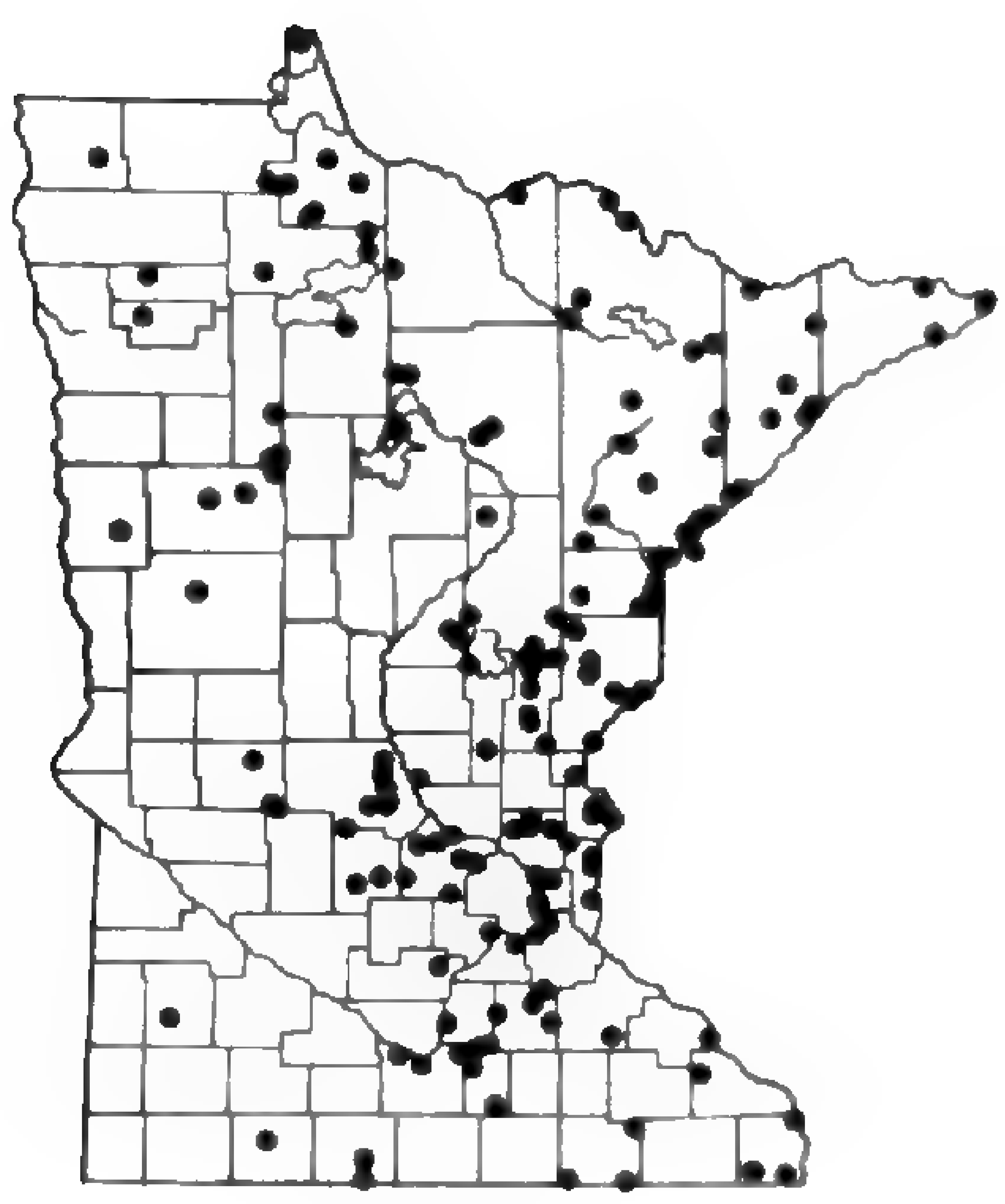

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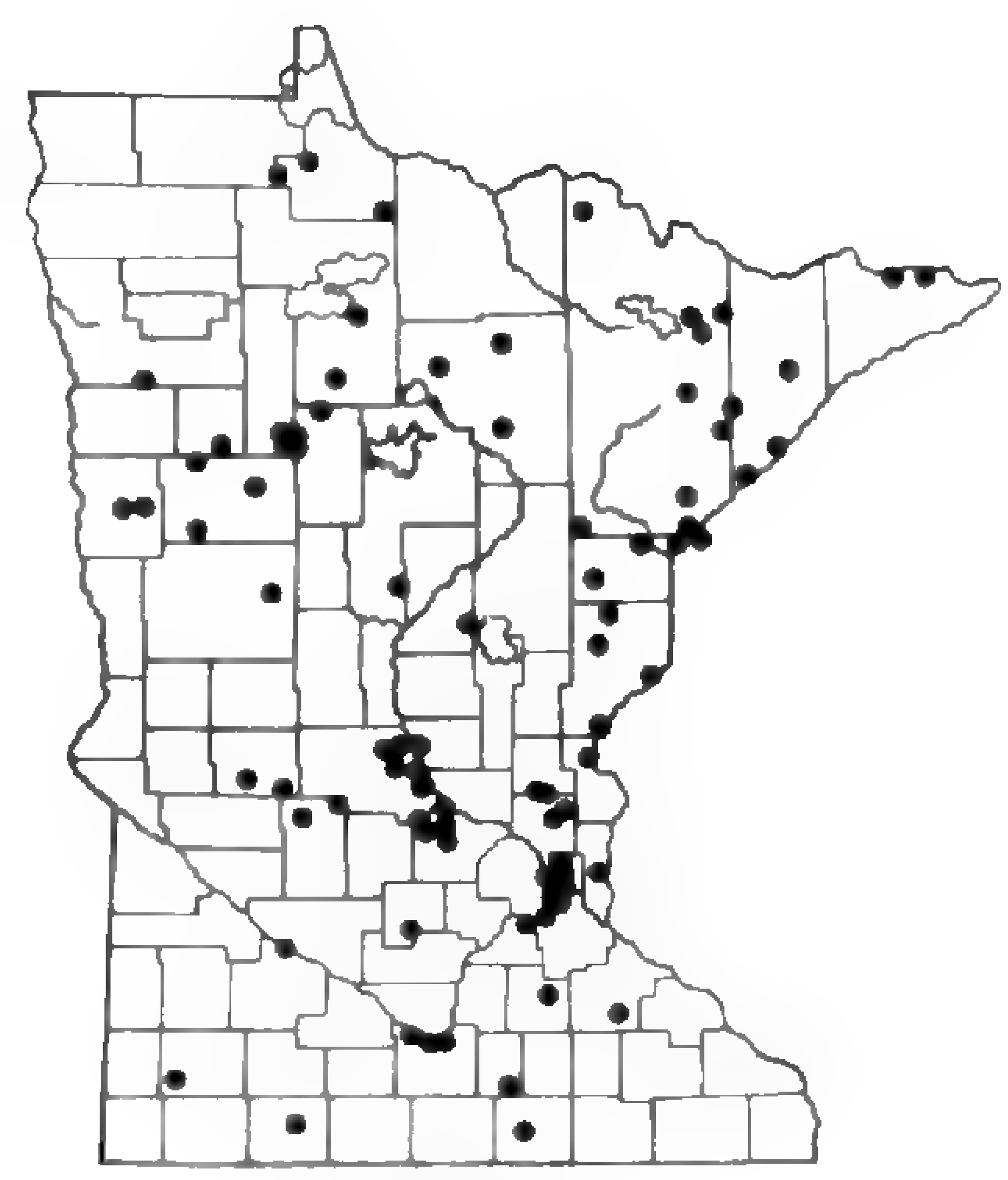

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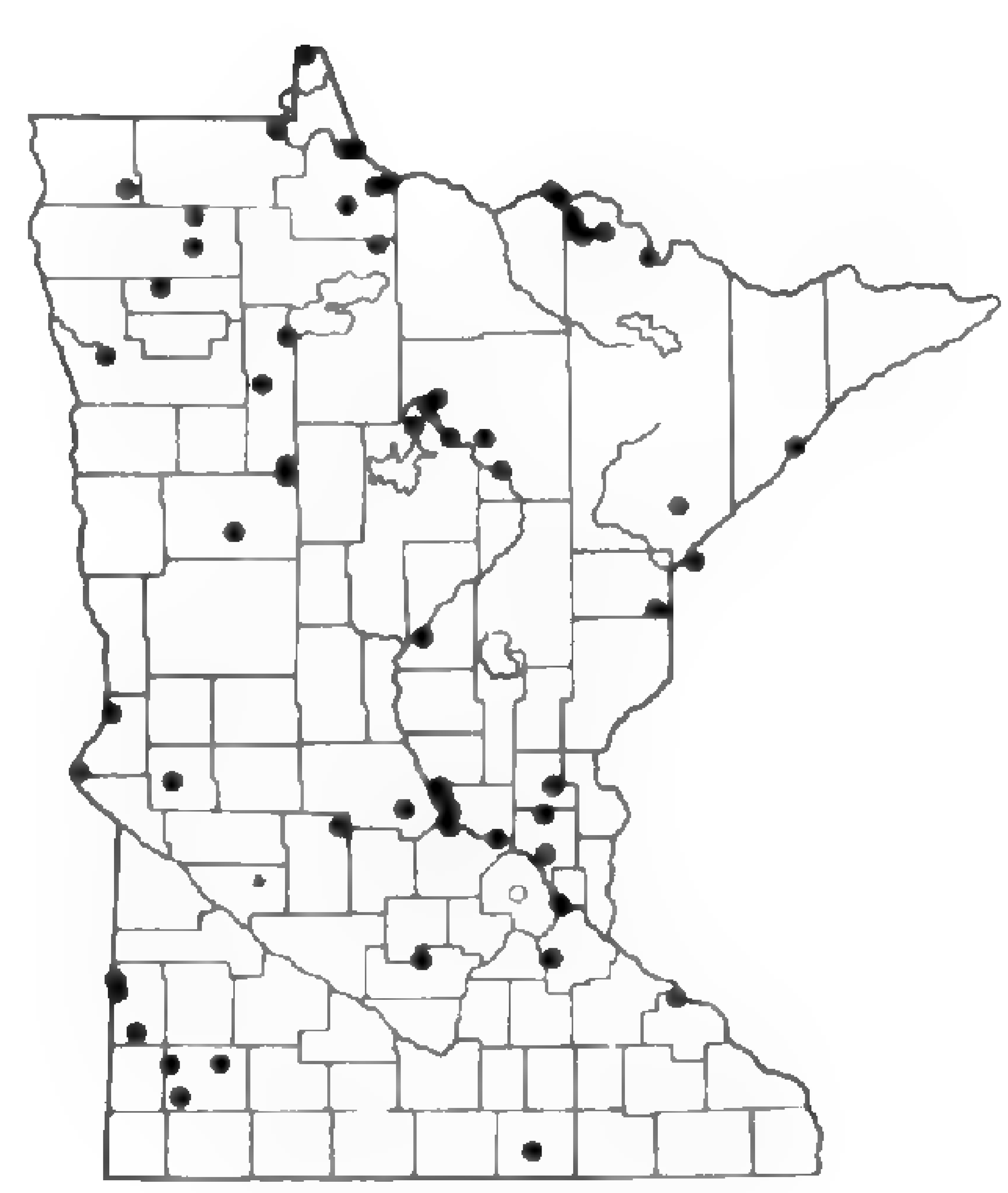

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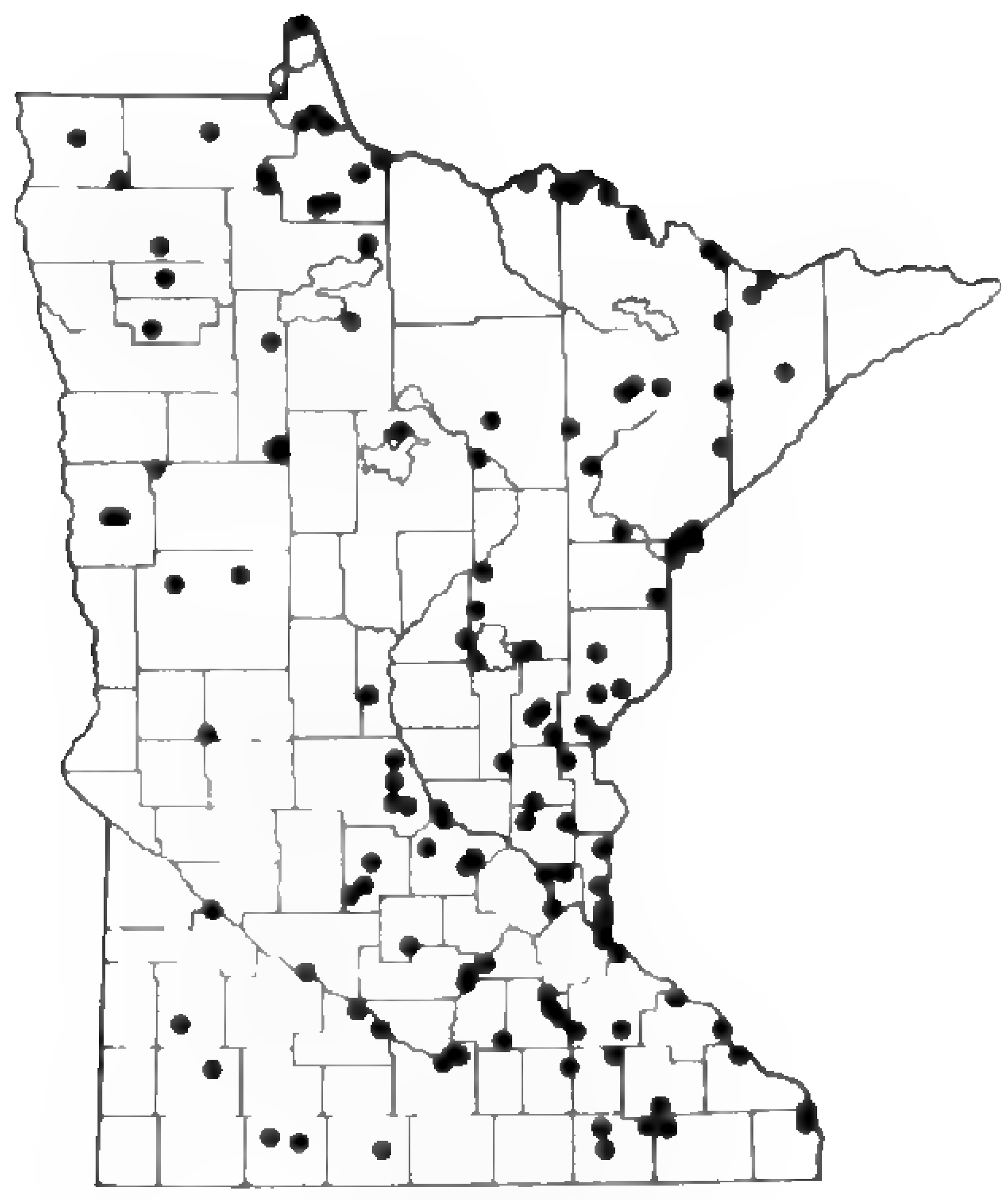

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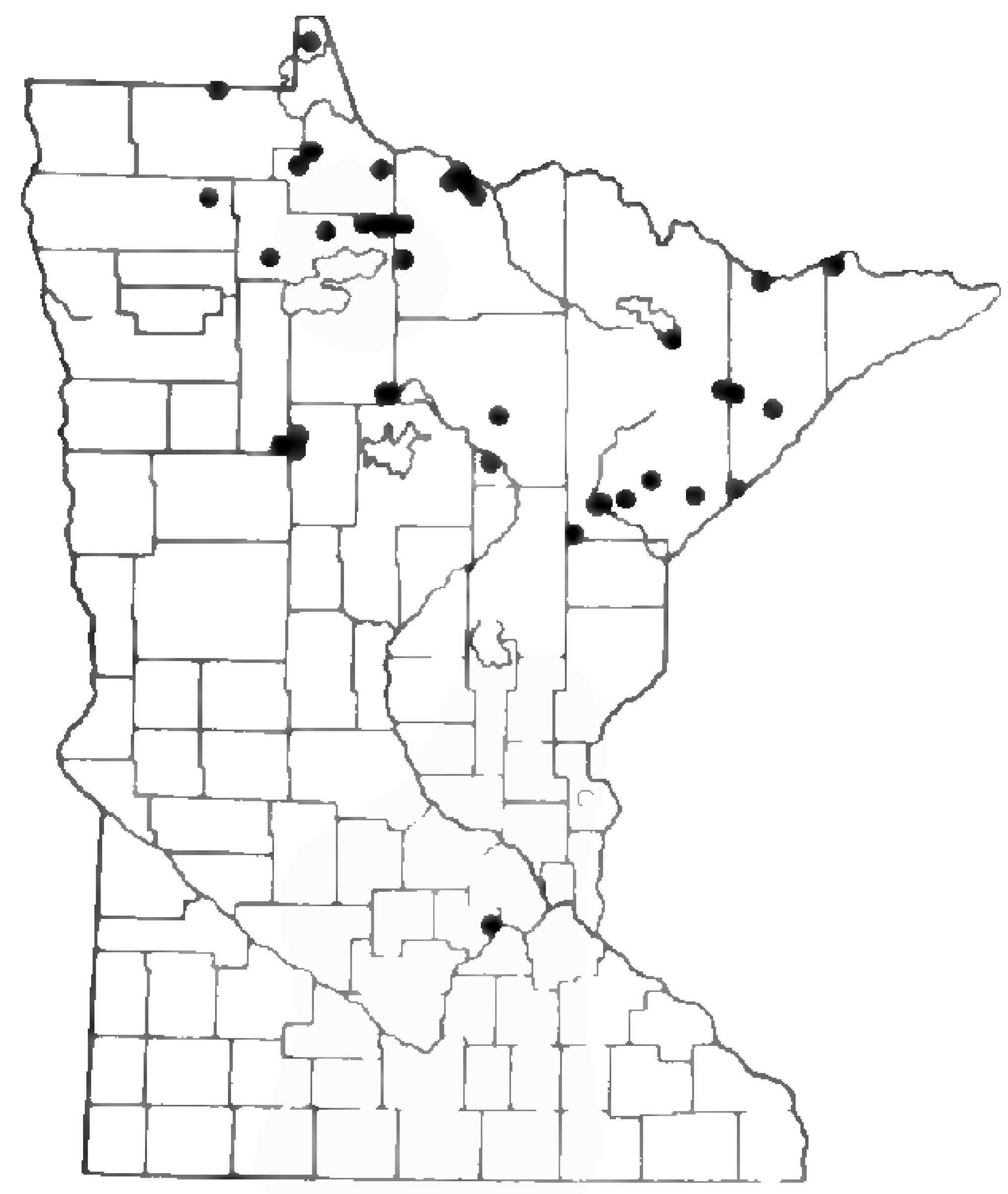

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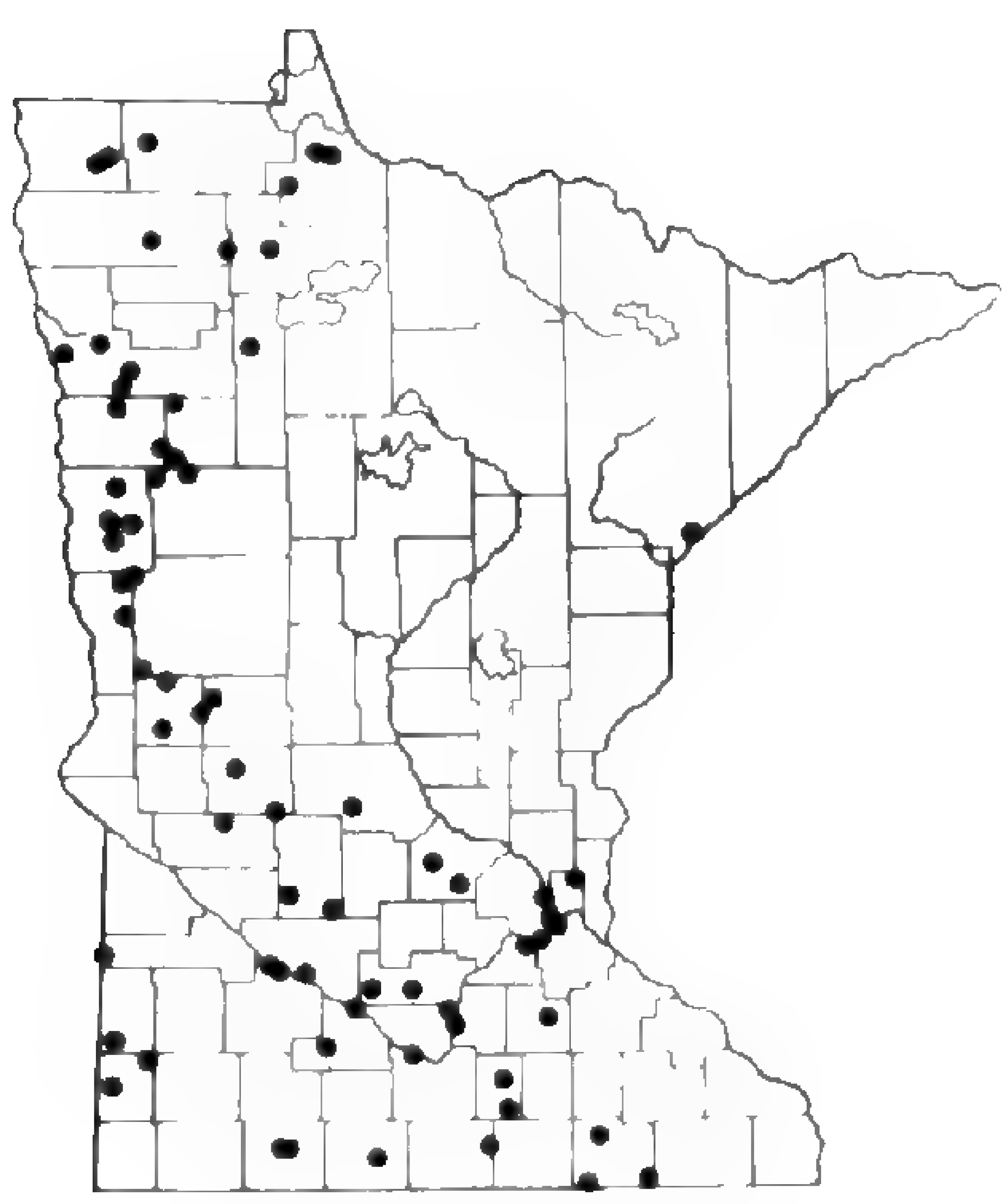

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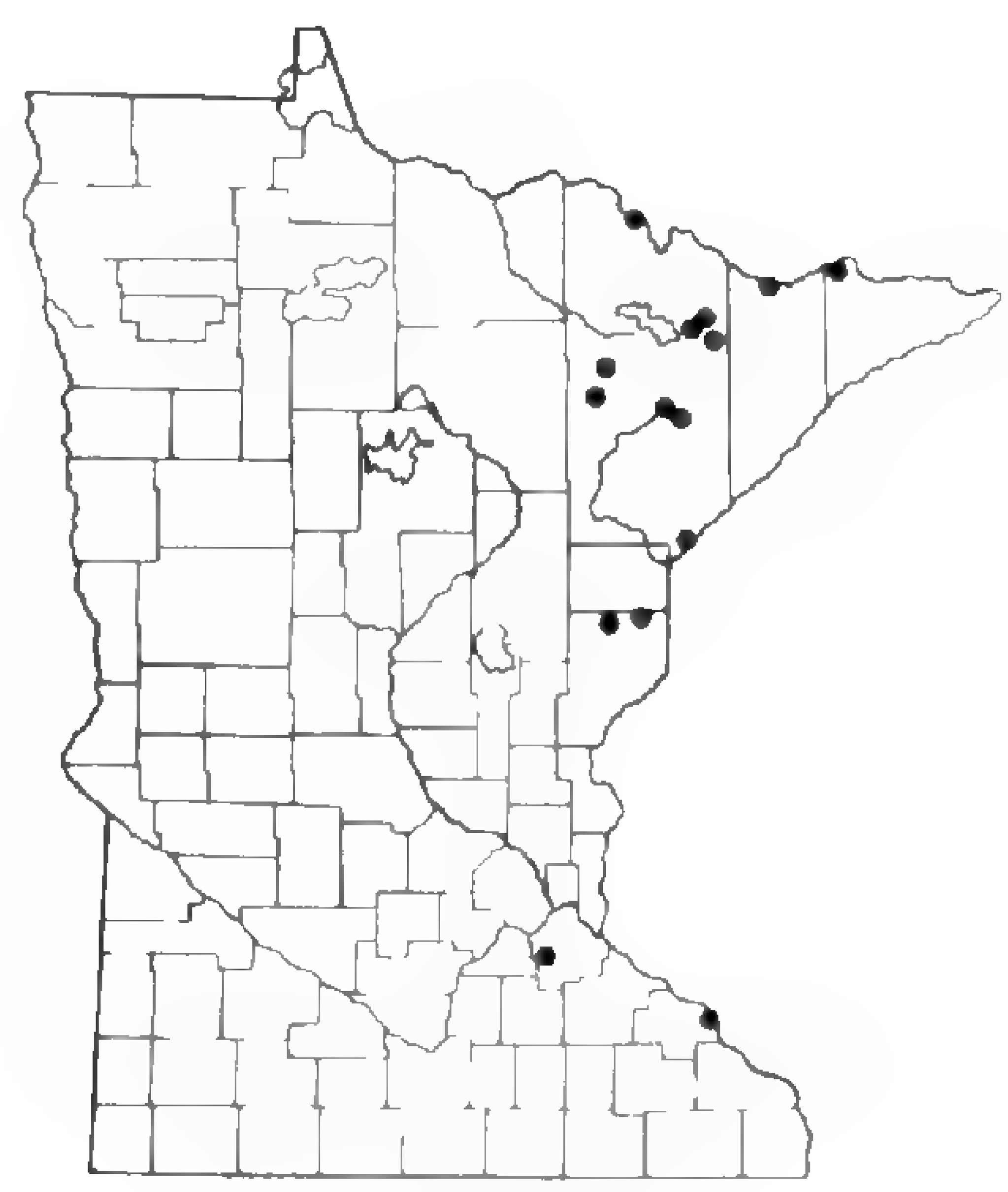

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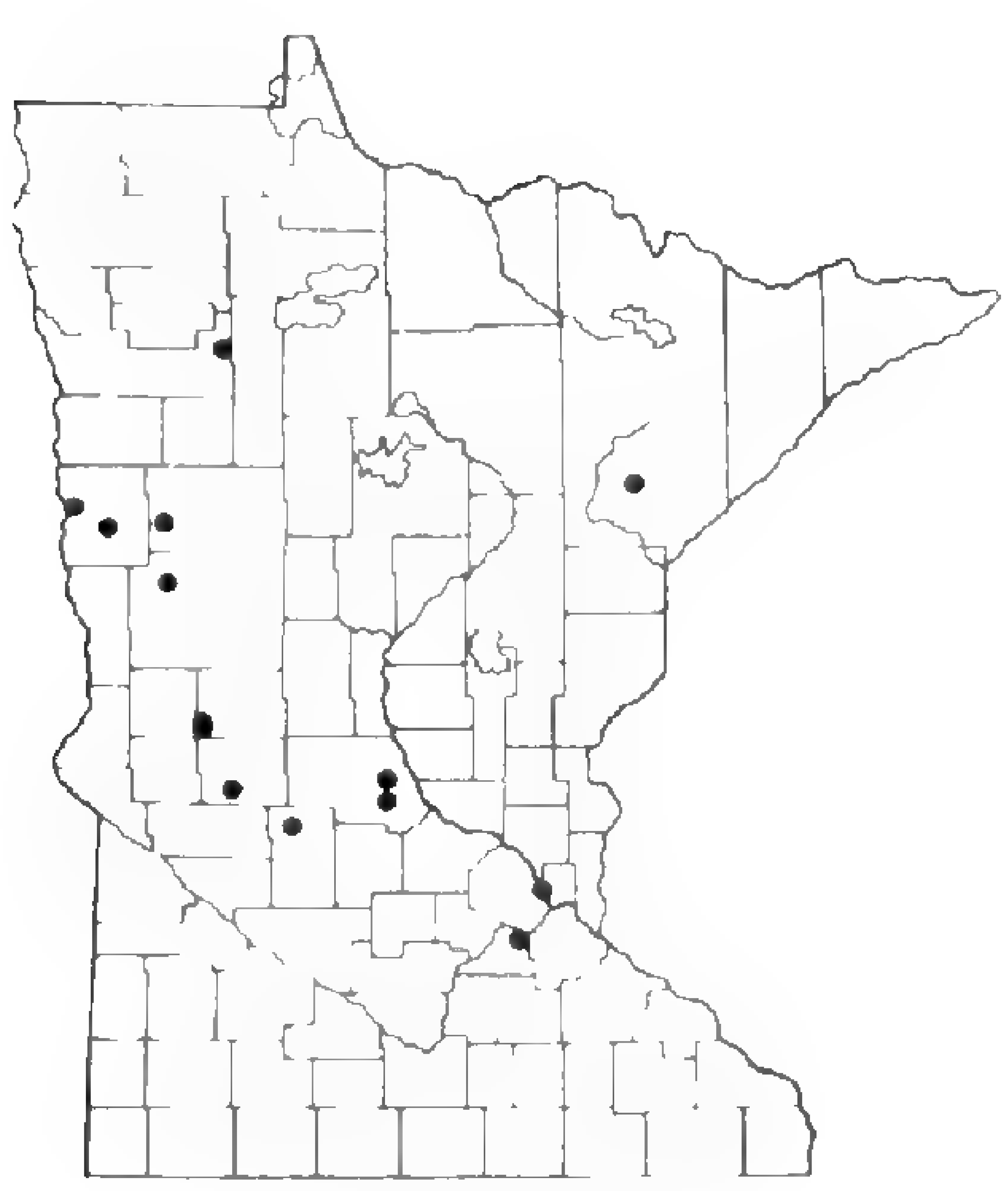

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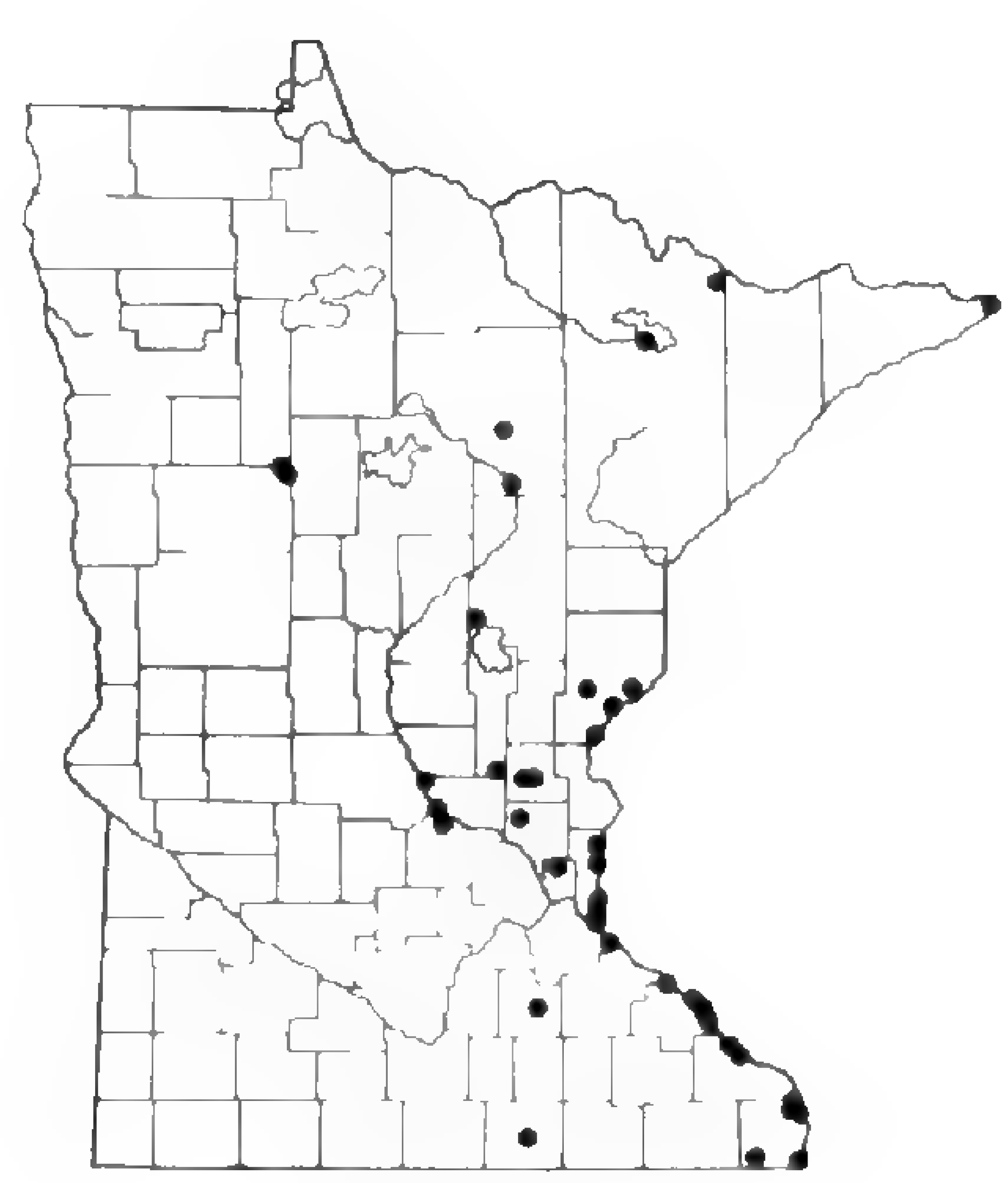

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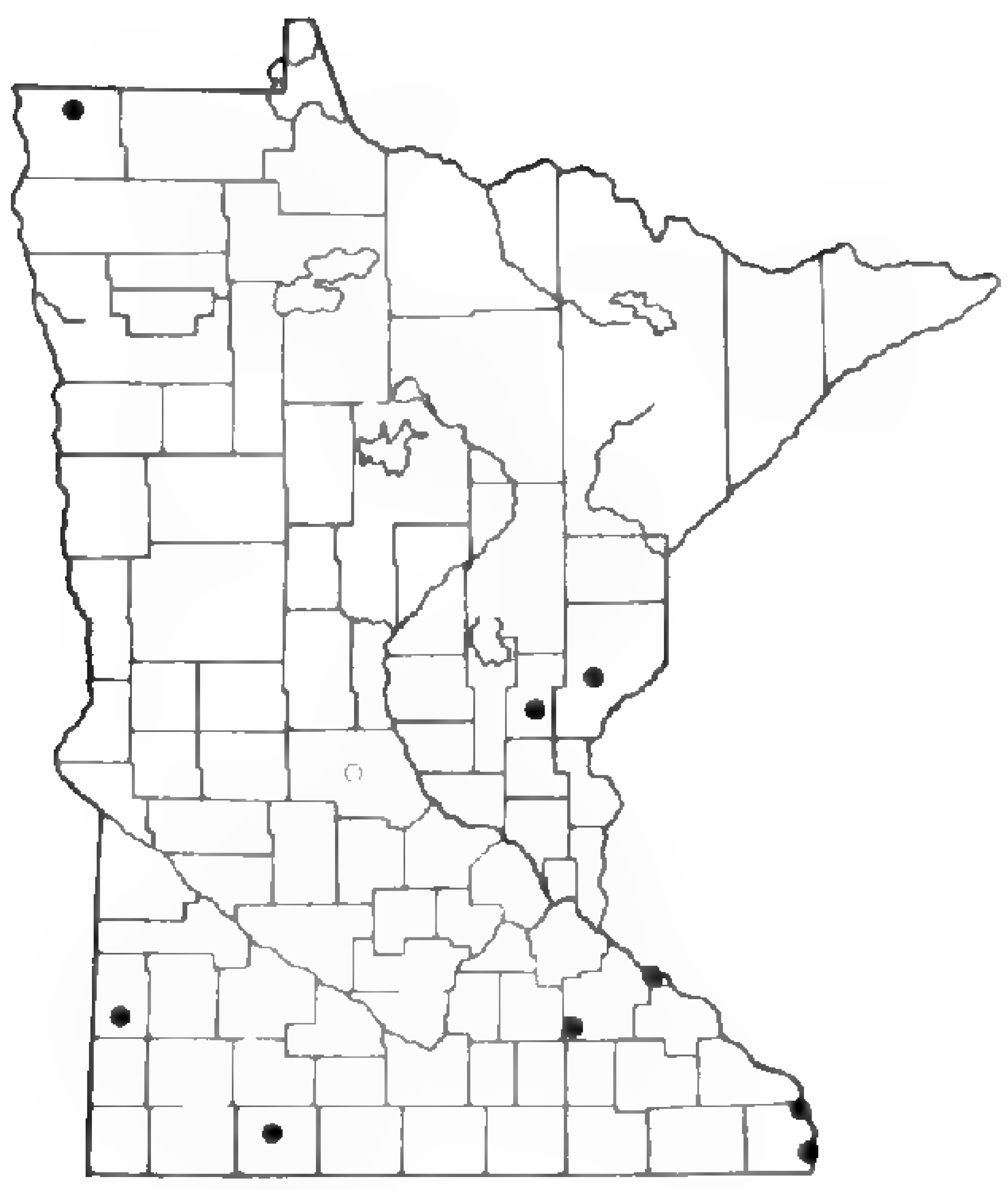

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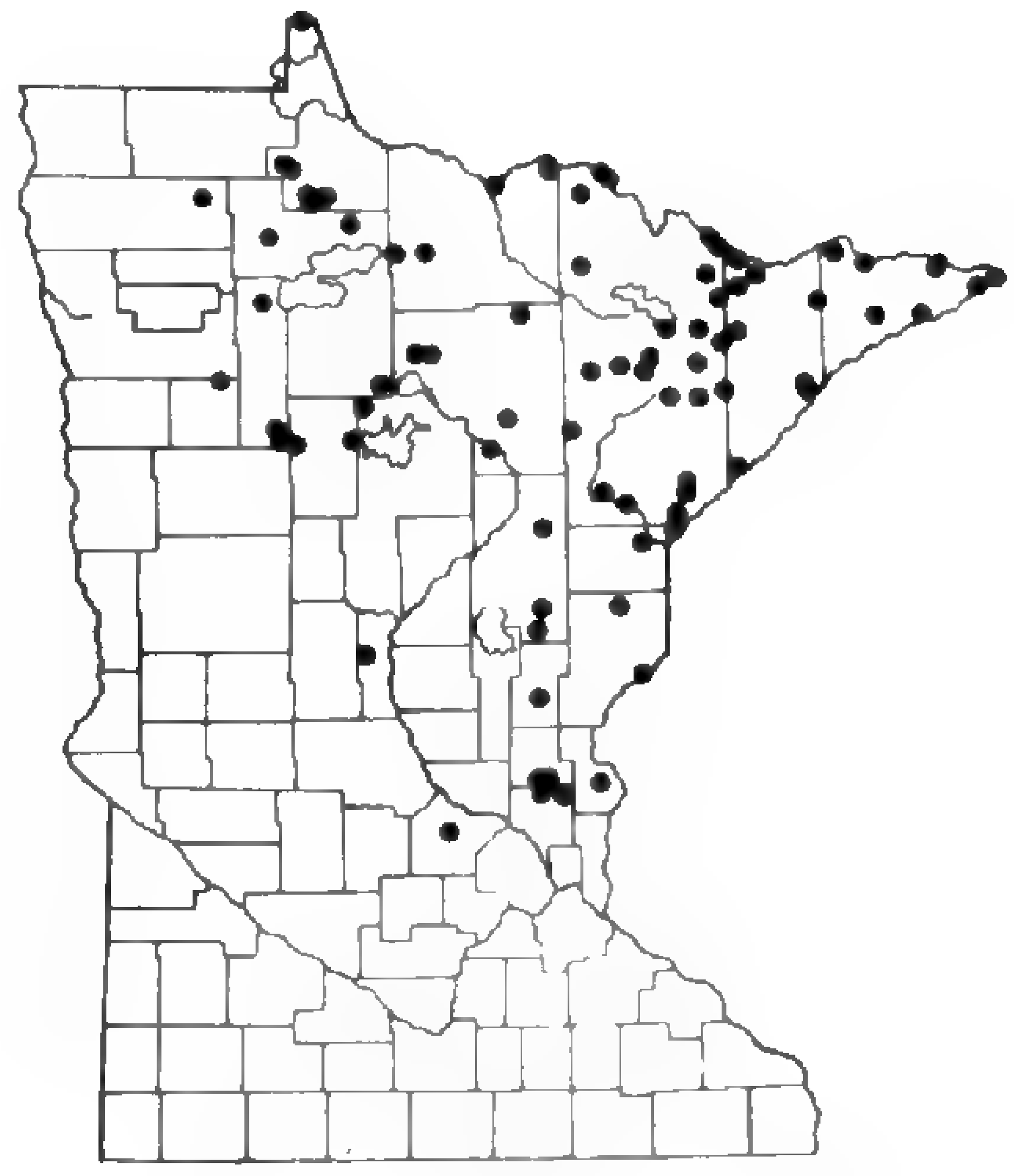

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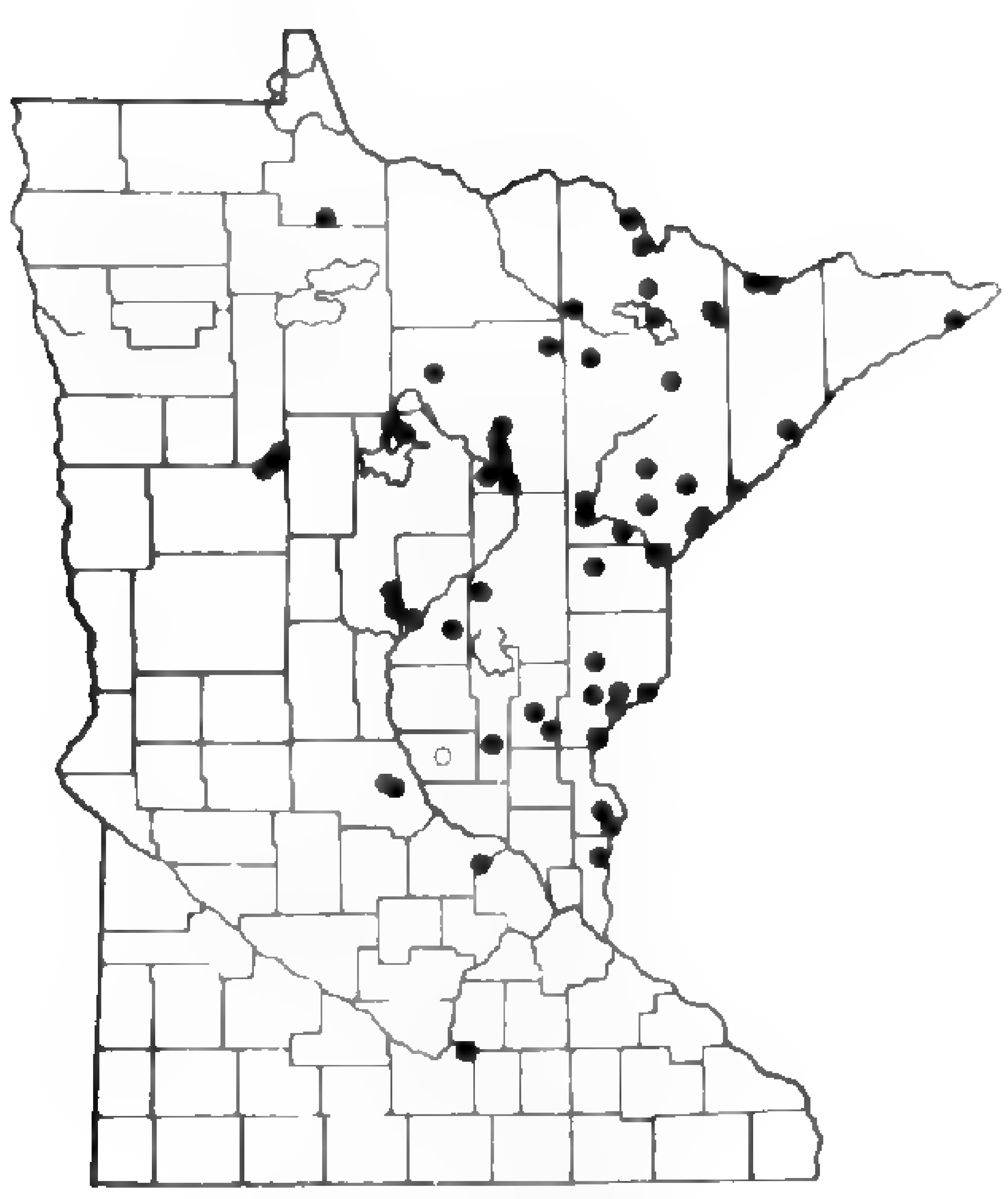

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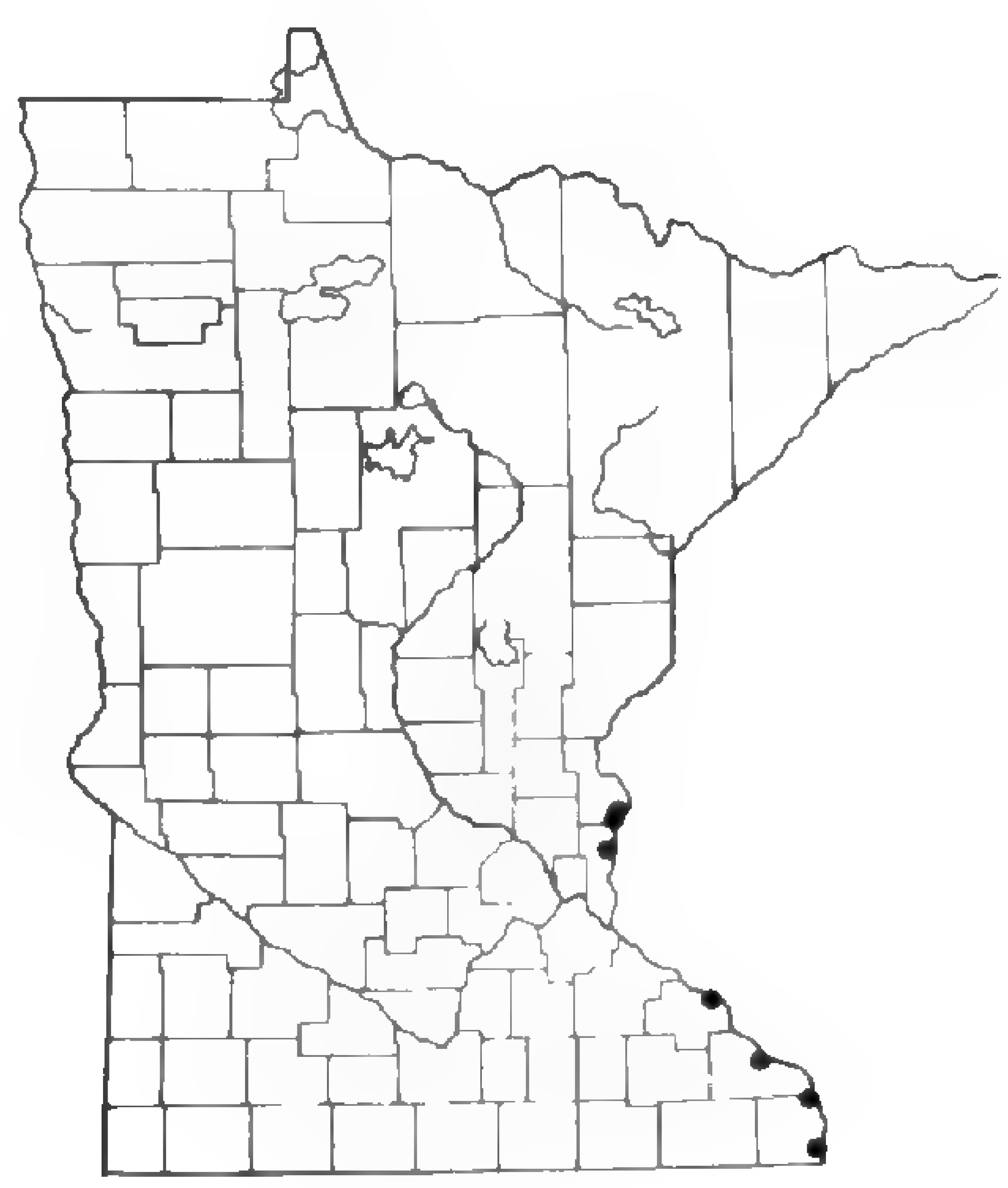

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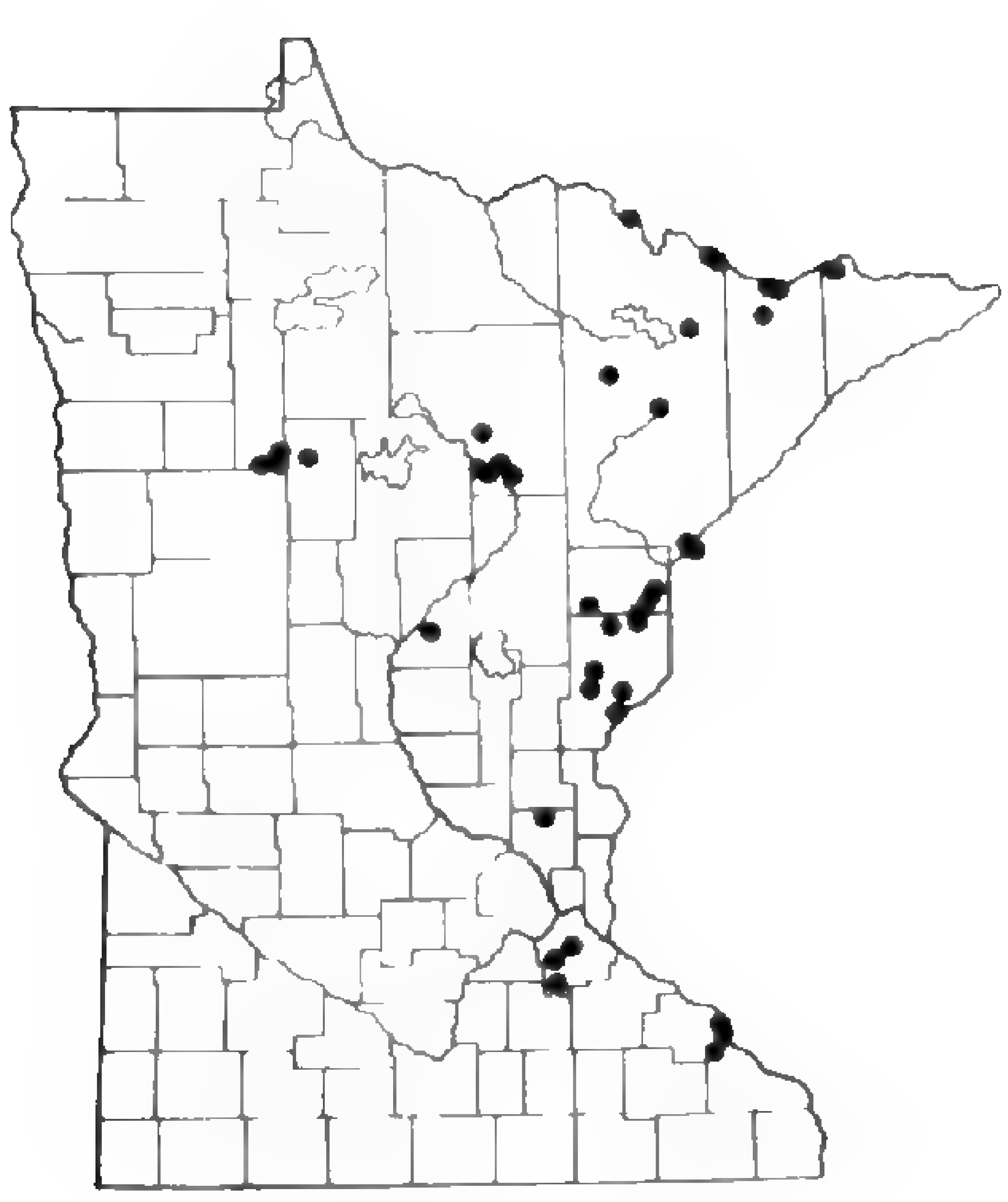

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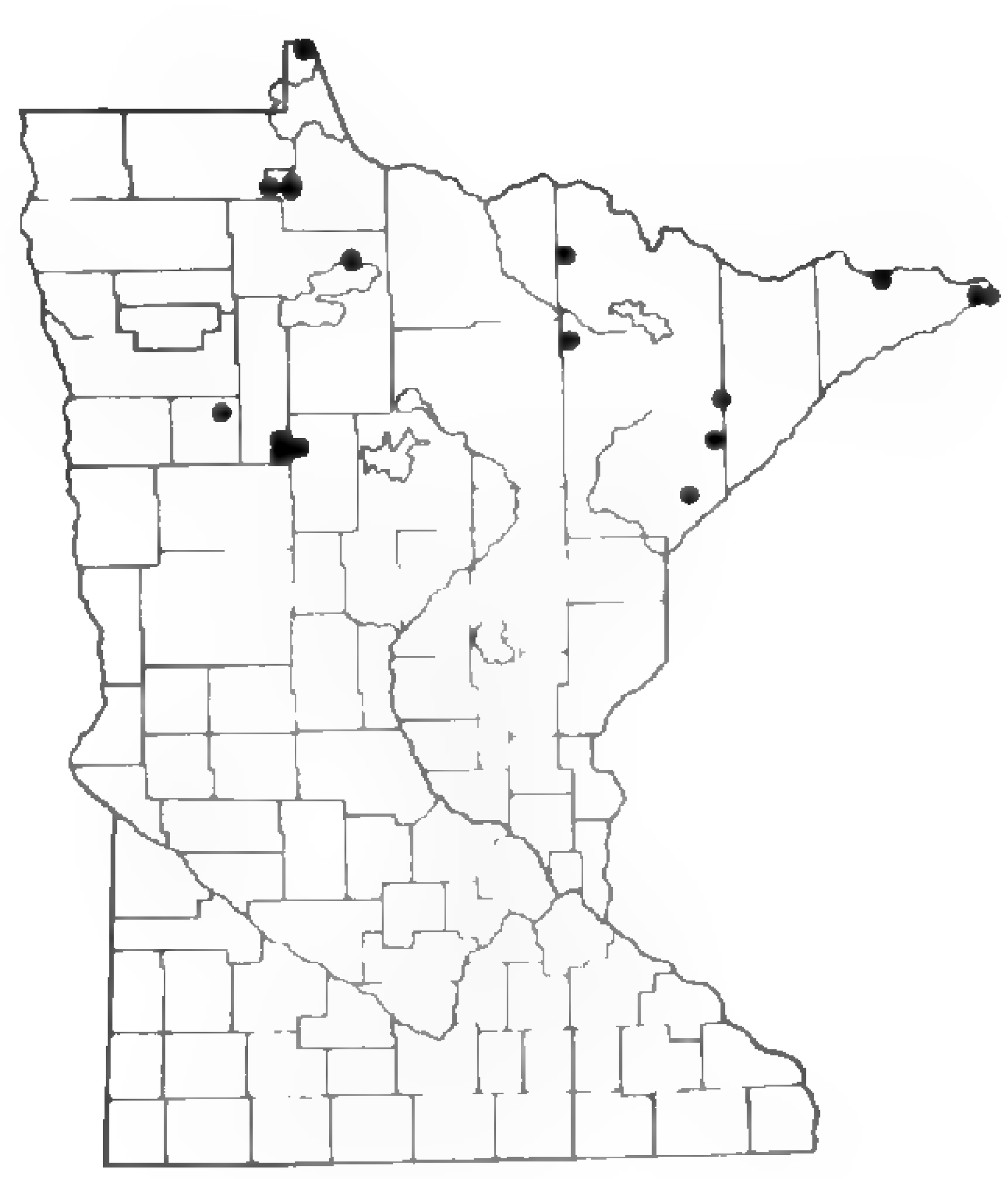

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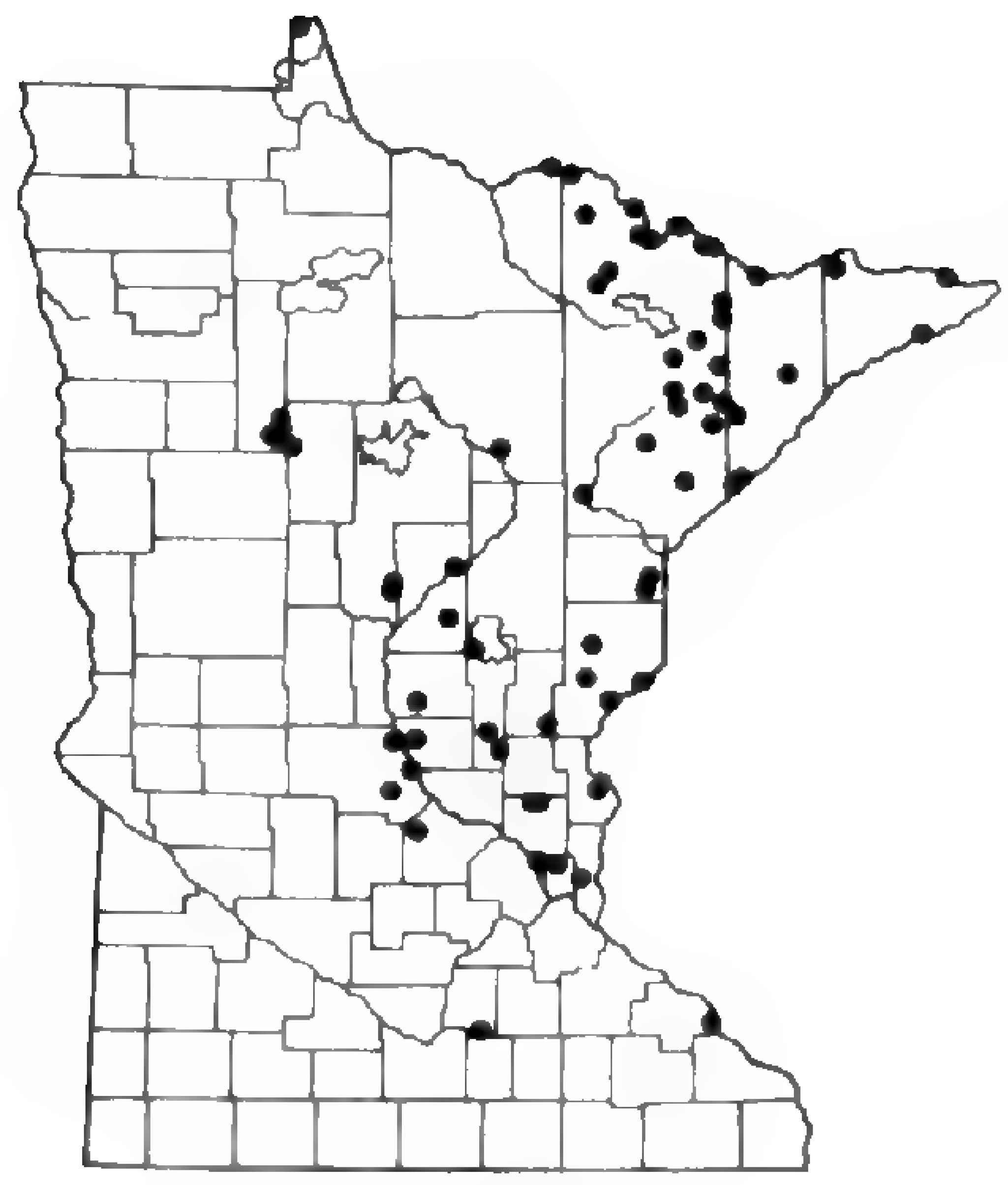

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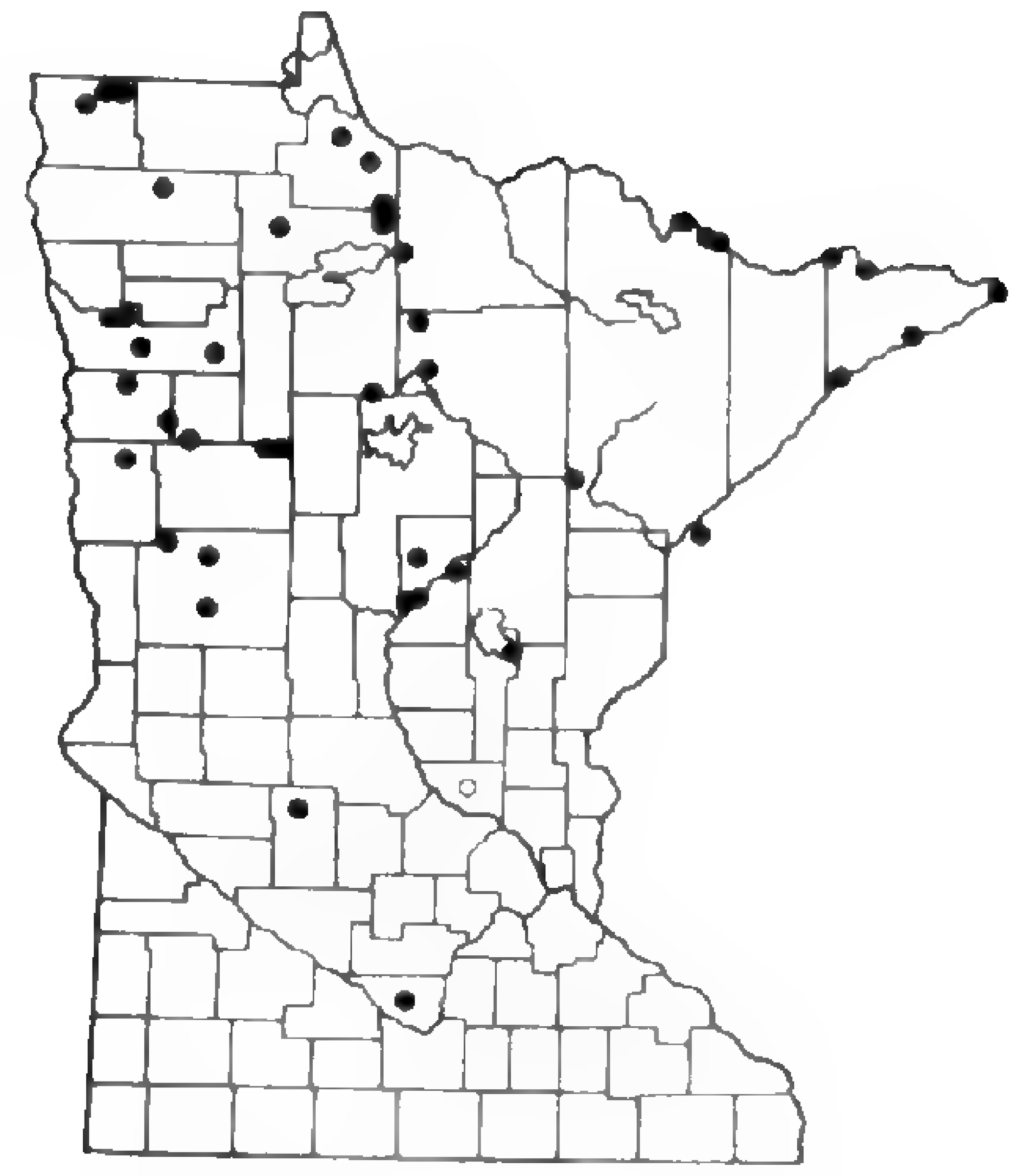

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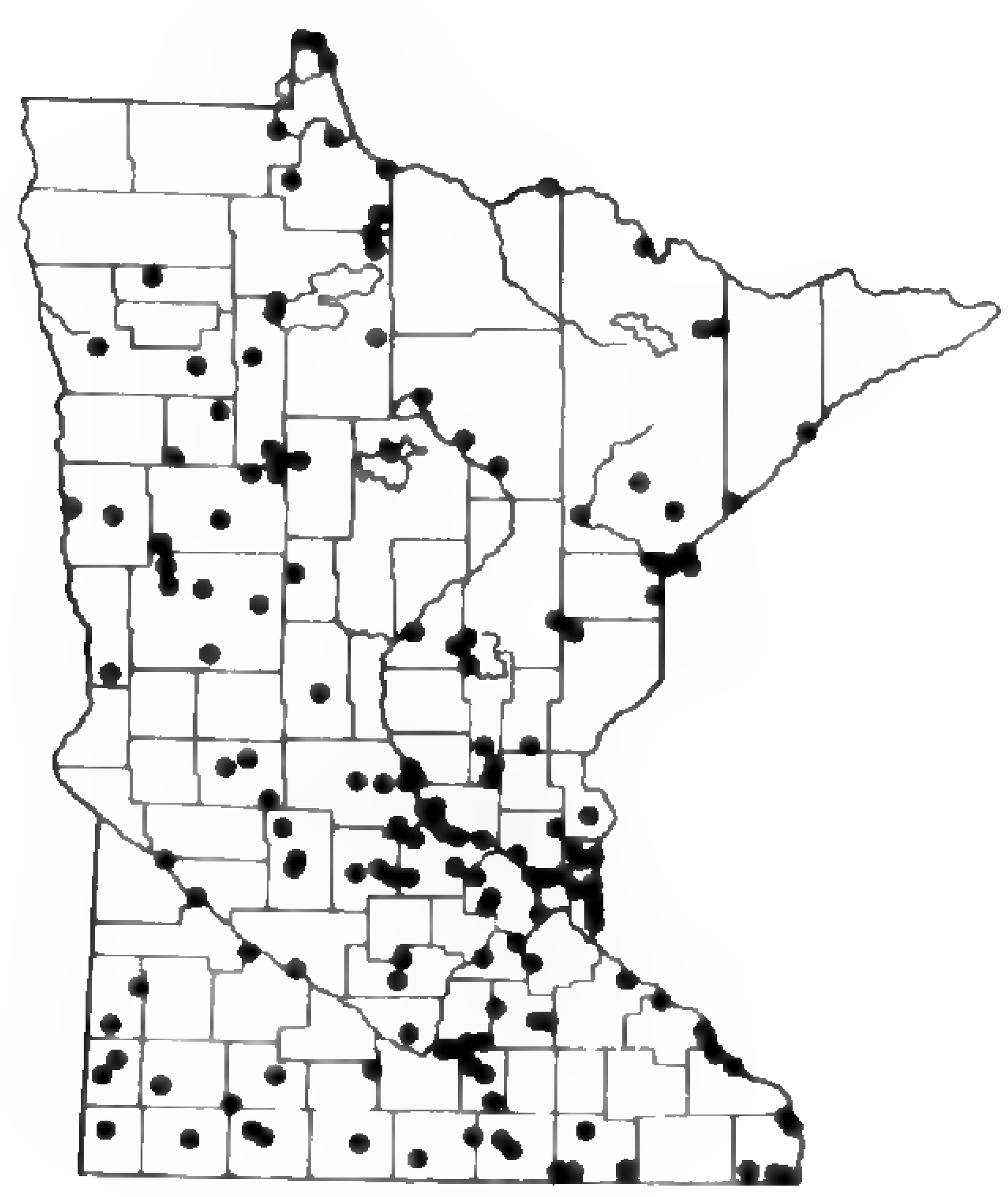

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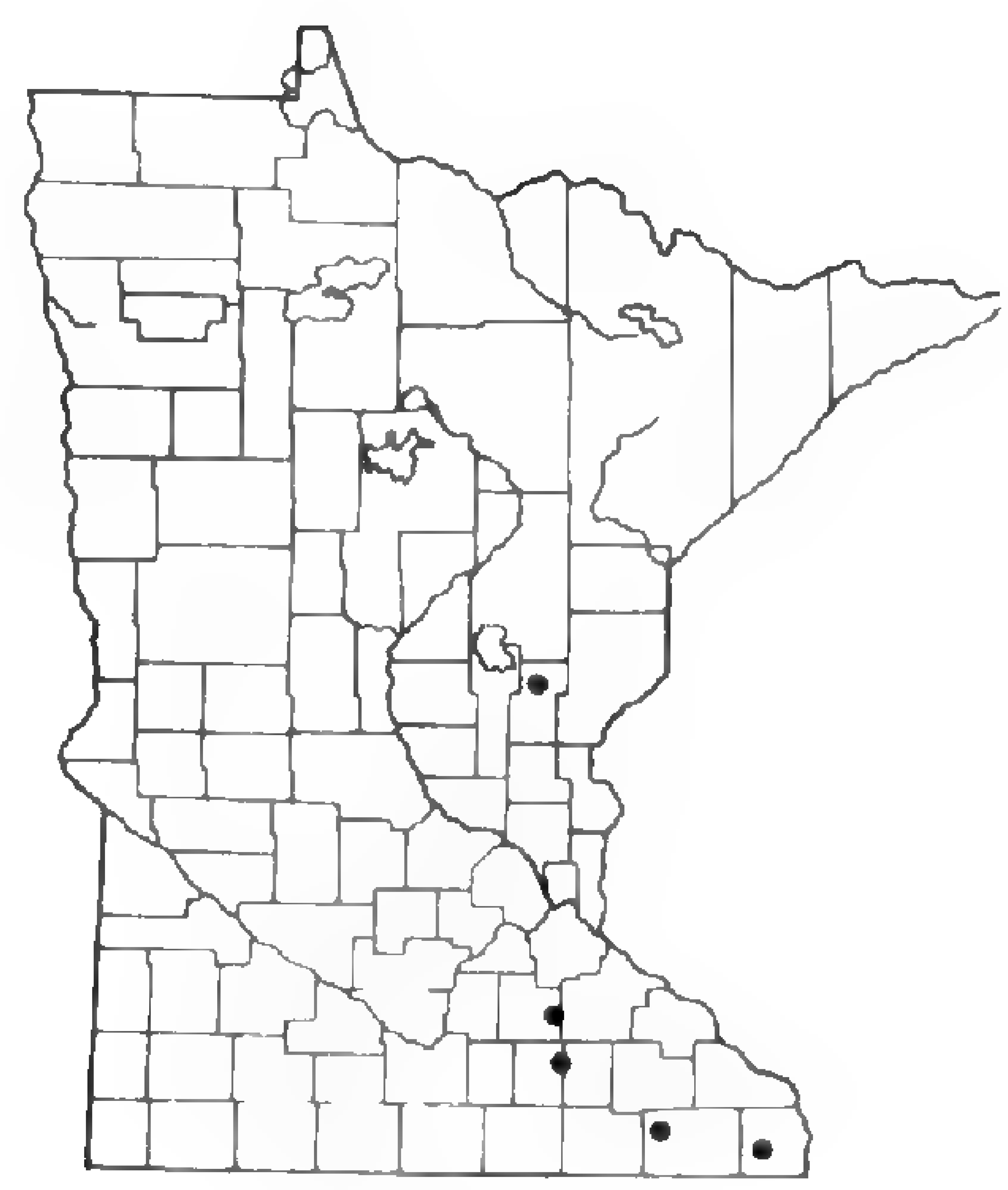

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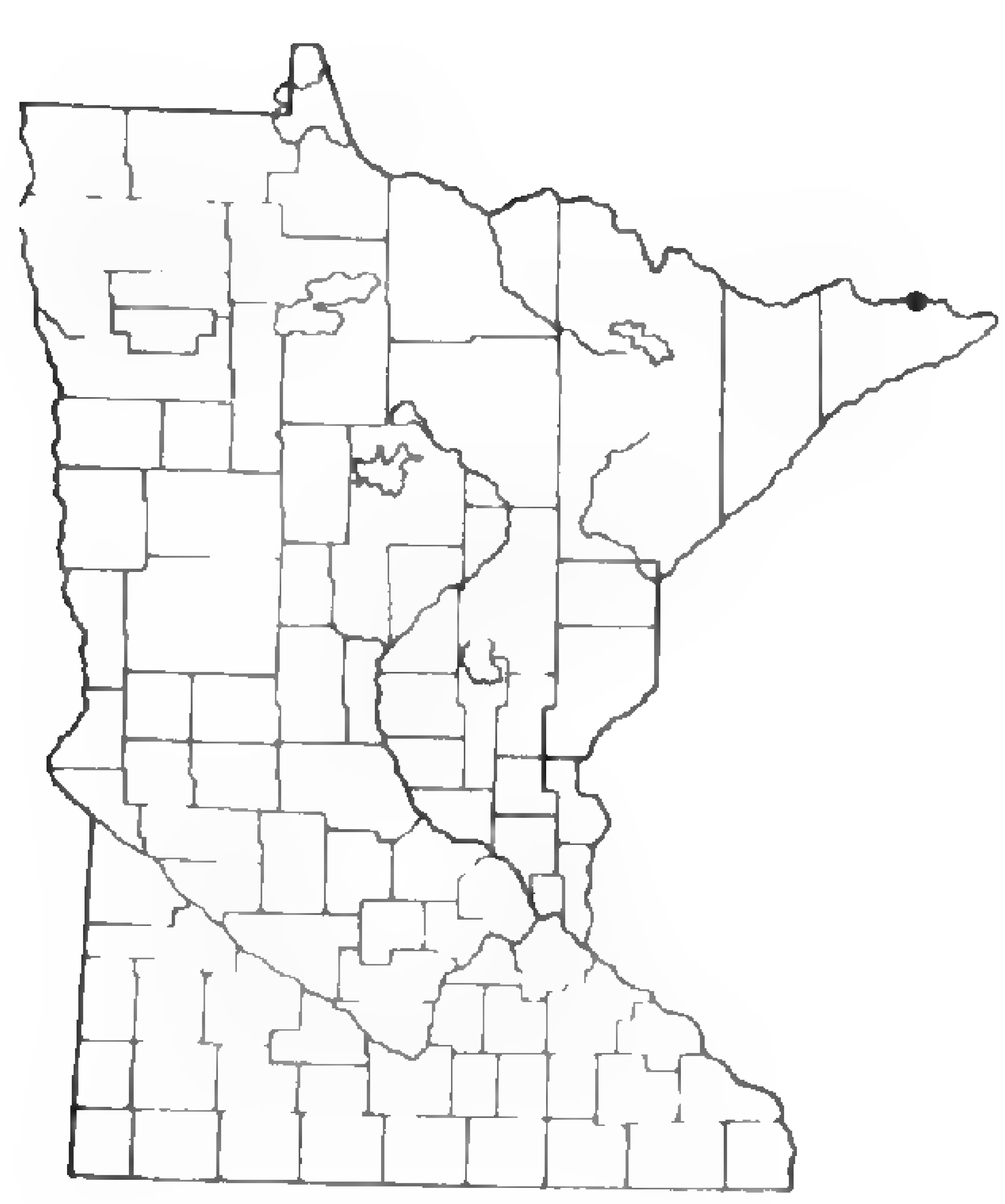

CAREX XERANTICA

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NEW ENGLAND NOTES

NOTE ON THE FIRST STATION OF *DENTARIA LACINIATA* MUHL. (BRASSICACEAE) REPORTED FROM MAINE

Sally C. Rooney

Dentaria laciniata occurs in rich woods, wooded bottom lands, and on calcareous rocky hillsides from western Quebec and Vermont west to Minnesota and Nebraska, and south to Florida and Louisiana.

In the spring of 1981, Ruth Ellis and I discovered a small clump of *Dentaria laciniata* growing on a west-facing slope of Westford Hill, Hodgdon (Aroostook Co.), Maine. This species had not been previously reported from the State (Bean, *et al.,* 1966; Critical Areas Program, 1981). Cut-leaf toothworth is rare in New Brunswick (Hinds, 1983), New Hampshire (Storks and Crow, 1978), and Quebec (Bouchard *et al.,* 1983). The only site with proximity to Hodgdon is located in upper Woodstock, New Brunswick, Canada (ca. about 24 km to the northeast).

In June of 1982, Martin Rasmussen (pers. comm.) a botanist from Caribou, Maine, located another small group of plants near our original site on Westford Hill; these individuals were in poor condition and about to die for the season.

Mapping of the population was undertaken for the Maine Critical Areas Program in May of 1983; the *D. laciniata* site was calculated to occupy about 5 ha on the west and south slopes of Westford Hill. The population is large, numbering thousands of individuals, patchily distributed over the steeper rocky portions of the hill. Two voucher specimens were collected for deposition in the herbaria of the University of Maine (MAINE) and the New England Botanical Club (NEBC).

Dentaria laciniata is an early blooming ephermeral, dying down before tree leaves appear. At the Hodgdon site, *D. laciniata* dominates the herbaceous vegetation on the disintegrating calcareous slopes. It grows under a *Quercus rubra/Acer saccharum* canopy, and is commonly associated with *Dicentra cucullaria, Claytonia caroliniana, Trillium erectum* and *Erythronium americanum.*

D. laciniata is not rare south of Maine. After consultation with many botanists, the site in Hodgdon remains the single known Maine station for this species. The site is a Registered Critical Area.

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TWO NEW LOCALITIES FOR *MEDEOLARIA FARLOWII* IN NEW ENGLAND

DONALD H. PFISTER

Heretofore, only three localities have been reported for the distinctive parasite *Medeolaria farlowii* Thaxter. These localities were given by Thaxter (1922) in the paper describing the new genus and species as Magnolia, Massachusetts; Kittery Point, Maine; and Chocorua, New Hampshire. Despite both the widespread occurrence of the host, *Medeola virginiana,* and the peculiarity of the fungus with its resultant hypertrophy, the fungus was known only from these localities. In September, 1970 Richard P. Korf and I collected it again on the hillside near William G. Farlow's former house where Thaxter had made a large collection in 1904. That collection allowed a study which resulted in Korf's (1972) delimitation of the monotypic order Mediolariales and family Mediolariaceae for the monotypic fungus genus *Medeolaria.* Two new localities for this fungus are here reported: in damp mixed woods near Stevens Corner Road, West Newfield, Maine, on the property of Reed and Kathryn Rollins, September 1983; and in mixed woods on Parker Trail, Mt. Monadnock, New Hampshire, October 12, 1983.

I call attention to this intriguing, seemingly rare parasite in hopes that others will look for infected plants to help develop a more complete picture of its distribution. Infected plants are characterized by having shortened, swollen internodes between leaf pseudowhorls. Below the lower pseudowhorl, the stem is thickened and is at first green, later becoming brownish with olive to yellowish-green patches. It is in these patches, which are mostly paraphyses, that asci are found in mature specimens. The asci are thick-walled except at the tip where they become thinned. Each ascus has eight bilaterally asymmetrical ascospores, dark brown at maturity and longitudinally striate. The above details agree with Thaxter's description.

Ascus dehiscence was discussed by Korf (1972) who questioned whether it might not deliquesce rather than split. Study of the large collection from Maine showed empty asci each with a rupture of the apical region. The apical part of the ascus is thin and apparently breaks down at maturity. No spores were released when ascus-bearing portions were suspended above agar.

Many of the swellings had holes which may have been made by foraging insects. This observation suggests that insects might be involved in spore dispersal, which might explain the spotty distribution. Incidence of infection in populations is also of note; in some populations numerous infected plants can be found in close proximity, while in others only single infected plants are found. While this spottiness may have to do with systemic infection in the vegetatively reproducing plants of *Medeola* (growth patterns in *Medeola* were outlined by Bell in 1974), essentially nothing has been worked out regarding the infection cycle of this parasite.

Attempts were made to establish the fungus in culture. It grew slowly out of excised plant tissue and after two days was overtaken by other fungi. No spores were formed by *Medeolaria farlowii* in culture. The hyphae are characteristically hyaline and branch repeatedly at nearly right angles.

ACKNOWLEDGMENTS

Work on this project was supported in part by National Science Foundation grant DEB 80-23018. I thank Reed and Kate Rollins for access to their property and Gennaro Cacavio for help in collecting. To establish distributional records, all of the collections of *Medeola virginiana* in the Harvard University Herbaria were examined as well as those in the New England Botanical Club collection. However, no infected plants were found, which is perhaps a testimony to good collecting.

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BOOK REVIEW: WHERE HAVE ALL THE WILDFLOWERS GONE?

Mohlenbrock, R. H. 1983. Where have all the wildflowers gone? Macmillan Publ. Co., New York, 239 pp. (price $15.95).

This book is a popular guide to selected threatened and endangered wildflowers of the United States. Mohlenbrock divides the country into seven geographical areas and discusses the rare plants that occur within each area. There are usually 15–20 species treated in each region; each is allotted a brief, simple description and a page or two of text. In all, 120 plants are discussed, with 40 illustrated by color photographs and 80 by excellent line drawings. The latter were prepared by the author's son, Mark Mohlenbrock, himself a plant taxomomist and accomplished botanical illustrator.

The first chapter, entitled "The Disappearance of Thismia", unlike the others, is not a regional account of rare plants. Instead, it details the story of the remarkable plant *Thismia americana,* found only twice in a sand prairie on the south side of Chicago and never again seen. The second half of the chapter summarizes the important steps in the history of endangered plant protection at the national level in the United States. As such, it is a good introduction to the nationally endangered plants that follow in later chapters.

Chapters 2–8 are regional accounts of endangered plants. Informative, interesting and highly readable, they do an excellent job of telling the fascinating stories behind these plants. The more technical information is omitted, and the text emphasizes the humanistic aspects. One learns about many famous past and present American botanists, and how they contributed to our knowledge of these rare plants. The poem about Furbish's Lousewort, written by Charles Osgood of CBS, is particularly enjoyable. There are many interesting anecdotes of Mohlenbrock's personal experience with the plants. They reveal the problems and pleasures of field botany and the genuine excitement that occurs when something rare and beautiful is found for the first time.

The front flap of the dust jacket promotes the book as a field guide, but I believe that it is primarily a book to be read and enjoyed indoors. Its use in the field to distinguish endangered plants from

Vol. 86, No. 845 including pages 1–119 was issued April 6, 1984.

others is rather limited. Mohlenbrock has numerous qualifications and achievements which rank him as an eminent conservationist. The present book is a culmination of these conservation interests at the national level.

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Rhodora

JOURNAL OF THE NEW ENGLAND BOTANICAL CLUB

Vol. 86 July 1984 No. 847

The New England Botanical Club, Inc.

Botanical Museum, Oxford Street, Cambridge, Massachusetts 02138

RHODORA.—Published four times a year, in January, April, July, and October. A quarterly journal of botany, devoted primarily to the flora of North America. Price $20.00 per year, net, postpaid, in funds payable at par in the United States currency at Boston. Some back volumes and single copies are available. Information and prices will be furnished upon request. Subscriptions and orders for back issues (making all remittances payable to RHODORA) should be sent to RHODORA, Botanical Museum, Oxford Street, Cambridge, Mass. 02138. In order to receive the next number of RHODORA, changes of address must be received prior to the first day of January, April, July or October.

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Second Class Postage Paid at Boston, Mass.

PRINTED BY
THE LEXINGTON PRESS, INC.
LEXINGTON, MASSACHUSETTS

Cover illustration

Ledum groenlandicum Oeder, Labrador tea, reaches its southeastern distributional limit in Concord, Mass. It was first collected by Thoreau in 1858, subsequently regarded as extirpated by Richard Eaton in 1974, and rediscovered by Ray Angelo in 1978. Angelo has since found it in two more Concord locations.

Original artwork by Josephine Ewing

Rhodora
(ISSN 0035 4902)
JOURNAL OF THE
NEW ENGLAND BOTANICAL CLUB

Vol. 86 July 1984 No. 847

TAXONOMY OF *ARNICA* (COMPOSITAE) SUBGENUS *AUSTROMONTANA*[1]

STEVEN J. WOLF AND KEITH E. DENFORD

ABSTRACT

Nine species, with no infraspecific taxa, are recognized in *Arnica* subgenus *Austromontana*, a group primarily restricted to montane western North America. Previous treatments, which have variously recognized several infraspecific taxa, radiate and discoid sections, and two subgenera for these nine species, are viewed as artificial. Chromosome counts, all based on $x = 19$, are reported for 74 populations representing seven of the species. A discussion of comparative features, phylogenetic relationships, distribution maps, descriptions, synonymies and a key to the species are presented.

Key Words: *Arnica* subgenus *Austromontana*, taxonomy, chromosome counts, montane western North America

Arnica L. is a circumboreal, predominantly montane genus of about 32 species, most of which are confined to western North America. The genus, with its yellow florets, opposite leaves, capillary pappus and basic chromosome number of $x = 19$, is well defined. However, its tribal position within the Compositae has been the subject of considerable debate (Nordenstam, 1977; Robinson, 1981).

Members of the genus are extremely variable and numerous nomenclatural variants have been recognized. Apomixis has long been reported in *Arnica* (Afzelius, 1936) while Cronquist (1955) suggested that much of the perplexing morphological variability

[1]This paper is based on a dissertation submitted to the Department of Botany, University of Alberta, by S. J. W. in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

within the genus may be due to microspecies formation via apomixis. Cytologically, the genus is very diverse, with all ploidy levels from diploid to octoploid being reported (Wolf, 1980). Barker (1966) established that polyploidy within the genus always indicates apomixis and Straley (1980) confirmed this observation for the subgenus *Austromontana*.

Members of subgenus *Austromontana* are distinguished from the other four subgenera of *Arnica* by their turbinate to campanulate heads, white, barbellate pappus and broad leaves. The subgenus, as circumscribed in the present study, consists of nine species distributed in montane to alpine habitats from central Alaska through southern California and northern New Mexico, with a few disjunct populations of *A. cordifolia* occurring in Ontario and Michigan. Four of the nine species are relatively rare and restricted to the Klamath region of southwestern Oregon and northwestern California.

The only worldwide monograph of the genus *Arnica* (Maguire, 1943) was based largely on herbarium material; only two populations were available for study of some taxa, and the consequences of apomictic reproduction in the genus were largely unknown at the time. More recent taxonomic treatments of the genus in North America (Ediger and Barkley, 1978) and subgenus *Austromontana* (Straley, 1980) are based largely on Maguire (1943), with added observations on reproductive biology. The present revision of subgenus *Austromontana* incorporates observations from morphology, cytology, geography and flavonoid chemistry (Wolf, 1980; 1981; Wolf and Denford, 1983; 1984a; 1984b). More than 13,000 herbarium specimens were examined and over 250 populations were studied in the field.

TAXONOMIC HISTORY

The concept of subgenera in *Arnica* originated with Maguire (1943) when he described five subgenera: *Andropurpurea, Arctica, Austromontana, Chamissonis,* and *Montana.* Maguire (1943) recognized thirteen species and six subspecies in subgenus *Austromontana* and placed the seven radiate species and two subspecies in section *Eulatifoliae* and six discoid species and four subspecies in section *Eradiatae.* Maguire (1947) later recognized four varieties of *A. cordifolia* subsp. *genuina:* vars. *cordifolia, macrophylla, pumila* and *humilis.* Cronquist (1955), in his treatment of *Arnica* for the Flora of the Pacific Northwest, included *A. grayi* and *A. parviflora* in the new combination *A. discoidea* var. *eradiata* (A. Gray) Cronquist and treated *A. gracilis* as a variety of *A. latifolia.* Shortly thereafter, Cronquist (1958) proposed the name *A. discoida* var. *alata* (Rydb.) Cronquist for *A. alata* Rydb.

In their revision of *Arnica* for the North American Flora, Ediger and Barkley (1978) essentially adopted Maguire's (1943) treatment of subgenus *Austromontana,* recognizing nine species and treating his (Maguire's) subspecies as varieties. Exceptions include their acceptance of Cronquist's (1955, 1958) treatment of *A. discoidea* with three varieties (var. *discoidea,* var. *alata,* and var. *eradiata*) and his recognition of *A. gracilis* as a variety of *A. latifolia.* In addition, Ediger and Barkley considered *A. paniculata* a possible hybrid between *A. cordifolia* and *A. parryi* A. Gray but did not give it formal taxonomic recognition.

In a recent systematic study, Straley (1980) retained Maguire's (1943) two sections and recognized seven species in a revised subgenus *Austromontana* and included *A. venosa* and *A. viscosa* in the newly erected subgenus *Calarnica.*

In the present revision of subgenus *Austromontana* nine of Maguire's (1943) species are recognized; however, in light of considerable evidence, particularly with respect to flavonoid chemistry and the morphological consequences of apomixis, we recognize no infraspecific taxa and reject Maguire's sections and Straley's (1980) new subgenus as artificial.

CHROMOSOME NUMBERS

Chromosome numbers from the species of subgenus *Austromontana* were determined for either mitotic or meiotic material using techniques previously outlined (Wolf, 1980).

Arnica chromosome numbers, including many species of *Austromontana,* published prior to 1980 have recently been reviewed (Wolf, 1980). Consequently, the following discussions will be largely limited to comments on more recent data which, in addition to the seventy-four new counts presented in Table 1, incorporates reports by Löve and Löve (1981) and Straley (1980, 1982). As previously noted, the basic chromosome number of the genus *Arnica* is $x = 19$ and all new counts within subgenus *Austromontana* conform to this basic number. In the present study a new count of $2n = 57$ for *A. discoidea* is reported (Table 1).

Arnica cernua, A. venosa and *A. viscosa* are all uniformly diploid, while *A. nevadensis* is uniformly tetraploid. *A. spathulata* and *A. latifolia* are largely diploid; however, both have a few tetraploid populations. *A. gracilis* has both triploid and tetraploid chromosome races. *A. discoidea* has diploid, triploid and tetraploid races; however, the diploids are largely restricted to the Klamath region while the polyploids occur at the northern, eastern and southern limits of its distribution.

Arnica cordifolia, with five chromosome races, has previously been recognized as a mature polyploid complex (*sensu* Stebbins, 1971) (Wolf, 1980). Subsequent chromosome sampling, now totalling more than 150 populations from throughout its entire distribution, has confirmed this observation. Tetraploids are widespread, occurring throughout the entire species' range, triploids are found largely in the front ranges of the Rocky Mountains, and diploids, pentaploids and hexaploids are rare and of scattered occurrence. Diploids are largely restricted to northeastern Oregon and southern Yukon Territory, pentaploids are restricted to Colorado and hexaploids have been found in Alberta and central Washington.

MORPHOLOGY AND TAXONOMIC CRITERIA

In a discussion of the morphology of the genus *Arnica,* Maguire (1943) noted that there are some sharply defined species and a large number of other loosely-knit polymorphic ones. Within subgenus *Austromontana* most taxa fit into the latter category. Only *A. cernua, A. viscosa* and to some extent *A. venosa* are morphologically well defined. The remaining six species are highly polymorphic and show a wide range of morphological intergradation. In addition, superimposed upon this interspecific variability is a great deal of infraspecific variability. As Gustafsson (1947) and later Cronquist (1955) suggested, apomixis and polyploidy are probably largely responsible for this morphological variability within the genus. That *A. venosa, A. viscosa* and *A. cernua* are the only well defined species in subgenus *Austromontana* is not surprising since they are the only entirely sexual, diploid taxa in the subgenus. Although the several species of subgenus *Austromontana* are highly variable, a combination of several morphological features in conjunction with ecological and distributional data are sufficient to distinguish among them. The following discussions detail morphological variation and characters of taxonomic significance within subgenus *Austromontana.*

HABIT. All species of subgenus *Austromontana* are herbaceous perennials. With respect to underground parts, both *Arnica venosa* and *A. viscosa* possess a thick woody caudex at or below the soil surface, which gives rise to several flowering shoots. The remaining species possess slender rhizomes which give rise to both flowering shoots and numerous sterile basal rosettes of leaves (innovations). Both rhizomes and caudices are frequently covered with dark scales and old leaf bases which give them a thickened appearance. In *A. gracilis* the tip of the rhizome may have several branches, thus producing a many-stemmed crown (approximate crown) with the flowering shoots appearing in dense clumps.

STEMS. Stems in the species of subgenus *Austromontana* range from simple, as in *Arnica cordifolia* and *A. cernua* to highly branched. *A. discoidea* and *A. venosa* are sometimes several branched above the middle while *A. viscosa* is several-branched throughout, sometimes so much that it resembles a small bush. In addition, virtually all species are much more branched when they occur on more exposed or disturbed sites. Stem height varies from 10–30 cm in the relatively small *A. cernua* and *A. gracilis,* up to 60–70 cm in robust specimens of *A. discoidea* and *A. cordifolia.* In general, stem pubescence resembles leaf pubescence, although it is usually denser above and reduced below.

VESTITURE. Virtually all parts of all species of subgenus *Austromontana* are to some degree pubescent. Both long (1–2 mm) and short (0.1–0.2 mm) septate glandular and non-glandular hairs occur in the subgenus. The long stipitate glandular hairs have stalks 6–8 cells long while the short stalks are 2–3 cells long. Both are two cells thick. *Arnica latifolia* generally lacks glandular pubescence, *A. viscosa* has only the long type, *A. gracilis* has only the short type and the remaining species have both long and short. In *A. viscosa* the entire plant is densely covered with long stipitate glandular hairs, so much so that it feels slimy to the touch.

Non-glandular hairs are one cell thick and either long (1–3 mm) or short (0.3–0.5 mm).

Table 1. New chromosome counts in *Arnica* subgenus *Austromontana*.

Taxon	n =	$2n$ =	Location and voucher***
A. cernua	19		USA: CA: Humboldt Co.: Horse Mt., *W471*.
		38	USA: OR: Josephine Co.: Babyfoot Lake, *W464*.
A. cordifolia	19		CAN: YT: Canol Rd., km 16, *W507;* Squanga Lk, *W505*.
			USA: OR: Wallowa Co.: Minam Park, W449; Hwy 3, 8 km S Wa. state line, *W447*.
		57	CAN: YT: Skagway Rd., 19 km S. Carcross, *W499**. USA: MT: Flathead Co.: 8 km E Bigfork, *W496**; Lincoln Co.: 23 km W. Libby, *W444**; Missoula Co.: 34 km N Seeley Lk, *W495**.
	38		CAN: BC: Skagway Rd., 65 km S Carcross, *W500;* Hwy 93: 26 km N Jct Hwy 3, *W441;* 11 km S Jct Hwy 3, *W442;* Hwy 3, 15 km E Osoyoos, *B80055;* Hwy between Pavillion and Clinton, *B80060*. YT: Canol Rd., km 118, *W508;* Skagway Rd., 7 km S Carcross, *W498*.
			USA: CA: Nevada Co.: W side Donner Lk, *W476*. ID: Custer Co.: 15 km W Challis, *W486*. MT: Lincoln Co.: 25 km S Eureka, *W443*. Missoula Co.: 10 km E Bonner, *W493;* 22 km W Lolo City, *W491*. NV: White Pine Co.: Wheeler Peak, *W480*. OR: Grant Co.: 72 km S Ukiah, *W452;* Umatilla Co.: 14 km S Ukiah, *W451;* Union Co.: 40 km E Ukiah, *W450;* Wallowa Co.: 25 km N Enterprise, *W448;* Wheeler Co.: Ochoco Summit, *W453*. UT: Beaver Co.: 23 km E Beaver, *W482;* Cache Co.: Beaver Mt., *W484;* Iron Co.: 17 km E Cedar City, *W481;* Rich Co.: Bear Lake Summit, *W485;* Utah Co.: Mt. Timpanogos, *W483*. WA: Asotin Co.: Field Springs Park, *W446;* Spokane Co.: Mt. Spokane, *W445*.
		76	USA: CA: Plumas Co.: Gold Lake, *W478*. ID: Lemhi Co.: 5 km S Gibbonsville, *W487*. MT: Missoula Co.: Marshall Ski Area, *W492*. OR: Klamath Co.: Parker Mt. Summit, *W454*. UT: Duchense Co.: Hwy 33 at S border of Ashley Nat. Forest, *W396;* San Pete Co.: Jct Spring City-Skyline Drive Rd., *W393*. WA: Okanogan Co.: 23 km W Twisp, *W509*. WY: Teton Co.: Teton Nat. Park, Hidden Falls, *W429*.

A. discoidea	19		USA: CA: Humboldt Co.: 6 km W Briceland, *W472;* Mendocino Co.: 14 km W Boonesville, *W474;* San Mateo Co.: Kings Mt., *W475;* Siskiyou Co.: Baldy Mt., *W466;* Trinity Co.: 3 km E Burnt Ranch, *W470.*
		57**	USA: CA: Plumas Co.: Gold Lake, *W477**.
	38		USA: CA: Lake Co.: 13 km E Lower Lake, *W473;* Santa Barbara Co.: La Cumbre Peak, *W515.*
A. latifolia	19		CAN: ALT: Banff Nat. Park, Moraine Lake, *W513.*
			USA: OR: Curry Co.: Iron Mt., *W457.*
		38	USA: AK: Hatcher Pass, *W503.* WA: Chelan Co.: Swauk Pass, *W367;* Kittitas Co.: Snoqualmie Summit, *W510.*
	38		USA: CA: Siskiyou Co.: Bolan Lake, *W465;* 13 km W Etna, *W467.* ID: Idaho Co.: Lolo Pass, *W490;* Lemhi Co.: 9 km S Lost Trail Pass, *W488.* MT: Missoula Co.: Seeley Lake, *W494;* 27 km W Lolo City, *W489.*
		76	CAN: ALT: Waterton Nat. Park, Carthew Mt., *W440.*
A. spathulata	19		USA: CA: Del Norte Co.: French Hill, *W458;* 10 km N Gasquet, *W459.* OR: Josephine Co.: Hugo, *W455;* Merlin, *W456;* Selma, *W463;* Store Gulch Guard Station, *W462.*
	38		USA: OR: Josephine Co.: 17 km N Patrick, *W460;* 20 km N Patrick, *W461.*
A. venosa	19		USA: CA: Shasta Co.: Hwy 5, 3 km S Gibson turnoff, *W468;* Shasta Bally Rd., S Brandy Creek, *W469.*
A. viscosa	19		USA: OR: Klamath Co.: Crater Lake Nat. Park, Garfield Peak, *W511.*

* Count based on meiotic cells.

** New count for this taxon.

***Abbreviations of collectors: B = J. F. Bain; W = S. J. Wolf. Vouchers at ALTA.

LEAVES. Although highly variable, characters of the leaves are generally the most reliable in distinguishing the species of subgenus *Austromontana*. Characters considered important in the present study are leaf number, shape, margin, position and petiole width. Within the subgenus there is a general evolutionary trend from few, broad, coarsely dentate, narrowly petiolate leaves mostly below the mid-stem towards many, narrower, entire margined, sessile, evenly distributed leaves.

The number of cauline leaves varies from 2 to 4 pairs in such species as *Arnica cordifolia* and *A. latifolia* to more than 25 in *A. viscosa*. Species intermediate between these extremes include *A. spathulata* (3–5), *A. discoidea* (3–5) and *A. venosa* (6–10). Additionally, in the few-leaved species the leaves tend to be mostly below mid-stem while, in contrast, in the many-leaved species they are evenly distributed along both the stems and branches. This appears to be a trend within the genus *Arnica* in general (Maguire, 1943).

Leaf shape varies from broadly cordate in *Arnica cordifolia* to broadly lanceolate in *A. discoidea*. Intermediate conditions include: ovate to ovate-elliptic in *A. cernua, A. latifolia, A. venosa* and *A. nevandenis;* spathulate in *A. spathulata* and ovate-oblong in *A. viscosa*. Leaf margins vary from coarsely dentate in the primitive *A. cordifolia* to entire in its derivative *A. nevadensis* and the highly advanced *A. viscosa*. Intermediate forms include crenate in *A. cernua* and serrate to serrate-dentate in the remaining species.

Within the subgenus *Austromontana* there is a distinct evolutionary trend in petiole width from narrow to broad to completely sessile leaves, with the latter being considered most advanced. Five of the nine species have narrowly petiolate leaves (*Arnica cordifolia, A. cernua, A. discoidea, A. nevadensis* and *A. gracilis*), three species have sessile leaves (*A. latifolia, A. venosa,* and *A. viscosa*) while *A. spathulata,* with broadly winged petioles, represents the intermediate condition. Occasionally, the lower leaves of *A. latifolia* are short petiolate while the lower leaves of *A. cernua* and *A. gracilis* are infrequently narrowly winged. In addition, in all of the rhizomatous species, including the sessile-leaved species, the leaves of the innovations are narrowly petiolate. Leaves of innovations are otherwise similar to the cauline leaves. Additionally, in all species of the subgenus the upper leaves are often reduced, bract-like and not infrequently sub-opposite.

INFLORESCENCE. Within subgenus *Austromontana* several characters of the inflorescence are considered important in both delimitation of the species and determination of evolutionary relationships. Among these characters are head type (radiate vs. discoid), number and shape, phyllary shape and characters of the pappus. With the exception of *Arnica parryi* (subgenus *Chamissonis*), no discoid species of *Arnica* occur outside the subgenus *Austromontana*. Within the latter, *A. viscosa, A. venosa, A. spathulata* and *A. discoidea* are discoid while the remaining are radiate. In addition, in *A. discoidea* some marginal disc florets may be ampliate (elongated and ray-like), resulting in some pressed specimens of this species being confused with *A. cordifolia*. Results of the present study support Maguire's (1943) observation that the discoid condition represents the advanced state in subgenus *Austromontana*. Indeed, Cronquist (1977) considered the discoid condition to be derived within the Compositae in general.

The number of ray florets varies from 5 to 15 while the number of disc florets varies from 10 to 90. Within the subgenus there is a general trend of reduction in the number of disc florets, particularly in the discoid species. *Arnica cordifolia* and *A. latifolia*, with up to 90 disc florets, represent the primitive condition while *A. viscosa*, with as few as 10 florets, is viewed as highly advanced.

Cronquist (1977) considered yellow-colored corollas primitive within the Compositae in general. With the exception of *Arnica viscosa*, which has cream-colored florets, all other *Arnica* species possess yellow corollas. Clearly, the cream-colored florets of *A. viscosa* represent the derived condition in subgenus *Austromontana*.

Within subgenus *Austromontana* heads may occur singly as in *Arnica nevadensis, A. cordifolia*, and *A. cernua* or more commonly 3 to several heads are arranged in a corymbose inflorescence. Species with several heads include *A. viscosa* (10–20), *A. gracilis* (5–15) and *A. discoidea* (3–10, or up to 30). Maguire (1943) considered solitary heads primitive within *Arnica* in general and Cronquist (1977) noted a similar trend towards increasing head number in the Compositae in general. In the present study, the solitary condition is considered primitive in subgenus *Austromontana* while, in contrast, an increased number of heads is interpreted as an advanced state.

The pappus in the genus *Arnica* is composed of a ring of 25–70 capillary bristles of varying length. Based on seta length, Maguire

(1943) recognized three conditions within the genus: barbellate (0.1–0.2 mm), subplumose (0.2–0.35 mm) and plumose (0.35–0.6 mm). Also, within the genus pappus color varies from white to tawny. Maguire (1943) considered the white, barbellate pappus primitive, while the tawny, plumose pappus was considered advanced. Most species of subgenus *Austromontana* have retained the primitive white, barbellate pappus. However, in *A. cernua, A. discoidea, A. nevadensis* and *A. viscosa* the pappus is infrequently subplumose. Additionally, in both *A. nevadensis* and *A. viscosa* the pappus is sometimes slightly tawny.

Although somewhat variable, characters of the involucral bracts are often quite helpful in delimiting species. Phyllary shape varies from ovate-lanceolate (*Arnica cordifolia, A. cernua, A. discoidea, A. gracilis* and *A. venosa*) to lanceolate (*A. latifolia* and *A. viscosa*). *A. nevadensis* has distinctive oblanceolate phyllaries. Phyllary vestiture, like that of the leaves, consists of various combinations of short and long stipitate glandular and non-glandular hairs. The vestiture is always densest and longest at the bases of bracts, at the point of their attachment to the peduncle.

ACHENES. Achene color in subgenus *Austromontana* is mostly gray with the exception of *Arnica gracilis* (black), *A. spathulata* (black), and *A. latifolia* (brown). Length varies from 4.5–10 mm, with *A. gracilis* and *A. viscosa* being the shortest and *A. cordifolia* the longest. Achene width is almost uniformly 1 mm with the exception of *A. venosa* (1.5 mm). Achene vestiture, which is quite useful in delimiting species, consists of various combinations of both short and long glandular hairs and duplex (forked) hairs. For example, *A. viscosa* has only long stipitate glandular hairs, *A. gracilis* has a few short glandular hairs, *A. venosa* has an abundance of duplex hairs and *A. discoidea* has both duplex and glandular hairs.

PHYLOGENY AND PHYTOGEOGRAPHY

Maguire (1943) considered the genus *Arnica* to have arisen in Arctic or sub-Arctic western North America from where it spread eastward, westward and southward. Hultén (1937) listed 22 species of *Arnica* (some of which were not recognized by Maguire, 1943) that are of probable northwestern North American origin. As most species of the genus are adapted to cool montane habitats and 25 of the 32 species recognized by Maguire (1943) are largely confined to northwestern North America this conclusion seems valid. Additional evidence to support this hypothesis is the presence of many relictual diploid races of otherwise widespread *Arnica* polyploid complexes in the unglaciated Alaska-Yukon region (Wolf, 1980). Phytogeographical evidence suggests that the genus *Arnica* is relatively old, and was part of the Arcto-Tertiary flora. The east-west disjunct distribution of *A. louiseana* Farr and *A. lonchophylla* D. C. Eaton, the circumpolar distribution of *A. angustifolia* Vahl and the close relationship between *A. montana* of Europe and *A. acaulis* of the eastern United States add support to this theory.

Raven and Axelrod (1978) included the genus *Arnica* within a group of genera that are well-developed in California, yet widespread elsewhere. They suggested that this recurrent pattern in the Californian flora is the result of spreading aridity from Upper Tertiary times in the western United States which culminated in the development of a full Mediterranean climate in the late Quaternary. A striking example of this distribution pattern occurs within subgenus *Austromontana* which contains both widespread species (e.g., *A. cordifolia* and *A. latifolia*) and several endemics (e.g., *A. cernua, A. venosa* and *A. viscosa*). In fact, the discoid species of *Austromontana* are confined almost entirely to the northern areas of the California Floristic Province, particularly within the Klamath region of southwestern Oregon and northwestern California. The occurrence of many endemics in the Klamath region and its significance in the evolution and development of the flora of the western states, particularly California, have been discussed by Whittaker (1960, 1961). Owing to its geological history, equable climate and diversity of parent soils, the Klamath region contains many endemics that probably represent both remnants of the Arcto-Tertiary flora and more recently derived taxa (Whittaker, 1961). In the case of subgenus *Austromontana,* the narrow endemics appear to be recently derived from the more widespread *A. cordifolia* and *A. latifolia* (Wolf & Denford, 1984b).

Speciation within the subgenus *Austromontana* has been accompanied by a number of ecological, morphological and chemical changes, some of which include: a shift from mesic to xeric habitats; temporal isolation of flowering periods; specialization to particular substrates; the replacement of solitary, radiate heads by more numerous, narrower, discoid heads with reduced numbers of disc florets; evolution from narrowly petiolate to sessile leaves; the replacement of simple flavonol glycosides by more complex methylated flavone aglycones, and a secondary loss of flavonoids in several rare and geographically restricted species (Wolf, 1981; Wolf and Denford, 1983; 1984b). Additional factors contributing to speciation in the subgenus include hybridization, polyploidy and changes in reproductive systems (Wolf, 1980; Wolf and Denford, 1984a; Barker, 1967; Straley, 1980).

Maguire (1943) considered *Arnica cordifolia* to represent the ancestral species in subgenus *Austromontana* which gave rise to the rest of the subgenus. Results of the present investigation support this hypothesis. With respect to morphology, *A. cordifolia* exhibits most features considered primitive within the genus *Arnica* in general and the subgenus *Austromontana* in particular. Significant primitive features of *A. cordifolia* include: solitary, broad heads with white, barbellate pappus; unbranched stems with few, narrowly petiolate, broad, dentate leaves and dark gray achenes. In addition, the flavonoid profile of *A. cordifolia,* which lacks complex methylation, is relatively primitive (Wolf and Denford, 1983). Additionally, the mesic-montane habitat of *A. cordifolia* represents the ancestral condition within the genus *Arnica* in general (Maguire, 1943). Indeed, within subgenus *Austromontana* there is a distinct evolutionary trend from mesic-montane habitats towards drier habitats at both lower and higher elevations.

Phytogeographical, cytological and chemical evidence suggests that *Arnica cordifolia* was probably a relatively widespread diploid species prior to the Pleistocene. Hultén (1937) included *A. cordifolia* in a group of species widespread prior to the Pleistocene, but whose ranges were interrupted by glaciation. He hypothesized that these species survived the Pleistocene glaciations south of the ice and in unglaciated areas of the Yukon and Alaska. Upon retreat of the ice, these populations were rejoined to form a continuous distribution. This hypothesis is supported by the fact that the flavonoid profiles of populations north of the maximum limits of Pleistocene glaciation differ from those to the south (Wolf and Denford, 1983). Cytological evidence also supports the hypothesis that *A. cordifolia* was probably a relatively widespread diploid species prior to the Pleistocene. Barker (1966) noted that within the genus *Arnica* diploids were probably more widespread in the past and that polyploidy in the genus is a relatively recent, i.e., inter- or post-glacial phenomenon. Stebbins (1971) noted that most mature polyploid complexes such as *A. cordifolia* are of Pliocene or Pleistocene origin. The occurrence of diploid populations of *A. cordifolia* in the unglaciated Yukon as well as south of the limits of glaciation (in Oregon) suggests a former, much wider distribution of diploid populations.

The geographical distribution, morphology, cytology and flavonoid chemistry of *Arnica latifolia* suggests that it is probably a pre-Pleistocene derivative of *A. cordifolia. A. latifolia* occurs throughout much of the range of *A. cordifolia* but in moister habitats at higher elevations. Morphologically the two species are very similar and are often difficult to distinguish on herbarium sheets. *A. latifolia* and *A. cordifolia* share several primitive features including: radiate heads with white, barbellate pappus; relatively few, broad leaves; innovations; and numerous, yellow disc florets. However, *A. latifolia* has several advanced features, including sessile leaves, narrow heads and phyllaries, and brown achenes. Its flavonoid profile, which consists largely of flavonol glycosides, is relatively primitive and similar to that of *A. cordifolia* (Wolf and Denford, 1984b). However, the two species, and their putative derivatives, differ largely with respect to the replacement of quercetin 6-methoxy-3-0-glucoside in *A. latifolia* for kaempferol 6-methoxy-3-0-glucoside in *A. cordifolia.* The largely diploid condition of *A. latifolia* suggests a pre-Pleistocene divergence from *A. cordifolia* prior to the elimination of the diploid level in the latter. *A. latifolia* may have been an ecological race of an archetypal "cordifolia" adapted to moister conditions, which became established after the advent of apomixis in the latter. The fact that *A. cordifolia* and *A. latifolia* probably hybridized to produce *A. gracilis* (Wolf and Denford, 1984a) also suggests a close relationship between the two species.

As previously noted (Wolf and Denford, 1984a), *Arnica gracilis* is probably a hybrid between *A. latifolia* and *A. cordifolia.* The flavonoid profile of *A. gracilis,* which consists of fourteen compounds, is essentially a summation of the two parental profiles. Although *A. gracilis* is somewhat intermediate between *A. latifolia* and *A. cordifolia,* it has several distinctive and advanced features of its own. These characters include a much more branched habit; narrower leaves; more numerous and smaller heads with a reduced number of disc florets; black, glandular achenes and the dry, alpine habitat. Since *A. cordifolia* is an apomictic, polyploid complex

(Wolf, 1980) with no known sexual populations and *A. latifolia* is largely sexual and diploid, *A. gracilis* was probably formed prior to or during the Pleistocene, before the elimination of the sexual condition in *A. cordifolia* (Wolf and Denford, 1984a).

As previously noted (Wolf and Denford, 1984b), there is little doubt that *Arnica discoidea* has been derived from *A. cordifolia.* Morphologically the two species are quite similar, almost to the extent that *A. discoidea* appears to be little more than a rayless *A. cordifolia.* However, *A. discoidea* is readily distinguished by several advanced features including: more numerous, narrower, discoid heads with a barbellate to subplumose pappus; more numerous, narrower leaves and glandular achenes. Additionally, *A. discoidea* and *A. cordifolia* are ecologically quite distinct. *A. cordifolia* is adapted to cool, mesic, montane habitats and is generally quite rare west of the Cascades. In contrast, *A. discoidea* occurs in hotter and drier habitats west of the Sierras and Cascades. In both instances where the two species have been observed in close association, in the Sierran foothills and in the central Cascades, *A. cordifolia* had flowered and set seed well over a month prior to the flowering of *A. discoidea.* Such early flowering of *A. cordifolia* is no doubt a means of escaping the relatively warm-dry summer conditions of these areas.

Cytological and chemical evidence suggests that *Arnica discoidea* was derived from *A. cordifolia* in the Klamath region. The flavonoid profiles of diploid Klamath populations of *A. discoidea* are strikingly similar to that of *A. cordifolia* while, in contrast, the polyploid populations outside the Klamath region have more advanced compounds and reduced flavonoid profiles (Wolf and Denford, 1984b). This suggests that *A. discoidea* has been derived from ancient diploid Klamath populations of *A. cordifolia* and that migration outward from this area has been accompanied by polyploidization and a change in flavonoid chemistry.

The Klamath region endemic *Arnica spathulata* has probably been derived from *A. discoidea* via saltational speciation into serpentine areas. Morphologically the two species are very similar, differing largely in leaf and petiole shape, and degree of pubescence. However, *A. spathulata* is readily distinguished by several advanced features including: narrow phyllaries; narrower, broadly petiolate leaves; and black achenes. Ecological distinctions between the two species are also readily apparent. *A. spathulata* occurs at lower elevations and in drier habitats on serpentine soils. Additionally, the flavonoid profile of *A. spathulata,* which consists of eight compounds, is a subset of diploid Klamath populations of *A. discoidea* (Wolf and Denford, 1984b).

Whittaker (1961) noted that the diversity of soil types in the Klamath region has contributed greatly to the formation of many local endemics. Kruckeberg (1954, 1969) suggested that serpentine endemism results from an adaptation to serpentine followed by biotype depletion and the development of isolated populations into local endemics. Lewis (1962) noted that many serpentine endemics originate by saltation speciation in marginal populations. As Raven and Axel (1978) noted, marginal populations often occur in edaphic situations that are unique for the species as a whole. What these ideas suggest is that *Arnica spathulata* may have initially diverged from marginal populations of *A. discoidea* that gradually adapted to, and later became restricted to serpentine soils. The subsequent restriction of these populations to local isolated areas may have resulted in a gradual depletion of their flavonoid profiles. The fact that *A. discoidea* and *A. spathulata* are still morphologically somewhat similar suggests a fairly recent derivation of the latter. Indeed, Raven and Axelrod (1978) suggested that most herbaceous, localized serpentine endemics of the California Floristic Province (such as *A. spathulata*) originated in late Pleistocene or more recent time. *A. spathulata* is therefore probably a relatively recent derivative of *A. discoidea* that gradually became adapted to, and later restricted to serpentine areas.

The rare Klamath region endemic *Arnica venosa* is probably a very recent derivation of *A. discoidea.* Typical populations of *A. venosa* differ from *A. discoidea* by several advanced features including: numerous sessile leaves, a woody caudex and a lack of innovations. *A. venosa* is also distinguished by its strongly reticulate-veined leaves, more leafy and branched habit and preference for hotter, drier disturbed habitats. However, some specimens of *A. venosa* with thin, slightly woody rhizomes and few, broadly petiolate, weakly veined leaves tend to resemble *A. discoidea* and suggest the two species are related. *A. venosa* is diploid and its flavonoid profile, which consists of six compounds, is merely a subset of the profile of *A. discoidea.* Since *A. venosa* and *A. discoidea* occur sympatrically, have several flavonoids in common and are sometimes morphologically similar, it seems likely that the former is derived from the latter. *A. venosa* is restricted to the foothills of Shasta County, California in the hottest and driest habitat of any *Arnica* species known. This represents considerable divergence from the ancestral cool-montane habitat characteristic of the genus *Arnica.* The very localized distribution of *A. venosa,* its preference for recently disturbed habitats and derived ecology suggest it is very recently derived, possibly during the post-glacial hypsithermal of 9,000 to 2,600 years ago (Flint, 1957).

Maguire (1943) and Straley (1980) considered the rare serpentine, Klamath endemic *A. cernua* to be derived from *A. latifolia.* However, both *A. cernua* and *A. cordifolia* share several primitive morphological features including: long, narrow petioles; broad solitary heads with pilose and glandular, ovate-lanceolate phyllaries; and dark gray achenes. In contrast, *A. latifolia* has sessile leaves; several narrow heads with lanceolate, sparsely pubescent phyllaries and brown achenes.

Raven and Axelrod (1978) suggested that *Arnica cernua* probably evolved from a more widespread species, in late Pleistocene or Recent times via saltation speciation in marginal populations that gradually became adapted to and later restricted to serpentine soils. It seems likely that *A. cernua* has been derived from the more widespread *A. cordifolia* prior to the elimination of the diploid condition in the latter.

Arnica nevadensis has been derived, at least in part, from *A. cordifolia. A. nevadensis* is an extremely variable species which sometimes resembles little more than a high altitude ecotype of *A. cordifolia.* In fact, in the past, many high altitude Rocky Mountain populations of *A. cordifolia* have been erroneously identified as *A. nevadensis. A. cordifolia* and *A. nevadensis* share several primitive features including: solitary, radiate heads and simple stems with few, relatively broad leaves. Additionally, the flavonoid profile of *A. nevadensis* is most similar to that of *A. cordifolia* (Wolf and Denford, 1984b). However, *A. nevadensis* is readily distinguished by its often tawny, subplumose pappus, entire leaves, oblanceolate phyllaries and relatively high altitude, exposed habitat. The extreme morphological variability of *A. nevandensis,* its tetraploid condition, apomictic reproductive system and resemblance to *A. cordifolia* suggests that either it is the result of introgression between the latter and another *Arnica* species or it is a high altitude microspecies of *A. cordifolia* that has become established and more widespread via apomictic reproduction. The evolution of *A. nevadensis* may have been facilitated by the climatic cooling of the late Pliocene or Pleistocene and/or saltation speciation of high altitude populations of *A. cordifolia.*

Arnica viscosa is one of the rarest and most distinctive species of the genus *Arnica.* It is known from only seven populations on high alpine volcanic slopes, largely in the Klamath region of Oregon and California. Its opposite leaves and chromosome number of $n = 19$, among other features, clearly place it within the genus and its pappus characters, broad leaves and flavonoid profile warrant its inclusion in the subgenus *Austromontana. A. viscosa* exhibits virtually every advanced morphological, ecological and chemical feature of both the genus *Arnica* and subgenus *Austromontana.* Significant derived morphological features include: numerous, narrow discoid heads with a reduced number of cream-colored florets; highly branched habit; numerous, sessile, entire leaves; woody caudex; and a lack of innovations. Its restriction to very recent volcanic soils and dry, alpine habitat are also considered derived features. Additionally, the flavonoid profile of *A. viscosa,* which includes several highly methylated flavones and a 6-hydroxylated flavone, is considered highly advanced (Wolf and Denford, 1984b).

The very distinctive morphology, ecology and flavonoid chemistry of *Arnica viscosa* as well as its restriction to very recent habitats, i.e., less than 14,000 years old (McKee, 1972), makes an evaluation of its evolutionary history quite difficult and highly speculative at best. Maguire (1943) noted the similar leafy, branching habit and rootstock shared by *A. viscosa* and *A. venosa* and suggested they might be related. Straley (1980) considered *A. viscosa* to be a recent derivative of *A. venosa* and erected the new subgenus *Calarnica* to encompass the two species. However, even Maguire (1943) noted that the two species differ significantly in several features. In fact, except for the superficial similarity of habit shared by the two species, they bear little resemblance to each other. Although quite distinct, *A. viscosa* shares several features with *A. latifolia* including: very narrow heads with lanceolate phyllaries; sessile leaves; similarly glandular achenes which lack duplex hairs; the cool high altitude ecology; diploid chromosome number; and several flavonoids (Wolf and Denford, 1984b). Additionally, in an extensive artificial hybridization program among the species of subgenus *Austromontana,* virtually the only successful crosses were between *A. viscosa* and *A. latifolia* (Straley, 1980).

The derivation of *Arnica viscosa* from *A. venosa,* as suggested by Straley (1980) also seems highly unlikely since the two species probably represent the two greatest ecological extremes within both the genus *Arnica* and subgenus *Austromontana. A. venosa* occurs at the lowest elevations and occupies the hottest and driest habitat of any *Arnica* while in contrast, *A. viscosa* is restricted to cold, high alpine habitats on volcanic soils. The derivation of *A. viscosa* from *A. latifolia,* a sub-alpine species, seems much more likely since it would require only a slight ecological shift. In addition, both *A. viscosa* and *A. latifolia* are diploid and occur sympatrically. Since *A. viscosa* shares several morphological, ecological and chemical features with *A. latifolia,* it seems more probable that *A. latifolia* has been involved, at least in part, in the derivation of *A. viscosa,* perhaps via saltational speciation onto very recent volcanic soils.

Assuming the above proposed phylogeny accurately represents evolutionary relationships, it is evident that the discoid condition has arisen independently at least twice within subgenus *Austromontana* and at least three times in the genus *Arnica* (cf. *A. parryi* A. Gray of subgenus *Chamissonis*). This is not surprising since the discoid condition has arisen independently numerous times in the Compositae (Cronquist, 1977). Maguire's (1943) recognition of radiate and discoid sections within subgenus *Austromontana* is therefore considered artificial and is rejected in the present study. Morphologically, both *A. venosa* and *A. viscosa* clearly belong in subgenus *Austromontana.* Additionally, both species contain two unusual quercetin glycosides common to all species of subgenus *Austromontana,* but lacking in the other subgenera of *Arnica* (Wolf and Denford, 1984b). Since *A. venosa* and *A. viscosa* do not appear to be related, as proposed by Straley (1980), his new subgenus *Calarnica* is also here rejected as artificial.

TAXONOMIC TREATMENT

Arnica L. subg. *Austromontana* Maguire, Brittonia. 432. 1943. Type species: *A. latifolia* Bong.

Arnica L. sect. *Austromontana* Maguire, Brittonia. 432. 1943.

Arnica L. sect. *Eulatifoliae* Maguire, Brittonia. 432. 1943. Lectotype: *A. latifolia* Bong. (*nom. illegit.*).

Arnica L. sect. *Eradiatae* Maguire, Brittonia. 452. 1943. Lectotype: *A. discoidea* Benth.

Arnica L. subg. *Calarnica* Straley, Ph.D. diss., Univ. British Columbia. 1980. Type species: *A. viscosa* A. Gray. This name has been proposed, but at present it has not been validly published.

Perennial herbs; stems simple to much branched, arising from a scaly rhizome or woody caudex. Leaves simple, opposite, relatively broad, 1.0–2.5 times as long as wide, cordate to narrowly ovate or spathulate, entire to dentate or crenate, sessile to broadly or narrowly petiolate, uppermost leaves often reduced or bract-like. Heads solitary or numerous in a corymbiform inflorescence, radiate or discoid, broadly campanulate to narrowly turbinate; involucral bracts ovate to lanceolate, acute to acuminate. Ray florets yellow; disc florets yellow or cream-colored, anthers yellow; pappus white or rarely tawny, barbellate to subplumose. Achenes gray, brown or black, ± stipitate-glandular and/or ± hirsute with duplex hairs.

KEY TO THE SPECIES OF *ARNICA* SUBGENUS *AUSTROMONTANA*

1. Heads discoid (marginal corollas sometimes ampliate in No. 3).
   2. Leaves sessile.
      3. Leaves toothed, veins conspicuous; achenes hirsute with duplex hairs; florets yellow . . . . 8. *A. venosa.*
      3. Leaves entire, veins inconspicuous; achenes stipitate-glandular; florets cream colored . . . . 9. *A. viscosa.*
   2. Leaves petiolate, the petiole sometimes broad.
      4. Lowermost leaves ovate to subcordate or broadly lanceolate; petioles narrow or scarcely winged; achenes dark gray, stipitate-glandular with duplex hairs; species of southern Washington to southern California, including the Klamath region . . . . 3. *A. discoidea.*
      4. Lowermost leaves spathulate; petioles broad, achenes black, stipitate-glandular, lacking duplex hairs; species mostly restricted to serpentine soils of Klamath region . . . . 7. *A. spathulata.*
1. Heads radiate.
   5. Cauline leaves sessile; heads turbinate; achenes brown . . . . . . 5. *A. latifolia.*
   5. Cauline leaves petiolate; heads campanulate to campanulate-turbinate; achenes dark gray or black.
      6. Leaves glabrous, thick, leathery; heads nodding in bud; plants restricted to serpentine soils of Klamath region . . . . 1. *A. cernua.*
      6. Leaves variously pubescent, thin; heads erect in bud; plants not of serpentine soils, widespread.

7. Stems several-branched, mostly clumped; heads numerous (5–15); achenes black, mostly lacking duplex hairs .... 4. *A. gracilis.*
7. Stems mostly simple, not clumped; heads solitary or few (1–3); achenes dark gray with duplex hairs.
   8. Leaves cordate, toothed; heads broadly campanulate; involucral bracts ovate-lanceolate; pappus white, barbellate; achenes ± hirsute and ± stipitate-glandular; widespread cordilleran species .... 2. *A. cordifolia.*
   8. Leaves ovate to elliptic, entire; heads campanulate-turbinate; involucral bracts oblanceolate; pappus white to tawny, barbellate to subplumose; achenes stipitate-glandular; species of Sierra Nevada, north less commonly to Washington .... 6. *A. nevadensis.*

TREATMENT OF INDIVIDUAL TAXA

1. **Arnica cernua** Howell, Fl. NW. Am. 373. 1900. TYPE: Oregon, Josephine Co. On dry banks, base of the Coast mountains near Waldo, July 1884, *T. Howell 166* (HOLOTYPE, ORE!).

Arnica chandleri Rydb., N. Am. Fl. 34: 339. 1927. TYPE: California, Humboldt Co., Hupi (Hoopa) Indian Reservation, June, 1901, *H. P. Chandler 1298* (HOLOTYPE, NY!; ISOTYPES, UC!, US!).

Stems simple, rarely branched, often reddish-purple, 10–30 cm high, 1.5–2.5 mm diameter, glabrous to sparsely villous; rhizomes 2–3 mm thick, 2–3 pairs reddish scales at the summit. Cauline leaves 3–4 pairs, often reddish-purple, elliptic to ovate, sometimes subcordate, 1.5–8 cm long, 1.5–4 cm broad, often thick and nearly succulent, glabrous to scabrous, acute to rounded, entire to serrate, commonly crenate or slightly lobed; petioles narrow or infrequently broadly winged on lowermost leaves, 2–6 cm long, 1–5 mm broad; uppermost leaves often reduced, lanceolate and sessile; leaves of the innovations 4–8, similar to cauline leaves. Inflorescence usually a single head or corymb of 3–5 heads, often nodding in bud; peduncle 3–15 cm long, sparsely to densely pilose and scabrous, heads radiate, campanulate-turbinate, 10–25 mm high; involucral bracts 8–14, ovate to broadly lanceolate, 8–16 mm long, 3 6 mm broad, sparsely to densely pilose and stipitate-glandular, acute to acuminate. Ray florets 5–10, yellow to slightly orange, broadly linear to elliptic, 10–20 mm long, 4–6 mm broad, 1–3 dentate; disc florets 20–60, yellow, tubular, 10–15 mm long, villous below; pappus of both ray and disc florets white, barbellate to subplumose. Achenes dark gray, 6–8 mm long, 1 mm broad, sparsely to densely hirsute with duplex hairs. Figure 1. Chromosome number $2n = 38$.

Figure 1. *Arnica cernua.*

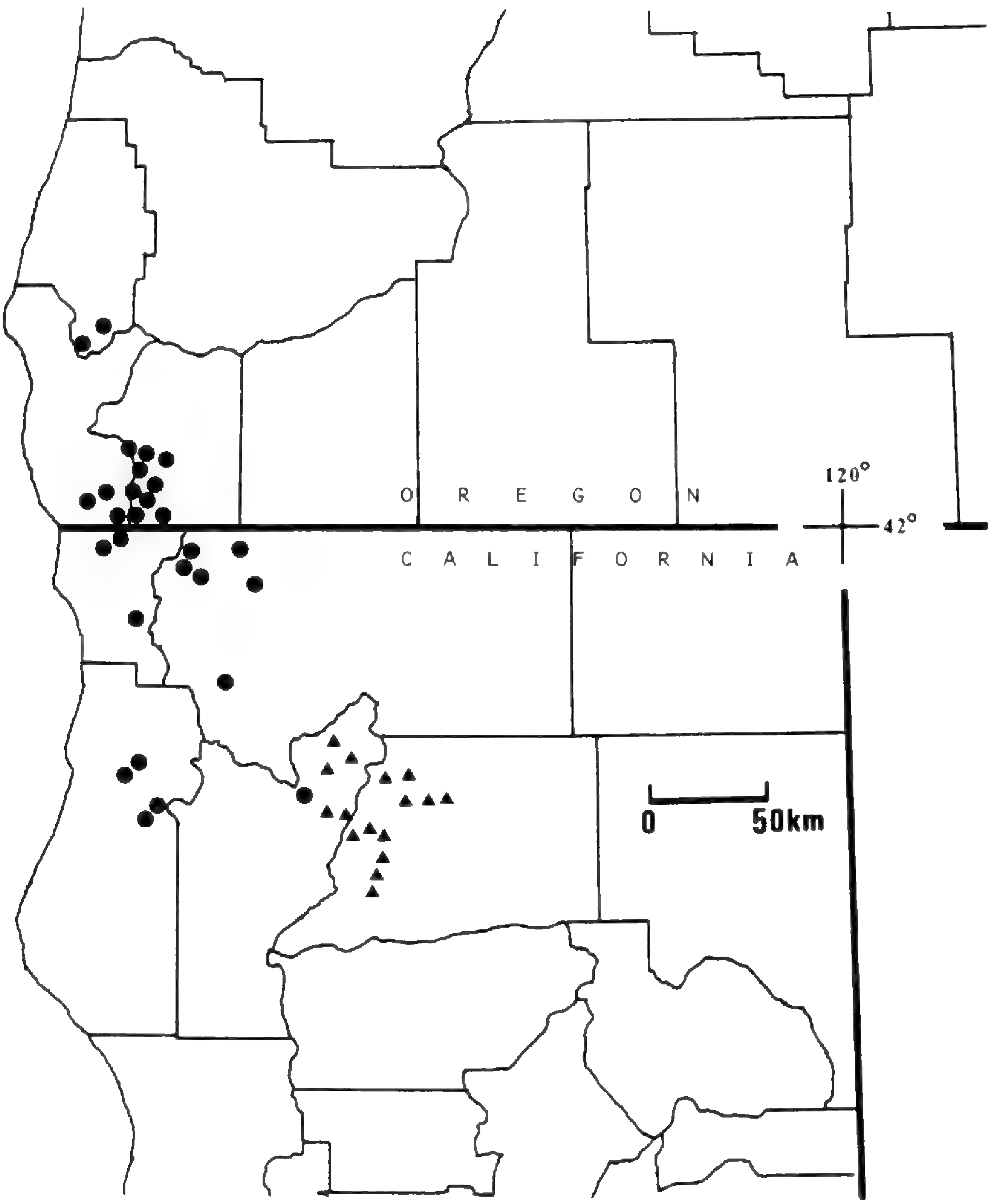

Figure 2. Distribution of *Arnica cernua* ● and *Arnica venosa* ▲.

ECOLOGY AND DISTRIBUTION: Relatively rare, but locally abundant in dry, open *Pinus–Pseudotsuga menziesii* forests at moderate elevations (500–1500 m). Known only from serpentine soils in Coos, Curry and Josephine Counties, Oregon and Del Norte, Trinity and Siskiyou Counties, California. Figure 2. Flowers late April to June.

REPRESENTATIVE SPECIMENS: **United States:** CALIFORNIA: Del Norte Co.: Gasquet-O'Brien Toll Rd., 7.7 mi. N. E. Patrick Creek Rd., *D. Breedlove 3178*

(CAS); Boundary Hill, near Telephone Point, *A. Eastwood s.n.* (CAS); Telephone Point, *A. Eastwood 148* (US). Humboldt Co.: Hoopa, *J. Davy and W. Blasdale 5645* (UC); Hoopa Indian Reservation, *H. Chandler 1298* (NY, UC, US); Ruby Creek, Willow Creek Canyon, *J. Tracy 7449* (UC); Horse Mt., *J. Tracy 15902* (CAS, UC), *S. J. Wolf 471* (ALTA); Willow Creek Canyon, *J. Tracy 7057* (CAS, UC); Hoopa Mt., *J. Tracy 7561* (UC). Siskiyou Co.: 15 mi. n. Happy Camp, *G. L. Stebbins 3269* (UC); Baldy Lookout, *F. Hoffman 3547* (UC); Klamath River Canyon, 1/2 mi. below mouth of Scott River, *R. Barneby 11513* (CAS). Trinity Co.: w. side Backbone Ridge on trail to Raymond Flat, *E. Carter 1116* (CAS); Mt. Bally, *S. Kleeberger s.n.* (CAS).

OREGON: Coos Co.: Iron Mt., *W. Baker 6822* (OSC, UC). Curry Co.: headwaters Chetco River, *R. J. Howell and G. True 48823* (CAS). Josephine Co.: base Coast Mts., near Waldo, *T. Howell 166* (ORE), *T. Howell 1446* (NDG, UC); Eight Dollar Mt., *L. Savage s.n.* (UC); Little Rock Creek, 2 mi. s.w. O'Brien, *L. Constance and R. Rollins 2993* (CAS, MICH, UC, WTU); Cedar Creek, Deer Creek Canyon, *L. Delting 4036* (UC); Siskiyou Mts., near O'Brien, *J. Thompson 1027* (CAS, NDG); Kerby, *A. Sweetser s.n.* (CAS); Babyfoot Lake Trail, *S. J. Wolf 464* (ALTA).

This species is easily distinguished by its glabrous, thick, ovate, crenate, petiolate leaves that are often reddish or purple; solitary, nodding heads, and serpentine habitat. Maguire (1943) considered *Arnica cernua* a derivative of *A. latifolia.* However, both *A. cernua* and *A. cordifolia* share several features including: long petiolate leaves, broad solitary heads with pilose and stipitate-glandular, ovate-lanceolate involucral bracts and dark gray achenes. In contrast, *A. latifolia* has sessile leaves, several narrow heads with narrow, sparsely pubescent bracts and brown achenes. In addition, the leaves of *A. cernua* are sometimes subcordate or even cordate (*T. Howell 1446, 1936* NDG) like *A. cordifolia.*

In the original description of *Arnica cernua* (Howell, 1900) no specimens were cited and no type was designated. Maguire (1943) designated a Howell collection (*T. Howell 1466* UC, NDG) as the lectotype for this species. However, as Rollins (1972) notes, "the existence of a holotype in the institution where the author worked is assumed until proven otherwise". Examination of Howell's collections at the University of Oregon has revealed that he did in fact designate a type by writing "Typ[sic] specimen" on one specimen (*T. Howell 166* ORE). According to the criteria of Rollins (1972) there would be no need to designate a lectotype since *Howell 166* would automatically be the holotype for *A. cernua.*

Rydberg (1927) described a smaller, more glandular form of *A. cernua* as *A. chandleri.* Examination of the type specimens (*Chandler 1298,* NY, UC, US) as well as two other collections of this taxon (*Davy and Blasdale 5645* UC and *Tracy 7449* UC) indicates that they are all referable to *A. cernua.*

2. **Arnica cordifolia** Hook, Fl. Bor. Am. 1: 331. 1834. TYPE: Alpine woods of the Rocky Mountains, on the east side, *Drummond s.n.* (HOLOTYPE, K photo!).

Arnica macrophylla Nutt., Trans. Am. Phil. Soc. II. 7: 408. 1841. *Arnica cordifolia* Hook. var. *macrophylla* (Nutt.) Maguire, Am. Midl. Nat. 37: 1947. TYPE: Blue Mountains of Oregon, *Nuttall s.n.* (HOLOTYPE, K photo!).

Arnica chionophila Greene, Pittonia 4: 171. 1900. TYPE: Ruby Mountains, Nevada, July 20, 1896, *E. L. Greene s.n.* (HOLOTYPE, NDG!).

Arnica subcordata Greene, Pittonia 4: 173. 1900. TYPE: on the Athabasca River, June 26, 1898, *W. Spreadborough* (*Geol. Surv. Can. No. 19644*) (HOLOTYPE, CAN!).

Arnica pumila Rydb., Mem. N. Y. Bot. Gard. 1: 433. 1900. *Arnica cordifolia* Hook. var. *pumila* (Rydb.) Maguire, Madroño 6: 154. 1942. TYPE: Gray's Peak, Colorado, Aug.-Sept., 1872, *Torrey s.n.* (HOLOTYPE, NY!).

Arnica parvifolia Greene, Pl. Baker. 3: 28. 1901. TYPE: Marshall Pass, Colorado, 10,000 ft., July 19, 1901, *C. F. Baker 515* (HOLOTYPE, NDG!; ISOTYPES, CAS!, POM!, UC!, US!, WS!).

Arnica paniculata A. Nelson, Man. Bot. Rocky Mts. 572. 1909. TYPE: moist timber, Bridger Peak, Carbon Co., Wyoming, Aug. 24, 1903, *L. N. Gooding 1974* (HOLOTYPE, RM!; ISOTYPES, CAS!, GH!, MO!, NY!, RM!, UC!, US!).

Arnica evermanii Green, Ottawa Nat. 23: 215. 1910. TYPE: shores of Petit Lake, Idaho, Aug. 13, 1895, *B. W. Evermann 318* (HOLOTYPE, US!).

Arnica abortiva Greene, Leaflets 2:47. 1910. TYPE: open spaces in timber, Wind River Mts., Wyoming, July 23, 1881 *W. H. Forwood s.n.* (HOLOTYPE, US!).

Arnica andersonii Piper, Proc. Biol. Soc. Wash. 33: 106. 1920. TYPE: Skeena, British Columbia, Sept. 11, 1910, *J. R. Anderson 677* (HOLOTYPE, US!; ISOTYPES, US!, WS photo!).

Arnica austinae Rydb., N. Am. Fl. 34: 340. 1927. TYPE: Lake City Canyon, California, July 1898, *Austin and Bruce 2165* (HOLOTYPE, NY!; ISOTYPES, NY!, UC!).

Arnica humilis Rydb., N. Am. Fl. 34: 341. 1927. *Arnica cordifolia* Hook. var. *humilis* (Rydb.) Maguire, Am. Midl. Nat. 37: 138. 1947. TYPE: on "the saddle", Lake Louise, Alberta, July 20, 1904, *J. Macoun* (*Geol. Surv. Can. No. 65504*) (HOLOTYPE, NY!; ISOTYPE, CAN!).

Arnica whitneyi Fernald, Rhodora 37: 334. 1935. *Arnica cordifolia* Hook. var. *whitneyi* (Fernald) Maguire, Brittonia 4: 452. 1943. TYPE: dry deciduous woods near Copper Harbor, Keweenaw Co., Michigan, July 4, 1934, *Fernald and Pease 3579* (HOLOTYPE, GH!).

Arnica hardinae St. John, Fl. SE. Wash. 419. 1937. TYPE: open woods, Lake Chatcolet, Benewah Co., Idaho, Oct. 2, 1927, *G. Weitman 226* (HOLOTYPE, WS!).

Stems mostly simple, sometimes branched, 10–40 (70) cm high, 2–3 mm diameter, glandular-puberulent to densely villous, especially above; rhizomes long, giving rise to several basal rosettes and flowering stems, 1.5–3.0 mm thick, 2–3 pairs of thin brown scales and often old leaf bases at the summit. Cauline leaves 2–4 (6) pairs, cordate or subcordate to narrowly ovate, 3–10 cm long, 2–10 cm broad, puberulent to sparsely villous and sometimes stipitate-glandular, especially above, acute to rounded, dentate to coarsely dentate; petioles (2) 5–10 (20) cm long; uppermost leaves often reduced, ovate-lanceolate, short-petiolate or sessile, sometimes bract-like; leaves of the innovations 2–4, similar to cauline leaves or often more coarsely dentate. Inflorescence usually a single head or corymb of 3–5 (10) heads; peduncle 4–20 cm long, pilose and stipitate-glandular; heads radiate, broadly campanulate, 1.5–3.0 cm high; involucral bracts, 10–20, narrowly ovate to lanceolate, 10–20 mm long, 2–5 mm broad, pilose at base to puberulent above, sometimes glandular, acute to acuminate, margins scarious. Ray florets 6–13, yellow, elliptic-oblong, 15–30 mm long, 5–10 mm broad, subentire to 3-dentate; disc florets numerous, 20–90, yellow, tubular, 9–12 mm long, sparsely glandular above, sparsely to densely villous and stipitate-glandular below; pappus of both ray and disc florets white, barbellate. Achenes dark gray, 5–10 mm long, 1 mm broad, sparsely to densely hirsute with duplex hairs, also sometimes stipitate-glandular. Figure 3. Chromosome number $2n$ = 38, 57, 76, 95, 114.

ECOLOGY AND DISTRIBUTION: Very common in mesic *Picea-Pinus-Pseudotsuga menziesii* forests or occasionally sub-alpine meadows from the central Yukon south through northern New Mexico, northern Arizona, Nevada and northern California. Also found in the Cypress Hills of Alberta and Saskatchewan and with outlying populations in the Black Hills of South Dakota, the Pasquia Hills of Saskatchewan and Riding Mt. Provincial Park, Manitoba. Also found in *Abies balsamea-Betula-Acer* forests in Keweenaw County, Michigan and Sibley Provincial Park, Ontario. Figure 4. Elevational distribution from 500 m in the Yukon to 3000 m in Colorado. Flowers May–July.

REPRESENTATIVE SPECIMENS: **Canada:** ALBERTA: Mt. Park, *M. Malte and W. Watson 1969* (UC); Jasper, near Icefields, *A. and R. Nelson 4889* (UC); Squaw Mt., *F. Lewis 92130* (CAN); Mt. Norquay, *B. LaSalle 45155* (CAN); Pyramid Mt., *A. E. Porsild and A. J. Breitung 16351* (CAN); Porcupine Hills, *Malte and Watson 603* (CAN); Lake Louise, *Malte and Watson 1014* (CAN); Mt. Park, *Malte and Watson 1995* (CAN); Mt. Edith Cavel, *J. Macoun 96072* (CAN); Cottonwood Creek, *E. H. Moss 4654* (ALTA, CAN); Mt. Eisenhower, *A. E. Porsild and A. J. Breitung 15808* (CAN); Sunshine Ski Lodge, *A. E. Porsild and A. J. Breitung 13604* (CAN); Medicine Lake, *M. Dumais 2816* (ALTA, CAN); Swan Dive Fire Tower, Swan Hills, *M. Dumais 4024* (ALTA, CAN); Palisades Mt., *A. E. Porsild 22526* (CAN). Mt.

Figure 3. *Arnica cordifolia.*

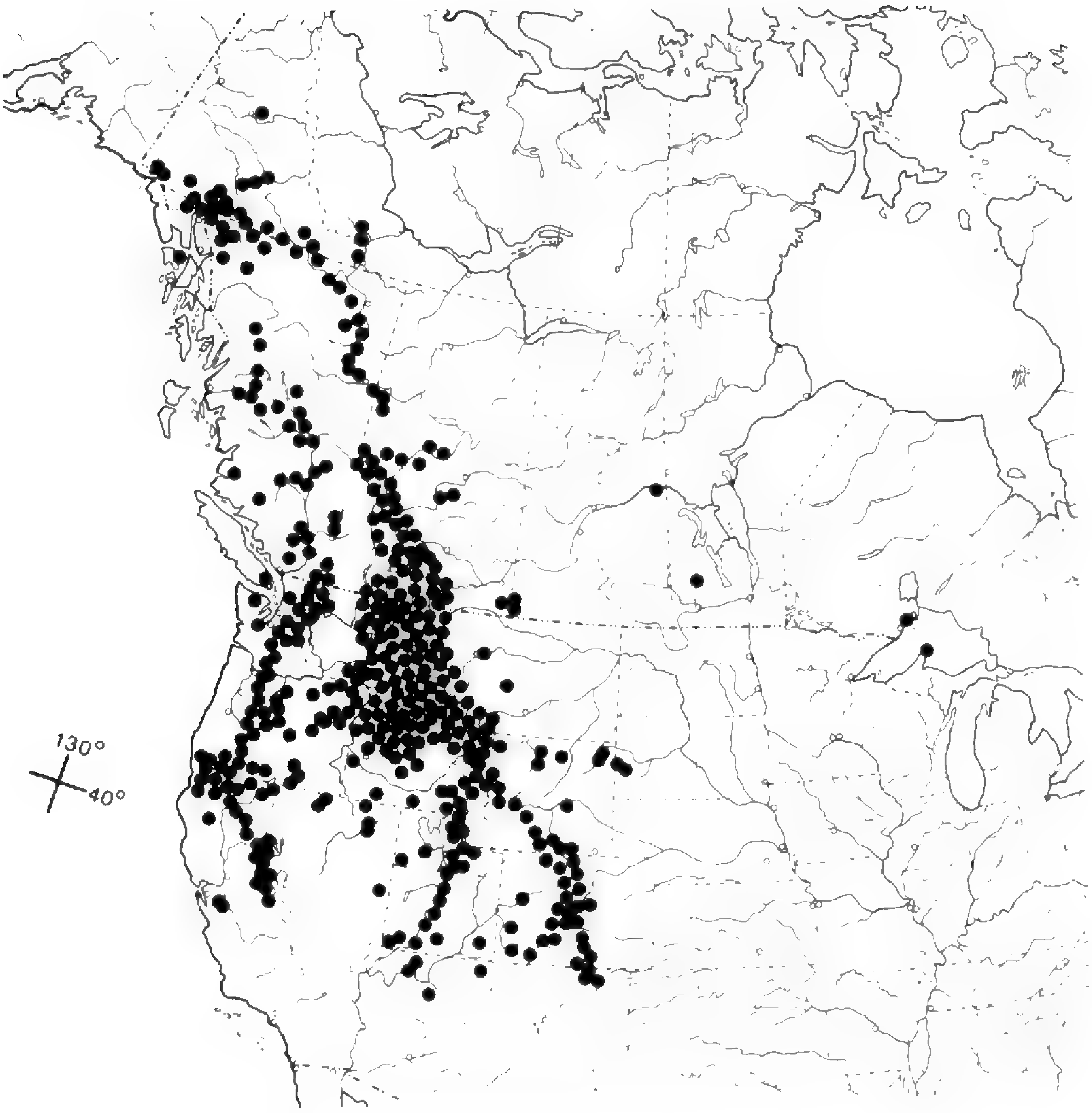

Figure 4. Distribution of *Arnica cordifolia.*

Norquay, *L. Jenkins 1586* (DAO); Waterton Lakes, *L. Carmichael 88* (DAO); Cypress Hills, Spring Creek, *R. S., A. J. Breitung 5661* (DAO); Saskatoon Mt., *L. Jenkins 738* (DAO); mi. 21, Jasper-Banff Hwy., *W. McCalla 4578* (ALTA); Lake Louise, *G. Turner 11517* (ALTA); Pyramid Lake, *T. Turner 6872* (ALTA); 20 mi. NW Edson, *I. Corns 12108* (ALTA); Ram Mt., *M. G. Dumais 7767* (ALTA); Lake George, *G. La Roi s.n.* (ALTA); Saskatoon Mt., *Prairie and Heywood 69* (ALTA); Swan Hills, *M. G. Dumais 4024* (ALTA); Surprise Lake, *M. G. Dumais 6212* (ALTA); Jarvis Lake, *M. G. Dumais 2420* (ALTA); Saddle Hills, N. of Sexsmith, *E. H. Moss 8464* (ALTA); Winfield, *F. Rusconi s.n.* (ALTA); Mercoal, *E. Woollven 23* (ALTA). Mt. Park, *E. Woollven 7* (ALTA).

BRITISH COLUMBIA: Alaska Hwy., 12 mi. NW Dawson Creek, *Calder and Kukkonen 26801* (UC); Revelstoke, *W. Spreadborough 64984* (NDG); Lake

Osoyoos, *J. Macoun 69323* (NDG); Skagit Valley, *J. Macoun 69325* (NDG); SW corner Dease Lake, *T. McCabe 8726* (UC); Crowsnest Pass, *T. McCabe 6463* (UC); Takla Landing, *T. McCabe 7835* (UC); Germansen Landing, *T. McCabe 7664* (UC); Clearwater, *T. McCabe 2078* (UC): 15 mi. SW Kleena Kleen, *T. McCabe 583* (UC); Atlin, *Setchell and Parks s.n.* (UC); Sinclair Pass, *T. McCabe 6219* (UC); Arnarchist Mt., *T. McCabe 5956* (UC); Atlin, *A. Eastwood 651* (CAS, UC); Bear Lake, *T. McCabe 7997* (UC); Pavilion Mt., *T. McCabe 213* (UC); Pinantan, *T. McCabe 2013* (UC); Skeena Crossing, *T. McCabe 7027* (UC); Princeton, *A. McCallum s.n.* (UC); Lake Bootahnie, *J. and E. Thompson 119* (MICH); 2 mi. E. Williams Lake, *J. Calder et al 16938* (DAO, OSC); Annaham Lake, *G. Bellinger 32395* (OSC); Cooper Mt., near Princeton, *Taylor and Szczawin s.n.* (OSC, UBC); Smithers, *J. Menzies 6016* (UBC); Cathedral Park, Twin Buttes, *R. Hainault 7879* (UBC); Mt. Edziza, *Annas and Klinka s.n.* (UBC); Hedley, *T. Taylor 2089* (UBC); 10 mi. E. Summit Pass, *H. Raup and D. Correll 10738* (UBC); 49 mi. E. Teslin, *H. Raup and D. Correll 11099* (CAN, UBC); Cassier, *T. Taylor et al 398* (CAN, UBC); mi. 81, Haines Rd., *T. Taylor et al 1342* (UBC). Mt. Defot, NW Dease Lake, *J. Teit 99* (UBC); mi. 206, Alaska Hwy., *A. E. Porsild 9111* (GH); Mt. Finlayson, Vancouver Island, *C. Newcomb 60* (GH); Laird Hot Springs, *A. E. Porsild and A. J. Breitung 22259* (CAN); Revelstoke, *J. Macoun 64984* (CAN). Mt. Brilliant, *H. Laing 687* (CAN); Osoyoos Lake, *J. Macoun 69323* (CAN); Telegraph Creek, *Dawson s.n. 14731* (CAN); Victoria, *J. Tolmie 1053* (DAO); Mt. Pope, *J. Whitehorn 382* (DAO); Blanchard River, 66 mi. S. Haines Jct., *Calder and Kukkonen 28185* (DAO); mi. 625 Alaska Hwy., *Calder and Gillet 25623* (DAO). Hurricane Creek, Atlin Dist., *J. Aitken 10* (DAO); Kootney Nat. Park, Sinclair Nature Trail, *K. Seel 27* (DAO); 12 mi. E. Field, *G. Turner 3899* (DAO); 8 mi. NE Ft. Steele, *R. Taylor and D. Ferguson 629* (DAO); 32 mi. W Prince George, *Mulligan and Woodbury 1688* (DAO); Kleena Kleen P.O., *Calder and Parmelee 19185* (DAO); 5 mi. N. Little Fort, *Calder and Saville 8638* (DAO); Nuttbide Lake, *Quiquet and Ritcey 57* (DAO); 9 mi. E. Williams Lake, *Calder and Parmelee 17040* (DAO).

MANITOBA: Rassburn Tower Cabin, Riding Mt. Provincial Park, *A. Lovaas 61-8* (DAO).

NORTHWEST TERRITORIES: Laird River between Nahanni Butte and Simpson, *C. Crickmay 114* (CAN); SW MacKenzie Mt., Laird Range, 15 mi. NW Ft. Laird, *W. Jeffrey 424* (CAN).

ONTARIO: Ravine Lake, Sibley Provincial Park, *C. Garton 15485* (CAN, MICH, UC): *15163* (UC), *15164* (CAN).

SASKATCHEWAN: Mt. Cabin, Pasquia Hills, *J. Rowe 983* (CAN); Cypress Hills; *C. Frankton 266* (DAO); *R. Newsome 394-64* and *470-64* (DAO); *Ledingham and Hudson 1788* (DAO); *G. Selleck 394* (DAO); *R. Russell s.n.* (DAO).

YUKON TERRITORY: Mi. 802, Alaska Hwy., *D. Bolinger s.n.* (OSC); Whitehorse, *J. Gillett and D. Mitchell 3862* (DAO, OSC); mi. 23, Campbell Hwy., *V. Harms 17193* (DAO, GH); mi. 116, Canol Rd., *A. E. Porsild and A. J. Breitung 10079* (CAN); St. Elias Mt., *A. Pearson 67-210A* (CAN); Keno, *G. Potack 119369* (CAN); Canol Rd., km 15.5, *S. J. Wolf 507* (ALTA); km 118, *S. J. Wolf 508* (ALTA); 3 mi. S Whitehorse, *J. Gillett 3259* (DAO, RM); lower Kathleen Lake, Kluane Nat. Park, *G. and G. Douglas 5884* (DAO); mi. 858, Alaska Hwy., *Calder and Gillett 25734* (DAO); mi. 777, Alaska Hwy., *Calder and Kukkonen 28318* (DAO); 16 mi. S. Haines Jct., *S. J. Wolf 300* (ALTA); km 196, Haines Rd., *S. J. Wolf 301* (ALTA); km

1479, Alaska Hwy., *S. J. Wolf 307* (ALTA); Alaska Hwy., 1.6 km E Squanga Lake, *S. J. Wolf 505* (ALTA).

United States: ALASKA: Sitka, *A. Paska s.n.* (UC); mi. 17.5 Haines Hwy., *M. Williams 1473* (OSC); Sitka, *A. Heller 14942* (WTU).

ARIZONA: Apache Co.: Lukachukai Mts., *Goodman and Payson 2865* (GH); rd. to Wide Lake, Lukachukai Mts., *C. Mason et al 2441* (UC). Coconino Co.: N. Rim, Grand Canyon, *U.S. Park Service 2007* (US); Indian Hollow, Kaibab Plateau, *L. Gooding 203* (UC); N. slope, San Francisco Peaks, *J. Leiberg 5897* (US).

CALIFORNIA: Alpine Co.: Hermit Valley, *F. Peirson 11593* (UC). El Dorado Co.: Magies Peak, *H. M. Hall 8810* (UC). Glenn Co.: Black Butte, *V. Rattan s.n.* (CAS). Humboldt Co.: Salmon Summit, *J. Tracy 14372* (UC). Lassen Co.: 1 mi. E Fredonyer Pass, *A. Heller* (UC). Madera Co.: Shadow Lake Trail, 1 mi. fm. Agnew Meadow, *J. and C. Reveal 427* (RM, UC, WTU). Mariposa Co.: Yosemite Valley, *G. Grant 4356* (UC); Signal Peak, *C. Quick 1997* (CAS). Modoc Co.: 15 mi. NE Alturas, *C. L. Hitchcock s.n.* (UC); Cedar Pass, *J. Weiler 61235* (UC); Emerson Creek, *Alexander and Kellogg 4668* (UC). Mono Co.: Slate Creek Basin, E. Mt. Conness, *J. Clausen 1124* (OSC); Mammoth Lakes, Lake Mary, *L. Rose 42194* (WTU). Nevada Co.: Donner Lake, *S. J. Wolf 476* (ALTA). Placer Co.: Deer Park, *H. Geis 38* (UC); W. side Donner Lake, *M. Denton 3901* (WTU). Plumas Co.: Gold Lake Rd., *S. J. Wolf 478* (ALTA); American Valley, *R. Austin s.n.* (NDG). Santa Clara Co: Mt. Hamilton, *R. Pendleton 873* (UC). Siskiyou Co.: Caribou Lake, *I. Wiggins 13562* (UC); English Lake, *F. Oettinger 1023* (UC); Marble Mt., *H. Chandler 1615* (UC); Salmon Mts., 10 mi. SW Etna, *A. Eastwood and J. Howell 5037* (CAS). Trinity Co.: Oregon Gulch Mt., *J. Tracy 7538* (UC); Musser Hill, *H. Yates 395* (UC). Tuolumne Co.: Gaylor Lakes, *H. Mason 11368* (UC).

COLORADO: Boulder Co.: Mts. between Sunshine and Ward, *F. Tweedy 4893* (RM); Boulder, *F. Ramaley 71* (RM). Chaffee Co.: Morass Creek, *I. Clokey 3474* (UC). Clear Creek Co.: Chicago Creek, *J. Ehlers 8402* (MICH). Custer Co.: Westcliffe, *C. Erlanson 1768* (MICH). Douglas Co.: 7.3 mi. SW Sedalia, *W. Weber 7440* (WTU). Eagle Co.: 2 mi. E. Tennessee Pass, *I. Tidstrom 4098* (US). El Paso Co.: 2 mi. W Palmer Lake, *G. Robbins 463* (DAO). Fremont Co.: Sierra Sangre de Cristo, *T. Brandegee 241* (UC). Gilpin Co.: Tolland, *E. Palmer 31255* (GH). Fontleroy Place, *H. Rodeck 58* (DAO). Grand Co.: Berthoud Pass, *J. Ehlers 8452* (MICH); Berthoud Pass, *F. Tweedy 5821* (RM). Gunnison Co.: Bonton Mine, *I. Clokey 3009* (UC). Hinsdale Co.: W. Slumgullion Pass, *J. Barrell 249-65* (US). Huerfano Co.: Mt. SW Blue Lake, *Mosquin and Gillett s.n.* (UC). Jefferson Co.: Lookout Mt., *H. Shacklette 5934* (MICH). Lake Co.: Lost Man Camp. 6 mi W Independence Pass, *U. Waterfall 11623* (UC); Leadville, *J. Ehlers 8218* (MICH). La Plata Co.: Eagle Pass, *Mosquin and Gillett 5430* (UC). Larimer Co.: Rocky Mt. Nat. Park, *D. McNeal 202* (RM). Mesa Co.: Grand Mesa, *U. Waterfall 11653* (UC). Mineral Co.: Wolf Creek Pass, *C. Wolf 3007* (CAS). Ouray Co.: Ouray, *Biltmore 1149* (US). Pitkin Co.: West Springs Creek, *J. Langenhein 1399* (UC). Sanguache Co.: Marshall Pass, *J. Barrell 29-66* (US). Summit Co.: Breckenridge, *K. Mackenzie 80* (RM).

IDAHO: Bannock Co.: 3 mi. above Pocatello, *A. Cronquist 2302* (GH). Bear Lake Co.: Aspen Range, Georgetown Canyon, *N. Holmgren and B. Bethers 4411* (UC). Benewah Co.: SE Plummer, *W. Baker 16085* (WTU). Bonneville Co.: Tie Canyon, 6 mi. SW Victor, *N. Holmgren and V. Marttala 5376* (UC). Butte Co.:

Craters of the Moon Nat. Monument, *Dole 49* (UC). Camas Co.: Soldier Mts., Ketchum-Featherville Rd., *C. L. Hitchcock and C. V. Muhlick 10417* (WTU). Custer Co.: 10 mi. W. Cape Horn, *C. L. Hitchcock and C. V. Muhlick 9654* (UC). Elmore Co.: 23 mi. NE Mountain Home, *Davidse and Collotzi 453* (UC). Franklin Co.: 2 mi. SW Franklin Basin R.S., *B. Maguire 21645* (WTU). Idaho Co.: Warren Summit, *R. Davis 2555* (UC). Kootenai Co.: Albany Falls, *C. Speilberg 452* (RM). Latah Co.: Moscow Mt., *L. Abrams 613* (UC). Lemhi Co.: Moccasin Creek, *C. L. Hitchcock and C. V. Muhlick 14287* (UC). Nez Perces Co.: Lake Waha, *A. and E. Heller 3170* (UC). Owyee Co.: Silver City, *J. Macbride 955* (RM). Rich Co.: Bear Lake Summit, *S. J. Wolf 485* (ALTA). Shoshone Co.: Bullion Pass, St. Line, *W. Baker* 13446 (OSC). Valley Co.: McCall, *W. Boone 29* (RM); 15 mi. N. Banks, *C. L. Hitchcock and C. V. Muhlick 8578* (WTU). Washington Co.: Mann Creek, *H. Tucker s.n.* (RM).

MICHIGAN: Keweenaw Co.: 3 mi. E. Agate Harbor, *F. Hermann 7995* (UC); Fort Wilkins State Park, *M. Feigley and L. Nagel s.n* (MICH); Copper Harbor Cemetery *C. Richards 3783* (MICH); *2221* (MICH); Grand Marias Harbor, *C. Richards 2144* (DAO, MICH); 1 mi. W. Copper Harbor, *F. Herman 7761* (MICH, RM); bluffs SE of Eagle Harbor, *M. Fernald and A. Pease 3580* (GH, MICH); Copper Harbor, *Pease and Ogden 25178* (GH).

MONTANA: Deerlodge Co.: Storm Mt. *S. J. Wolf 435* (ALTA). Flathead Co.: 8 km E. Bigfork, *S. J. Wolf 496* (ALTA). Gallatin Co.: Targhee Pass, *S. J. Wolf 433* (ALTA); Sage Creek, *D. Swingle s.n.* (MICH). Lake Co.: near Biological Station, Flathead Lake, *P. Smith 37* (NDG). Lewis and Clark Co.: 8 mi. W. Lincoln, *C. L. Hitchcock 17956* (UC). Lincoln Co.: Mt. Marston, *S. J. Wolf 343* (ALTA); 25 km S. Eureka, *S. J. Wolf 443* (ALTA). Madison Co.: E. of Brandon Lakes, *C. L. Hitchcock 16960* (UC). Meagher Co.: 35 mi. NW White Sulphur Springs, *C. L. Hitchcock 16225* (UC, WTU). Missoula Co.: Blackfoot Valley, *H. LaCasse 15* (MICH); Missoula, *Nawrodcki and Neff 2* (NDG); 34 km N. Seeley Lake, *S. J. Wolf 495* (ALTA); Marshall Ski Area, *S. J. Wolf 492* (ALTA). Ravalli Co.: 32 mi. E. Hamilton, *G. Hedgcock s.n.* (WTU). Saunders Co.: divide between Camas and Perry Basin, *F. Barkely 2568* (NDG). Sweetgrass Co.: 1 mi. below Rainbow Lakes, *C. L. Hitchcock 16506* (UC).

NEW MEXICO: Colfax Co.: Baldy Peak, *P. Standley 14307* (US); Hermatite Canyon, *D. St. John 52* (GH). Rio Arriba Co.: Chama, *P. Standley 6713* (US); Brazos Canyon, *P. Standley 10917* (US); Pecos River National Forest, Wuisor Creek, *P. Standley 4255* (US).

NEVADA: Elko Co.: Jarbridge Mts., Coon Creek, *P. Train 671* (NDG); Lamoille Lake, *A. Holmgren 14177* (UC); Steele Creek, Ruby Mts., *A. Borell s.n.* (UC); 8 mi. W. North Fork, *N. Nichols 321* (DAO). Humboldt Co.: Santa Rosa Range, *J. Gentry 1581* (DAO, NY, RM). Washoe Co.: Headwaters Galena Creek, *W. Archer 6677* (DAO, UC); Hunters Creek Rd., 9–11 mi. SW Reno *W. Archer 6295* (CAD). White Pine Co.: Wheeler Peak, *B. Maguire 21111* (GH, UC); *S. J. Wolf 480* (ALTA).

OREGON: Baker Co.: Eagle Creek, *T. Gustafson s.n.* (UC). Crook Co.: Ochoco N.F., *S. Warg s.n.* (OSC); 23 mi. NE Prineville, *F. Chisaki 780* (RM). Curry Co.: Summit of Pistol River Mt., *J. Thompson 4565* (CAS). Deschutes Co.: Pavilina Lake, *M. Peck 9658* (OSC). Grant Co.: Malheur N.F., Fields Park, *A. Kruckeberg 546* (UC). Harney Co.: Myrtle Creek Canyon, *M. Peck 2846* (OSC). Steens Mts., *C.*

Hansen 699 (OSC). Hood River Co.: Hood River, *T. Howell 477* (OSC). Jackson Co.: Mt. Ashland, *M. Peck 2934* (OSC). Jefferson Co.: Black Butte, *J. Johnson 470* (OSC). Josephine Co.: 4.6 mi. S. Hugo, *K. Chambers 2916* (OSC). Klamath Co.: Fossil Lake, near Crater Lake, *H. Furlong s.n.* (UC). Lake Co.: 2 mi. NW Crooked Creek, *M. Loveless 77* (UC). Morrow Co.: Tupper Guard Station, *E. Winn s.n.* (OSC). Umatilla Co.: 14 km S Ukaih, *S.J. Wolf 451* (ALTA). Union Co.: 40 km E Ukaih, *S. J. Wolf s.n.* (ALTA); Eagle Cap, *G. Mason 1395* (OSC). Jarboe Creek, *P. Standley s.n.* (OSC). Wallowa Co.: Lostine River, 18 mi. from Lostine, *J. Murphy 89* (UC); Hurricane Creek, *G. Mason 5365* (OSC); Lick Creek Rd. *H. Gilkey 8* (OSC). Wasco Co.: 2 mi. W. the Dalles, *M. Peck 2791* (OSC).Wheeler Co.: Fossil, *W. Lawrence 2988* (OSC).

SOUTH DAKOTA: Lawrence Co.: Spearfish Canyon, N Black Hills, *F. Bennett 941* (CAS); 10 mi. NW Deerfield, *P. Johnson 527* (MICH); top of Custer Peak, *E. Palmer 37547* (GH); Mt. Roosevelt, *W. Over 17639* (RM); Whitewood, *H. Hayward 1207* (RM).

UTAH: Beaver Co.: 23 km E. Beaver, *S. J. Wolf 482* (ALTA). Cache Co.: Logan Canyon, *B. Maguire 3881* (RM, UC). Carbon Co.: Willow Springs, 1 mi. E. Sunnyvale, *S. Blake 9587* (UC). Duchesne Co.: W. Mt. Agassiz, *B. Maguire et al 4317* (RM); Ashley Nat. Forest, *S. J. Wolf 396* (ALTA). Garfield Co.: Mt. Ellen, Henry Mts., *R. McVaugh 14652* (CAS, MICH). Iron Co.: 3 mi. N. Cedar Breaks Nat. Monument, *C. L. Hitchcock and C. V. Muhlick 4603* (UC, WTU); 17.2 km E. Cedar City, *S. J. Wolf 481* (ALTA). Juab Co.: Granite Canyon, *B. Maguire and R. Becraft 2853* (UC). Piute Co.: Marysvale, *M. Jones s.n.* (CAS). Rich Co.: Bear Lake Summit, *S. J. Wolf 485* (ALTA). Salt Lake Co.: Big Cottonwood Canyon, *P. Rydberg and E. Carlton 6652* (UC); City Creek Canyon, Salt Lake City, *K. Brizzee 7856* (WTU). San Pete Co.: Skyline Drive, B. Maguire 20033 (WTU); *S. J. Wolf 393* (ALTA). Summit Co.: Burntfork Creek, *E. Jensen s.n.* (UC). Tooele Co.: S. Willow Creek, Stansbury Range, *B. Maguire 21753* (GH, UC). Utah Co.: Mt. Timpanogos, *E. Applegate 8439* (CAS); 9.5 km E. Mt. Timpanogos, *S. J. Wolf 483* (ALTA). Washington Co.: Forsyth Creek, Pine Valley Mts., *P. Munz 16924* (WTU).

WASHINGTON: Asotin Co.: Field Springs Park, *S. J. Wolf 446* (ALTA). Chelan Co.: Tumwater Mt., *J. Thompson 6479* (WTU); Lookout Mt., *J. Thompson 6479* (WTU); Wenatchee Lake, *W. Dress 4228* (UC). Clallam Co.: Boulder Creek, Olympic Nat. Forest, *G. Jones 8475* (WTU). Columbia Co.: Wolf Fork, Touchet River, *H. St. John et al 6971* (UC). Garfield Co.: Blue Mts., *D. Peters 385* (UC); 15 mi. S. Pomeroy, *C. L. Hitchcock and C. V. Muhlick 8302* (UC, WTU). Kittitas Co.: Virden, *J. Thompson 11582* (UC, WTU); Lookout Mt., *J. Thompson 14512* (MICH; NDG). Klickitat Co.: NE Bingen, *W. Suksdorf 2760* (UC). Mason Co.: Mt. Elinor, *P. Freer 371* (WTU). Okanogan Co.: Salmon Creek, *C. Fiker 686* (WTU); 20 mi. W. Winthrop, *G. and G. Douglas 3514* (ALTA, DAO). Pend Oreille Co.: Calispell, *F. Kreager 351* (UC, WTU). Skamania Co.: Hamilton Mt., *L. Delting 7066* (UC). Snohomish Co.: Mt. Dickerson, *R. Owen s.n.* (WTU). Spokane Co.: Mt. Spokane, *S. J. Wolf 445* (ALTA). Stevens Co.: E. side Columbia River, 12 mi. above mouth of Spokane River, *H. Rogers 400* (UC). Yakima Co.: Mt. Aix, *J. Thompson 15016* (WTU); Chinook Pass, *J. Thompson 15136* (WTU); Bald Mt., *H. St. John 7854* (UC).

WYOMING: Albany Co.: 7.9 mi. W. Centennial, *S. J. Wolf 424* (ALTA); Woods Creek Canyon, *C. L. Porter and M. Porter 9810* (UC); Woods Creek, *L. Goodding*

1431 (UC); Centennial, *Kauffman and Erlanson 113* (MICH); University Camp, Medicine Bow Mts., *A. Nelson 7798* (RM). Big Horn Co.: 10–15 mi. E. Kane, *L. and R. Williams 3016* (RM). Carbon Co.: South Brush Creek Campground, *B. and L. Nelson 451* (RM). Crook Co.: 6 mi. NE Hulett, *M. Ownby 599* (RM, UC, WTU). Fremont Co.: Gannett Creek, *F. Jozwik 395* (UC); 1 mi. S. Pacific Spring, *C. L. Porter 4525* (RM). Lincoln Co.: Grover Park, Afton Area, *O. Harrison 55* (RM). Natrona Co.: Casper Mt., *R. Tresler 55* (RM). Park Co.: Crazy Woman Creek, Beartooth Mts., *L. and R. Williams 3518* (NDG). Saunders Co.: divide between Camas and Perry Basin, *F. Barkley 2568* (NDG). Sublette Co.: Green River Lakes, *A. Beetle 10534* (NDG); 16 km NE Pinedale, *S. J. Wolf 427* (ALTA). Teton Co.: Togowotee Pass, *S. J. Wolf 430; 432* (ALTA); Teton N. P., Hidden Falls, *S. J. Wolf 429* (ALTA); Jackson Hole, *J. and M. Reed 2250* (RM). Washakie Co.: 3 mi. E. Tensleep, *H. Fisser 784* (RM). Yellowstone N.P.: *W. Setchell s.n.* (UC); Mammoth Hot Springs, *F. Burglehaus 94* (MICH).

Arnica cordifolia is probably the most widespread *Arnica* in western North America, occupying fairly mesic habitats, in *Pinus-Pseudotsuga menziesii* or *Picea* forests throughout most montane areas of the region. In such areas as the foothills of Alberta, it forms extensive, nearly continuous populations for many kilometers. In the east *A. cordifolia* is restricted to only a few populations in *Betula-Acer* forests of Keweenaw Co., Michigan and Sibley Provincial Park, Ontario. *A. cordifolia* has also been recently collected in the Pasquia Hills, east of Saskatoon, Saskatchewan (*J. Rowe 983* CAN) and in Riding Mountain Provincial Park, Manitoba (*A. Lovaas 61-8* DAO).

In its typical woodland habitat, *Arnica cordifolia* displays little variability and is easily recognized by its large, solitary heads with broad rays and its cordate, dentate leaves. However, as Maguire (1943) noted, when it occurs in more exposed or disturbed habitats the leaves become smaller, narrower and lose their cordate bases; the pubescence becomes denser, harsher and more glandular; and the plants become smaller and more branched with several heads. This morphological form is characteristic of triploids and led to the suggestion that it may be the result of hybridization (Wolf, 1980). However, since recent flavonoid studies revealed no significant systematic differences among the chromsome races of *A. cordifolia,* including the triploids (Wolf, 1980), a hybrid origin can probably be ruled out.

Higher elevation forms of *Arnica cordifolia* tend to be much reduced, lack cordate leaf bases and have subentire leaves. This form has previously been recognized as *A. pumila* Rydb. or as *A. cordifolia* Hook. var. *pumila* (Rydb.) Maguire. However, when such plants are transplanted to the greenhouse they revert to typical *A. cordifolia* (cf. *S. Wolf 306* ALTA). The high altitude form has often been confused with *A. nevadensis,* particularly in the mountains of Utah. However, the latter can be recognized by its narrower heads, oblanceolate phyllaries, less pubescent leaves and darker pappus with longer setae.

According to Maguire (1943), Drummond's explorations were largely in the vicinity of Jasper House, Alberta, along the Upper Athabasca River and at the headwaters of the North Saskatchewan River. Bird (1967) also concluded that most of Drummond's collections from the "Rocky Mountains" probably came from Jasper National Park. The type of *Arnica cordifolia* from "Alpine woods of the Rocky Mts.", was therefore probably collected in the front range of the Rocky Mountains, probably in Jasper National Park, Alberta. The type sheet consists of four specimens, the holotype collected by Drummond and three specimens collected by Douglas on the same expedition.

Maguire (1943) considered the rare *Arnica paniculata* A. Nelson a distinct species while noting it may be a hybrid between *A. cordifolia* and *A. parryi* A. Gray. Ediger and Barkley (1978) considered this taxon a hybrid and therefore did not give it taxonomic recognition. In fact, with the exception of its numerous heads and ovate leaves, *A. paniculata* differs very little from *A. cordifolia* as circumscribed in the present study. Additionally, a chromosome voucher of an *A. cordifolia* population with $2n$ = ca. 97 (*T. Mosquin and J. Gillett 5425* La Plata Co., Colorado; UBC) bears considerable resemblance to the type collection of *A. paniculata* (*L. N. Gooding 1974,* Carbon Co., Wyoming). It is very likely that *A. paniculata* represents an *A. cordifolia* with a high chromosome number and/or the product of introgression between the latter and some other taxon. It is therefore reduced to synonymy under *A. cordifolia.*

Arnica whitneyi of Keweenaw Co., Michigan was first described by Fernald (1935). It occurs as one large discontinuous population between Copper and Eagle Harbors (Straley, 1980). Recently it has also been located in Sibley Provincial Park, Ontario (*Garton 15164* CAN, *15486* MICH). Maguire (1943) noted that this taxon differed little from western populations of *A. cordifolia* but retained it as a subspecies of the latter because of its disjunct distribution. However, Ediger and Barkley (1978) did not give this taxon formal taxonomic recognition. The facts that these eastern populations represent very typical *A. cordifolia,* share similar chromosome numbers (Wolf, 1980) and flavonoid chemistry (Wolf and Denford, 1983) with *A. cordifolia,* and that intervening populations of *A. cordifolia* in Saskatchewan and Manitoba also exist, support Ediger and Barkley's (1978) treatment. In the present study *A. whitneyi* is therefore reduced to synonymy under *A. cordifolia.*

3. **Arnica discoidea** Benth., Pl. Hartw. 319. 1849. TYPE: Monterey, California, *Hartweg 1805* (HOLOTYPE, K photo!; ISOTYPES, GH photo!, NY!).

Arnica parviflora A. Gray, Proc. Am. Acad. 7: 363. 1867. TYPE: Chaparral, Humboldt Co., California, Geol. Surv. Calif. 1867. *H. N. Bolander 6051* (HOLOTYPE, GH!; ISOTYPES, UC! K photo!, US!).

Arnica cordifolia Hook. var. *eradiata* A. Gray, Syn. Fl. N. Am. 1: 381. 1884. *Arnica discoidea* Benth. var. *eradiata* (A. Gray) Cronquist, Vasc. Pl. Pac. NW. 5: 49. 1955. TYPE: Hood River, Oregon, 1884, *Mrs. Barrett s.n.* (HOLOTYPE, GH!).

Arnica grayi A. Heller, Muhlenbergia 1: 5. 1900. TYPE: Hood River, Oregon, 1884, *Mrs. Barrett s.n.* (HOLOTYPE, GH!).

Arnica falconaria Greene, Ottawa Nat. 23: 215. 1910. TYPE: Falcon Valley, Washington, June 27, 1892, *W. N. Suksdorf 1617* (HOLOTYPE, US!; ISOTYPES, UC!, GH photo!, NY!).

Arnica alata Rydb., N. Am. Fl. 34: 342. 1927. *Arnica parviflora* A. Gray subsp. *alata* (Rydb.) Maguire, Brittonia 4: 455. 1943. *Arnica discoidea* Benth. var. *alata* (Rydb.) Cronquist, Contr. Dudley Herb. 5: 102. 1958. TYPE: Yosemite, California, 1865, *J. Torrey 258a* (HOLOTYPE, NY!).

Arnica sanhedrensis Rydb., N. Am. Fl. 34: 342. 1927. TYPE: Foothills of Mt. Sanhedren, Lake Co., California, *Heller 5985* (HOLOTYPE, NY!; ISOTYPES, POM!, UC!, US!).

Stems mostly simple to branched above, 15–60 cm tall, 2–5 mm diameter, villous and stipitate-glandular throughout; rhizomes giving rise to numerous basal rosettes and flowering stems, 2–5 mm thick, scales and old leaf bases crowded toward the summit. Cauline leaves 3–7 pairs, sometimes crowded toward stem base and often reduced above, ovate to broadly lanceolate, seldom subcordate, 2–12 cm long, 1–7 cm broad, glabrate to pilose and stipitate-glandular, serrate to coarsely dentate or crenate, rarely subentire; petioles narrow, 1.5–8.0 cm long, often broadly winged on upper reduced leaves; leaves of the innovations 4–10; similar to cauline leaves. Inflorescence a corymb of 3–10 (30) heads; peduncle 2–15 cm long, stipitate-glandular and densely pilose; heads discoid, the marginal corollas sometimes ampliate, turbinate-campanulate, 12–22 mm high; involucral bracts 8–15, ovate-lanceolate to narrowly lanceolate, 8–13 mm long, 1–4 mm broad, densely pilose and stipitate-glandular, acute to acuminate. Florets 20–50, yellow, tubular, 8–11 mm long, stipitate-glandular and sparsely to densely villous; pappus white, barbellate (to subplumose). Achenes dark gray, 6–8 mm long, 1 mm broad, stipitate-glandular and hirsute with duplex hairs. Figure 5. Chromosome number $2n = 38, 57, 76$.

ECOLOGY AND DISTRIBUTION: Relatively uncommon in moderately dry *Quercus-Pinus* forests from Klickitat County in southern Washington, south sparingly in the Cascades through northern California, but more common in relatively exposed chaparral in the coast ranges of California south to Orange County. Figure 6. Elevational distribution ranges from near sea level to 1500 m. Flowers May–July.

REPRESENTATIVE SPECIMENS: **United States:** CALIFORNIA: Butte Co.: Jonesville, *E. Copeland* 400 (MICH, UC). Contra Costa Co.: Inner Black Hills, W. of "1970," *M. Bowerman 2173* (UC); Meridian Peak, *M. Bowerman 849* (UC). Del Norte Co.: Black Butte, *A. Eastwood 2137* (CAS); Smith River, above Rock Creek Lodge, *W. Cooke s.n.* (UC). Glenn Co.: Alder Springs, *M. Baker 10872* (UC). Humboldt Co.: Croghan Hole, *J. Tracy 19273* (UC); Bee Mt., *C. Quick 59-31* (CAS); Hoopa Mt., *Davy and Blasdale 5668* (UC); Trinity Summit, *J. Tracy 14154* (UC); *J. Tracy 18182* (UC); Horse Mt., *J. Tracy 17833* (UC); Briceland, *J. Tracy 6335* (CAS, UC); White Thorn Valley, *J. Tracy 5001* (UC). Lake Co.: Mt. Hull, *H. M. Hall 9564* (UC). Coff Mt., *H. M. Hall 9595* (UC); Ukiah, *H. Yates 3735* (UC); Elk Mt., *H. M. Hall 9587* (UC); Adam's Springs, *R. Hoover 5347* (NDG, UC); Eel River, *L. Benson 3726* (NDG). Marin Co.: Mt. Tamalpais, *A. Heller 8392* (UC); *K. Brandegee s.n.* (UC); *W. L. Jepson s.n.* (UC); *F. Boiletti s.n.* (NDG, UC); Blithdale Canyon, *J. Howell 26621* (CAS); Lagunitas, *H. M. Hall 8502* (UC). Mariposa Co.: Cathedral Rocks, *C. Sharsmith 2168* (UC); Sherlocks, *J. Congdon s.n.* (CAS); Yosemite Valley, *L. Abrams 4527* (UC); *H. M. Hall 8867* (UC); Vernal Falls, *H. M. Hall and E. B. Babcock 3443* (UC). Mendocino Co.: 5 mi. E. Point Arena, *L. Rose 39170* (UC); Point Arena, *A. Eastwood and J. Howell 6252* (CAS); Comptche, *H. Walker 342* (UC). Modoc Co.: John Henry Hill, *M. Manning 370* (UC). Monterey Co.: Pacific Grove, *A. Elmer 4402* (CAS, OSC, UC); Chews Ridge, S. Jonesburg, *L. Snyder 3774* (UC); Los Burros Creek, 15 mi. SW Jolon, *C. Hardham 7037* (OSC); Big Sur, *Y. Mexia s.n.* (CAS, UC); Point Lobos, *Helley s.n.* (CAS); Hanging Valley, Santa Lucia Mts., *D. Breedlove 36264* (CAS); Jolon, *C. Hardham 7037* (WTU). Napa Co.: Howell Mt., *J. Tracey 2224* (UC); White Sulphur Springs, St. Helena, *H. Chandler 7579* (UC); E. side of Mt. St. Helena, *R. Hoover 5014* (UC). Orange Co.: Santa Ana Mts., 4.8 mi. above gate on Silverado Canyon Truck Trail, *P. Raven 17751* (UC); Mojeska Springs, Santa Ana Mts., *W. Pequegnat s.n.* (WTU). Plumas Co.: S. E. Quincy, *C. Quick 41-60* (CAS); Taylorsville, *M. Glemens s.n.* (CAS). San Luis Obispo Co.: Ocean View Mine, N. of Cambria, *C. B. Hardman 6828* (CAS, UCSB);

Figure 5. *Arnica discoidea.*

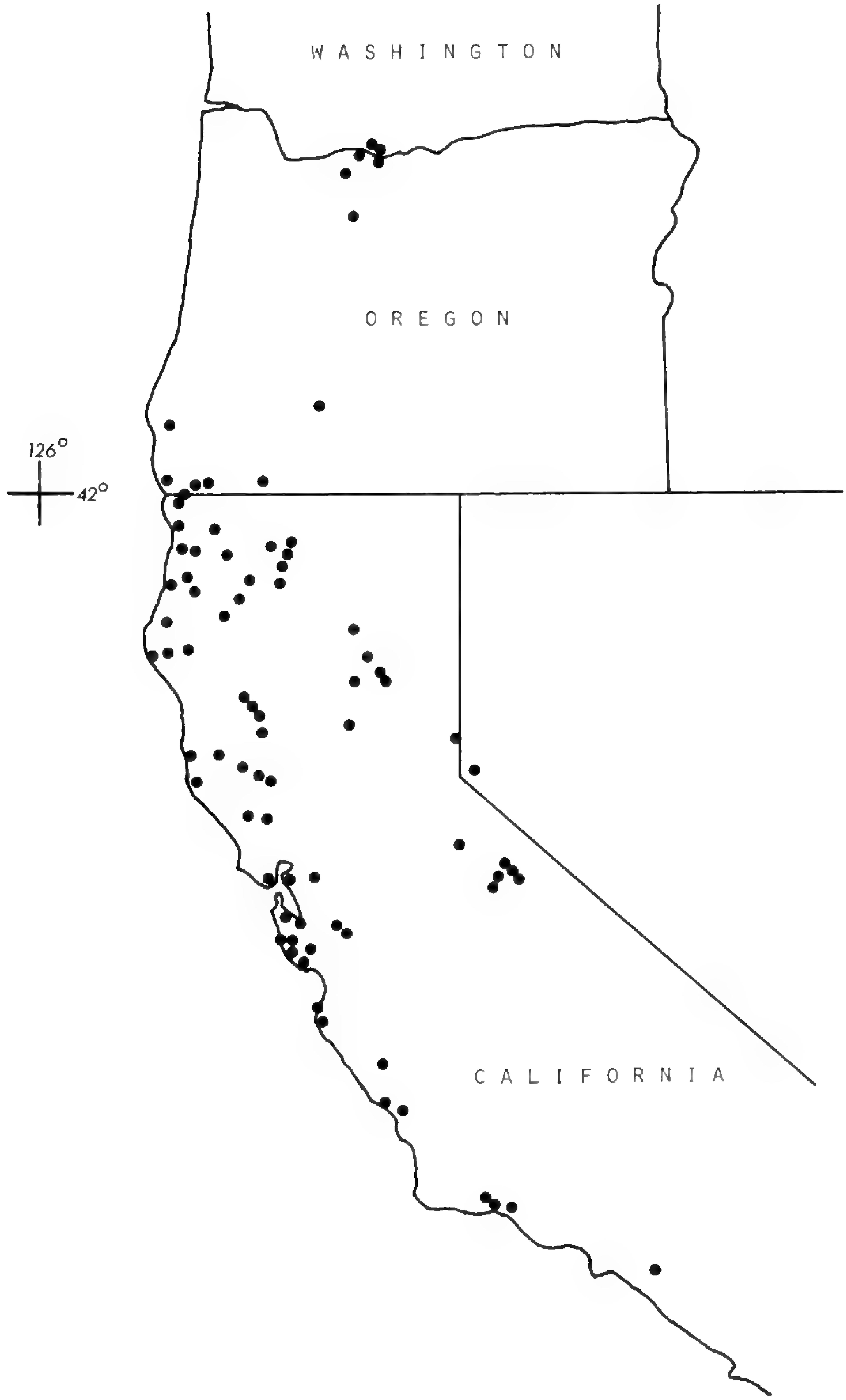

Figure 6. Distribution of *Arnica discoidea*.

Pine Mt., Santa Lucia Mts., *R. Hoover 8018* (CAS). San Mateo Co.: Skyline Drive, *D. Demaree 9150* (NDG); Kings Mt. Rd., *D. Keck 1775* (CAS, OSC, WTU); Portola State Park, *J. Thomas 9558* (CAS). Santa Barbara Co.: Mudulee Lookout Trail from Big Pine Rd., *E. Blakley* 6056 (CAS); LaCumbre Peak, *D. Breedlove 3762* (CAS); *D. Breedlove 585* (CAS, UCSB); *S. J. Wolf 514* (ALTA). Santa Clara Co.: Loma Prieta, *W. Price s.n.* (UC); *P. Covel s.n.* (CAS); Mt. Hamilton, *R. Pendleton s.n.* (UC); summit Santa Cruz Mts., *R. Pendleton 394* (UC); Alma Soda Springs *A. A. Heller 7490* (UC); Mt. Hamilton, *H. Sharsmith 1051* (UC). Santa Cruz Co.: Loma Prieta Pk., *H. Mason s.n.* (UC); Eagle Rock, *R. Ferri 11114* (UC); Felton, *B. Schreiber 319* (UC); Boulder Creek, *T. Kearny s.n.* (CAS); Redwood Park, *S. Blake 11766* (WTU). Shasta Co.: Castle Rock, *H. Ripley and R. Barneby 9646* (CAS). Montgomery Creek, *E. Bethel s.n.* (CAS). Siskiyou Co.: Mt. Eddy, *Copeland s.n.* (CAS, MICH, NDG, UC, US); China Creek, S. Fork Salmon River, *I. Wiggins 13465* (UC); Mt. Shasta, *E. Palmer 2455* (UC); trail between Taylor and Cow Creeks, *G. Butler 322* (UC); McCloud, *A. Eastwood 1105* (CAS, UC); Castle Lake, *A. Eastwood 10719* (CAS). Sonoma Co.: Guernewood Park, *H. M. Hall s.n.* (UC); Dohrman Creek, N. E. Jensen's Ranch, *H. Mason 8063* (UC). Tehama Co.: 1.9 mi. above Whitlock Camp, *M. Baker and H. Wagon 12833* (UC); Fish Ridge, *F. Hoffman 3531* (UC). Trinity Co.: Morrison Gulch Trail, *E. Carter 1094* (CAS); Ripstein Campground *P. Munz s.n.* (CAS); 1.5 mi. above Peanut on Hwy. 36, *R. Ferris and L. Lorraine 11693* (UC); White Rock Ranger Station, N. of Yolla Bolly, *A. Alexander and L. Kellogg 5115* (UC); Coffee Creek Canyon, *J. T. Howell 1359* (GH, MICH); Dunsmuir Retreat, *H. M. Hall and E. B. Babcock 8537, 8539* (UC); Battle Creek, *J. T. Howell 13590* (CAS). Tuolumne Co.: Dodge Ridge, Pine Crest, *F. Hoffman 1764* (UC). Ventura Co.: Ocean View Trail, near Divide Peak, Santa Ynez Mts., *H. Pollar s.n.* (CAS).

NEVADA: Washoe Co.: Hunter Creek, *P. Kennedy 1869* (US).

OREGON: Curry Co.: Iron Mt., *W. Baker 5677* (UC); 3 mi. NE Brookings, *M. Peck 2803* (OSC); head of Lawson Creek, *J. Leach 2250* (ORE). Hood River Co.: base of Mt. Hood, *F. Lloyd s.n.* (NY); Bald Butte, *M. Armstrong 471* (NY); Hood River, *L. F. Henderson 452* (NY); Mt. Defiance Trail, Columbia Gorge, *L. Delting 7169* (CAS, ORE); Mt. Hood, near Tollgate, *Drake and Dickson s.n.* (WTU). Jackson Co.: Ashland, *M. Peck 2795* (OSC); *2395* (OSC). Josephine Co.: Noname Creek, SW of the Caves, *E. Applegate 11917* (CAS); Siskiyou National Forest, 5 mi E. Jct. 3941 and 3942, *M. Denton 2550* (WTU). Klamath Co.: Crater Lake, *A. Coonebe s.n.* (CAS); E. of Lake of the Woods, *E. Applegate 3799* (CAS); Crater Lake, *F. Colville and E. Applegate 332* (US); *F. Hummewell 7876* (GH). Wasco Co.: 4 mi. E. Bear Springs, *J. Thompson 4935* (CAS, WTU).

WASHINGTON: Klickitat Co.: Falcon Valley, *W. Suksdorf 7301* (CAS, NY, UC); *12047* (CAS, NY, UC, WTU); *1617* (GH, NY, UC, US).

Arnica discoidea is an extremely variable species and occurs in a variety of habitats from open chaparral to conifer forests from near sea level to 1500 m. As early as 1884 Gray recognized the similarity of this taxon to *A. cordifolia* and noted that "northwardly it seems to pass into *A. cordifolia.*" Indeed, in southerly portions of its range, *A. discoidea* is quite distinct and can easily be recognized by its narrowly ovate leaves that are mostly crowded toward the base of the stem; broadly winged and reduced upper leaves; often numerous, narrower heads and frequently branched upper stem. However, northward it sometimes resembles little more than a rayless *A. cordifolia.* Further complicating its identification is the fact that ampliate marginal disc florets occur infrequently on some specimens of *A. discoidea* (e.g., *J. H. Thomas 4130* CAS and *H. M. Hall 9485* UC). When pressed, these florets resemble rays, causing some specimens to be erroneously identified as *A. cordifolia.* However, *A. discoidea* and *A. cordifolia* are distinct with respect to ecology, geographical distribution, flowering periods and a combination of several morphological features. *A. discoidea* occurs in hotter, drier, more exposed habitats at lower elevations west of the Sierras and Cascades and flowers 1–2 months later than *A. cordifolia.*

Based largely on leaf shape and geographical distribution, Maguire (1943) recognized four taxa within *Arnica discoidea sensu lato: A. grayi, A. discoidea sensu stricto, A. parviflora* ssp. *parviflora* and *A. parviflora* ssp. *alata.* Ediger and Barkely (1978) recognized the latter three taxa as varieties of *A. discoidea:* var. *discoidea,* var. *eradiata* (which included *A. grayi*) and var. *alata* respectively. However, since attempts to delimit these taxa produced no significant systematic correlations between morphology, chromosome number, geography or flavonoid chemistry (Wolf, 1981; Wolf and Denford, 1984b), *A. discoidea* is best treated as one highly polymorphic species with no infraspecific taxa.

4. **Arnica gracilis** Rydb., Bull. Torrey Bot. Club 24: 297. *Arnica latifolia* Bong. var. *gracilis* (Rydb.) Cronquist, Vasc. P. Pac. NW 5: 51. 1955. TYPE: Spanish Peaks (Madison Range, Montana). 6000 ft., July 14, 1896, *J. H. Flodman 901* (HOLOTYPE, NY!; ISOTYPES, NY!, US!).

Arnica columbiana A. Nelson, Bot. Gaz. 30: 200. TYPE: Columbia Falls, Montana, 1894, *J. J. Kennedy 24* (HOLOTYPE, MONT!).

Arnica multiflora Greene, Pittonia 4: 162. 1900. TYPE: Lake Pend d'Oreille, Idaho, June, 1891, *J. B. Leiberg 234* (HOLOTYPE, NDG!).

Arnica lactucina Greene, Ottawa Nat. 23: 214. 1919. TYPE: Hamilton Mt., Banff, Alberta, 5,800 ft., July 24, 1899, *W. C. McCalla 2014* (HOLOTYPE, US!, ISOTYPES, CU!, NY!).

Arnica betonicaefolia Greene var. *gracilis* (Rydb.) M. E. Jones, Bull. Univ. Mont. Biol. 15: 48. 1910.

Arnica puberula Rydb., Fl. Rocky Mts. 979. 1917. TYPE: Head of Lake Louise, Alberta, July 22, 1904, *J. Macoun (Geol. Surv. Can. No. 65523)* (HOLOTYPE, NY!; ISOTYPES, CAN!, US!).

Stems 3-several branched above, often in dense clumps of 5–10, 10–30 cm high, 1 mm diameter, mostly short stipitate-glandular above, becoming glabrate below; rhizomes 1–2 mm broad, covered with brown scales and old leaf bases; cauline leaves 2–3 pairs, ovate to ovate-lanceolate, 2–6 cm long, 1–3 cm broad, stipitate-glandular above, glandular below, acute, irregularly serrate to subentire; petioles narrow to broadly winged, 1–6 cm long; upper pair of leaves often reduced and connate-perfoliate; leaves of the innovations 5–14, similar to cauline leaves but narrowly petiolate. Inflorescence a corymb of (3)5–15 heads or rarely a single head; peduncle 1.5–7 cm long, stipitate-glandular, heads radiate, turbinate-campanulate, 10–15 mm high; involucral bracts 10–16, ovate-lanceolate, 6–12 mm long, 1–2 mm broad, short stipitate-glandular, acute to acuminate. Ray florets 5–12, yellow, linear-elliptic, 10–20 mm long, 3–5 mm broad, 3-dentate; disc florets 10–25, yellow, tubular, 4–6 mm long, short stipitate-glandular; pappus of both ray and disc florets white, barbellate. Achenes black, 4.5–7 mm long, 1 mm broad, short stipitate-glandular with few duplex hairs. Figure 7. Chromosome number $2n$ = 57, 76.

ECOLOGY AND DISTRIBUTION: Dry, exposed, rocky, alpine slopes or occasionally sub-alpine meadows in the Rocky Mountains of Alberta, south irregularly to southern Wyoming, the Uintah Mountains, of Utah, Wallowa Mountains of Oregon and infrequently in the Cascade Mountains of southern British Columbia south to Mt. Rainier, Washington. Also known from Vancouver Island. Figure 8. Elevational distribution from 1200–2500 m. Flowers July–August.

REPRESENTATIVE SPECIMENS: **Canada:** ALBERTA: Peyto Lake, *W. Weber 2445* (GH, UBC, UC); Bertha Lake, *A. Breitung 16228* (UC); Lake Louise Trail, *Malte and Watson 164A* (UC); Lake Louise, *Butters and Holway 336* (GH, US); Tonquin Valley, *Beamish and Pindar-Moss 700151* (UC); Maligne Lake, *S. Brown 1287* (GH, WTU): Lake Louise, *S. Brown 703* (GH); Bertha Lake, *Gadd and Nagy 3573* (CAN); Bow Pass, *A. E. Porsild and A. J. Breitung 16208* (CAN); Mt. Bertha, *Blais and Nagy 1555* (CAN); Mt. Temple Ski Lodge *A. E. Porsild and A. J. Breitung 12722* (CAN); Whitehorse Creek, *M. Dumais 5248* (ALTA, CAN); Sunshine Ski Lodge, *A. E. Porsild and J. Lid 19570* (CAN); Mt. Eisenhower, *A. E. Porsild and A. J. Breitung 15807* (CAN); Goat Mt., *J. Macoun 96043* (CAN); Sofa Mt., *A. J. Breitung 17178* (DAO); Chief Mt., *A. Breitung 15867* (DAO); Sofa Mt., *P. Kuchar 2730* (ALTA);

Figure 7. *Arnica gracilis.*

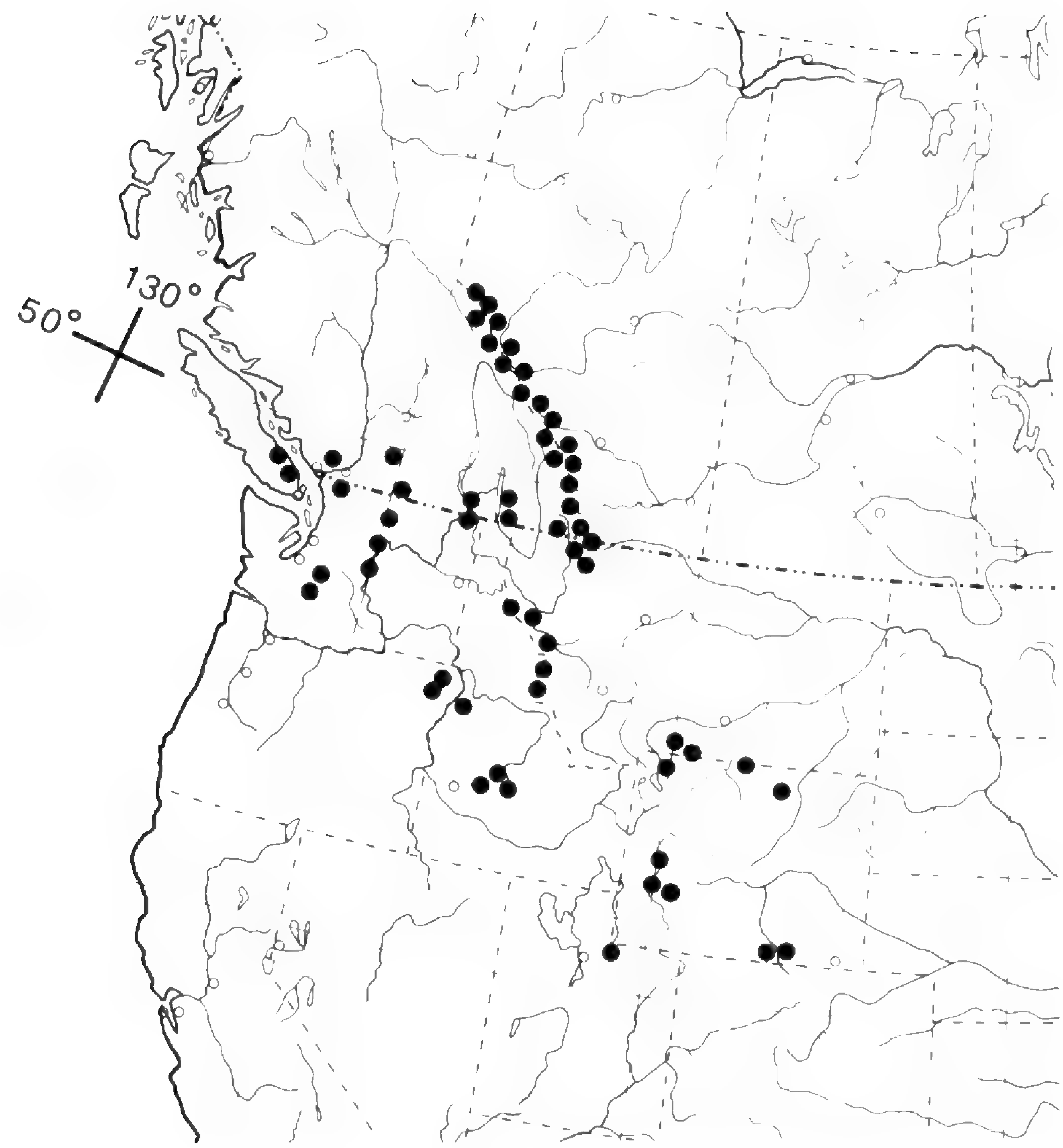

Figure 8. Distribution of *Arnica gracilis.*

Bertha Lake, *A. J. Breitung 16228* (ALTA); Maligne Lake, *H. Raup 2716* (ALTA); Red Rock Canyon, *E. H. Moss 374* (ALTA); Moraine Lake, *W. McCalla 4538* (ALTA); Lake Louise, *W. McCalla 7151* (ALTA); mi. 105, Banff-Jasper Hwy., *W. McCalla 7122* (ALTA).

BRITISH COLUMBIA: Ainsworth, *T. McCabe 5990* (UC); Kinbasket Lake, *T., McCabe 6275* (UC); between Burton and Fauquier, *T. McCabe 6629* (UC); trail, *J. Macoun 64977* (ND); Kicking Horse Valley, *S. Brown 298* (US); Mark Creek Falls, Kimberley, *F. Fedor 80* (UBC); Mt. Matier, *Pinder-Moss and Schofield 894* (UBC); Sage Creek Falls, *Bell and Davidson 359* (UBC); Commerce Mt., *Bell and Davidson 525* (UBC); Little Diamond Head, Garibaldi Park, *E. Peterson s.n.* (UBC); Boulder Creek, *F. Fedor 100* (UBC); Vancouver Island, Mt. Arrowsmith, *C. Rosendahl 1644* (GH); Mt. Assiniboine, *A. E. Porsild 18376* (CAN); Lake Agnes, *J. Macoun 14757* (CAN); Mt. Forget-Me-Not, *J. Macoun 22829* (CAN); Elk River, S. Elko, *J.*

Eastham 15629 (DAO); Flathead Summit, *Bell and Davidson 972* (DAO); Emerald Lake, Yoho Nat. Park, *W. McCalla 7032* (ALTA, DAO); Tuktakamin Mt., *J. Grant 65-5* (DAO); Vermillion Pass, *W. McCalla 2014* (ALTA).

United States: IDAHO: Clark Co.: West Camas Creek, 10 mi. above Kilgore, *A. Cronquist 1385* (ND, NY). Custer Co.: 3.5 mi. SW Stanley Lake, *Hitchcock and Muhlick 9630* (CAS, UC); 11 mi. NE Custer, *W. Baker 10790* (OSC); Seafoam, *Macbride and Payson 3653* (RM, US); McKay, *Nelson and Macbride 1497* (RM). Elmore Co.: 10 mi. W. Atlanta, *J. and C. Christ 19463* (OSC). Valley Co.: E. side Big Payette Lake, *P. Raven 18517* (CAS).

MONTANA: Carbon Co.: Rock Creek, 23 mi. SW Red Lodge, *A. Cronquist 8102* (CAN, CAS, MICH, NY, OSC, WTU). Gallatin Co.: Spanish Basin, *P. A. Rydberg and E. Bessey 5229* (US). Glacier Co.: Glacier Nat'l. Park. *B. R. and C. Maguire 15350* (UC). Lincoln Co.: Leigh Lake, Cabinet Mts., *D. Woodland 882* (CAS). Missoula Co.: Holland Creek, Holland Lake, *A. Cronquist* (CAS, UC); 5 mi. above Bonner, *Hitchcock and Muhlick 11432* (CAS, OSC, UC). Powell Co.: Shaw Creek R. S., Flathead N. F., *C. L. Hitchcock 18436* (WTU). Ravalli Co.: 4 mi. W. campground, Selway Bitterroot Wilderness, *D. Woodland 395* (CAS). Sweetgrass Co.: 6 mi. E. Box Canyon, Boulder River, *C. L. Hitchcock 16439* (UC, WTU).

OREGON: Wallowa Co.: Hurricane Creek, *M. Peck 22631* (UC); Boy Scout Ridge, *G. Mason 5981* (ORE, OSC).

UTAH: Summit Co.: 4 mi. N. Hayden Pass, *H. Bennett 8431* (CAS).

WASHINGTON: Chelan Co.: Mt. Stuart, *A. Kruckeburg 2638* (CAN, UC); Hwy. 2, 6 mi. NW Leavenworth, *W. Dress 4281* (UC). Kittitas Co.: Cle Elum River, *J. Thompson 10418* (CAS, CAN, WTU). Okanogan Co.: Angels Pass, *J. Thompson* (CAS, UC, US, WTU). Pend Oreille Co.: "Z" Canyon, 12 mi. N. Metaline Falls, *C. L. Hitchcock 2923* (UC, WTU). Pierce Co.: Mt. Rainier, *H. Leschke s.n.* (CAS). Whatcom Co.: Mt. Hermann, *J. Thompson 5352* (GH).

WYOMING: Albany Co.: Medicine Bow Mt., *A. and R. Nelson s.n.* (RM); Laramie Creek, *A. Nelson 7568* (RM). Carbon Co.: Chimneys of Pedro Mts., *L. Goodding 108* (RM, UC). Fremont Co.: Gannett Peak, *F. Jozwik 404* (RM, UC); Snow Lake, *R. Scott 9576* (RM). Johnson Co.: Headwaters of Clear Creek and Crazy Woman River, *F. Tweedy 3015* (RM). Park Co.: Olson's Meadow, *E. and D. Pearson 172* (RM). Sheridan Co.: Big Horn Mts., *J. Williams s.n.* (RM), *A. Nelson 8501* (RM). Sublette Co.: Fremont Lake, *E. and L. Payson 2834* (OSC, RM, UC, US); canyon above New Fork Lakes, *E. and L. Payson 4452* (GH); Horseshoe Lake, SE Pinedale, *C. L. Porter and B. Miller* 6069 (RM).

Arnica gracilis occurs on fairly exposed, rocky, alpine slopes or open sub-alpine meadows largely in the central Rocky Mountains. The close relationship of this taxon to *A. latifolia* has long been noted. Indeed, in his original description of *A. gracilis,* Rydberg (1897) noted it resembles a depauperate *A. latifolia.* Maguire (1943) considered *A. gracilis* a distinct species but called it "... a loose entity which is maintained as distinct from *A. latifolia* with some difficulty...". Cronquist (1955) and later Ediger and Barkely (1978) treated *A. gracilis* as a variety of *A. latifolia,* while Wolf and Denford (1984a) recently re-elevated it to specific status.

This confusion with *Arnica latifolia* is not surprising since Wolf and Denford (1984a) have demonstrated that *A. gracilis* is a hybrid between *A. latifolia* and *A. cordifolia.* Although it is somewhat intermediate betwen these two species, *A. gracilis* has several distinctive features of its own. These include a much more branched habit; narrower leaves; more numerous and smaller heads with a reduced number of disc florets; black, glandular achenes; and the dry, alpine habitat. *A. gracilis* is relatively common, is morphologically distinguishable from its two parents and is an autonomous apomict that maintains itself quite vigorously in nature. It "behaves as a species" (Davis and Heywood, 1963) and is therefore recognized as such in the present study.

5. **Arnica latifolia** Bong., Mem. Acad. St. Petersb. VI 2: 147. 1832. *Arnica latifolia α genuina* Herder, Bull. Soc. Nat. Mosc. 40: 424. 1867. TYPE: Sitka, Alaska, *Mertens s.n.* (LECTOTYPE by Maguire, LE photo!).

Arnica menziesii Hook., Fl. Bor. Am. 1: 331. 1834. *Arnica latifolia β angustifolia* Herder, Bull. Soc. Nat. Mosc. 40: 424. 1867. TYPE: Northwest coast of America, *Menzies s.n.* (HOLOTYPE, K photo!).

Arnica betonicaefolia Greene, Pittonia 4: 163. 1900. TYPE: Mt. Steele, Olympic Mountains, Washington, 6000–7000 ft., Aug., 1895, *C. V. Piper 2002* (HOLOTYPE, NDG!; ISOTYPE, GH!).

Arnica teucriifolia Greene, Pittonia 4: 164. 1900. *Arnica latifolia* Bong. var. *teucriifolia* (Greene) L. Williams, Leafl. West. Bot. 1: 171. 1935. TYPE: Grassy mountain slopes, divide between St. Joe and Clear Water River, alt. 1820 m, region of the Coeur d'Alene Mountains, Idaho, July 10, 1895, *J. B. Leiberg 1229* (HOLOTYPE, US!; ISOTYPES, MO!, NY!, POM!, UC!).

Arnica ovalifolia Greene, Pittonia 4: 168. 1900. TYPE: Big Horn Mountains, Wyoming, 9000–10000 ft., July 17, 1890, *Blankinship s.n.* (HOLOTYPE, NDG!).

Arnica ventorum Greene, Pittonia 4: 173. 1900. TYPE: Union Pass, Wind River Mountains, Wyoming, Aug. 11, 1894, *A. Nelson 836* (HOLOTYPE, NDG!; ISOTYPES, MO!, NY!, RM!, WS!).

Arnica grandifolia Greene, Pittonia 4: 173. 1900. TYPE: Bridger Pass, Montana, July 28, 1896, *J. H. Flodman 896* (HOLOTYPE, NDG!; ISOTYPES, MO!, US!).

Arnica platyphylla A. Nelson, Bot. Gaz. 31: 407. 1901. TYPE: moist dark fir forests, Cascade Mts., Foothills, Hood River, Oregon, July 18, 1896. *L. F. Henderson s.n.* (LECTOTYPE by Maguire, RM!).

Arnica laevigata Greene, Ottawa Nat. 15: 279. 1902. TYPE: by springs in woods, Chilliwack Valley, B.C., alt. 3000 ft., Aug. 5, 1901, *J. M. Macoun (Geol. Surv. Can. No. 26926)* (HOLOTYPE, NDG!; ISOTYPES, CAN!, NY!).

Arnica aprica Greene, Ottawa Nat. 15: 280. 1902. TYPE: open ground along streamlets, Chilliwack Valley, B. C., alt. 3500 ft., July 10, 1901, *J. M. Macoun (Geol. Surv. Can. No. 26284)* (HOLOTYPE, NDG, photo UC!; ISOTYPES, CAN!, NO!, NY!). The holotype is listed at NDG but has not been located by the staff.

Arnica jonesii Rydb., Fl. Rocky Mts., 979. 1917. TYPE: Alta, Wasatch Mountains, Utah, July 31, 1879, *M. E. Jones 1119* (HOLOTYPE, NY!; ISOTYPES, NY!, POM!, UTC!).

Arnica eriopoda Gandoger, Bull. Soc. Bot. Fr. 65: 38. 1918. TYPE: Cascade Mountains, Oregon, July 27, 1902, *W. C. Cusick 2914* (HOLOTYPE, US photo!; ISOTYPES, MO!, NY!, POM!, UC!).

Arnica aphanactis Piper, Proc. Biol. Soc. Wash. 33: 105. 1920. TYPE: Mt. Baker, Washington, 1915, *G. W. Turesson s.n.* (HOLOTYPE, US!).

Arnica flodmanii Rydb., N. Am. Fl. 34: 334. TYPE: Spanish Peaks, Madison Range, Montana, July 14, 1896, *J. H. Flodman 898* (HOLOTYPE, NY!; ISOTYPES, MO!, NY!, US!).

Arnica glabrata Rydb., N. Am. Fl. 34: 335. TYPE: Crater Lake, Oregon, August 1898, *Austin and Bruce 1627* (HOLOTYPE, NY!).

Arnica paucibracteata Rydb., N. Am. Fl. 34: 336. 1927. TYPE: Medicine Bow Mountains, Wyoming, Aug. 3, 1900, *A. Nelson 7941* (HOLOTYPE, NY!; ISOTYPES, MO!, POM!, RM!, US!).

Arnica oligolepis Rydb., N. Am. Fl. 34: 336. 1927. TYPE: Hazelton, Skeena River, B. C., June 23, 1917, *J. M. Macoun (Geol. Surv. Can. No. 96048)* (HOLOTYPE, NY!; ISOTYPE, CAN!).

Arnica leptocaulis Rydb., N. Am. Fl. 34: 336. 1927. TYPE: Mt. Mark, Vancouver Island, B. C., July 25, 1887, *J. M. Macoun s.n.* (HOLOTYPE, NY!; ISOTYPES, CAN!, US!).

Arnica membranacea Rydb., N. Am. Fl. 34: 338. 1927. TYPE: Wimmer, Jackson Co., Oregon, June 13, 1892, *E. W. Hammond 231* (HOLOTYPE, NY!; ISOTYPES, US!, WS!).

Stems simple, sometimes sparsely branched above, 10–50 cm high, 2–3 mm diameter, glabrate to villous throughout; rhizomes 1–3 mm thick, giving rise to several basal rosettes and flowering stems, rhizomes with several thin brown scales, frequently covered with old leaf bases at the summit. Cauline leaves 2–4(6) pairs, mostly sessile to sub-sessile, the lower rarely petiolate, ovate to elliptic-lanceolate, 2–10 cm long, 1–6 cm broad, glabrous to very sparsely villous, obtuse to acute, serrate to dentate; lower leaves sometimes reduced and short-petiolate, the petioles 5–15 mm long, broadly winged; leaves of the innovations 2–10, similar to cauline leaves, petiolate, the petioles 2–10 cm long. Inflorescence usually a single head or corymb of 3–5(9) heads; peduncle 3–25 cm long, glabrate to sparsely villous above; heads radiate, narrowly turbinate, 8–20 mm high; involucral bracts 8–20, lanceolate to oblanceolate, 8–15 mm long, 1–3 mm broad, sparsely villous and glandular, acute to acuminate. Ray florets 8–15, yellow, oblong-linear, 10–25 mm long, 2–6 mm broad, 3-dentate; disc florets 20–90, yellow, tubular, 6–10 mm long, sparsely villous; pappus of both ray and disc florets white, barbellate. Achenes dark brown, 5–9 mm long, 1 mm broad, sparsely short stipitate-glandular with few duplex hairs. Figure 9. Chromosome number $2n$ = 38, 76.

ECOLOGY AND DISTRIBUTION: Common in relatively moist, montane *Picea-Abies* forests, or more commonly sub-alpine meadows from southern interior and coastal Alaska south along the coast and through the Cascades to northern California, and south in the Rocky Mountains from the Yukon through southern Colorado. Also common on Vancouver Island and the Queen Charlotte Islands. Figure 10. Elevational distribution from 500–3300 m. Flowers July–August.

REPRESENTATIVE SPECIMENS: **Canada:** ALBERTA: Lake Louise, *W. Setchell s.n.* (UC); Banff-Jasper Hwy., *W. A. Weber 2490* (UC); Banff, *H. Davis s.n.* (ND); Mt. Edith Cavell, *T. McCabe 8355* (UC); Sheep Mt., *J. Macoun s.n.* (MICH); Vermillion Pass, *R. Ogilvie s.n.* (UBC); Castlemont, *M. Malte and W. Watson 488* (CAN); Mt. Temple, *A. E. Porsild and A. J. Breitung 13753* (CAN); Bow River Pass, *A. E. Porsild and A. J. Breitung 14929* (CAN); tower, Waterton Nat. Park, *W. Blais and J. Nagey 1639* (CAN); Snowshoe Cabin, Waterton Nat. Park, *G. Armstrong and J. Nagey 4554* (CAN); Crandell Lake, *G. Armstrong and J. Nagey 3874* (CAN); Cameron Lake, *G. Armstrong and J. Nagey 4094* (CAN); Crows Nest Lake, *Dawson 14756* (CAN); Red Rock Canyon, *F. Sudol 43* (DAO), Mt. Rowe, *A. J. Breitung 16979* (DAO); Bow Pass, *W. McCalla 6771* (ALTA); Lake Agness, *W. McCalla 3730* (ALTA); Bald Hills, *P. Kuchar 521* (ALTA); Marmot Mt., *W. McCalla 3105* (ALTA).

BRITISH COLUMBIA: E. end Summit Lake, *Calder and Saville 10015* (UC); Mt. Fougner at Bella Coola, *Calder and Saville 20373B* (UC); Khutze Inlet, *T. McCabe 3480* (UC); Harrison Creek, 20 mi. N. Takla Landing, *T. McCabe* (UC); Nine Mile Mt., *T. McCabe 8181* (UC); Mt. Revelstoke, *T. McCabe 5392* (UC); Apex Mt., *R. Bowerman s.n.* (UC); Green Mt., near Haylmore, *J. and E. Thompson 691* (MICH); Mt. Selwyn, *H. Raup and E. Abbe 4164* (CAS); Emerald Lake, *C. Shaw 993* (US); Ft. St. James, *Calder and Saville 13720* (DAO, US); Dam Mt., *W. Taylor 5993* (UBC); Grouse Mt., *V. Krajina s.n.* (UBS); 44 mi. NNW Dease Lake, *S. MacDonald 511* (CAN, UBC); 12 mi. NE Smithers, *V. Krajina et al s.n.* (UBC); Goodchap Mt., *D. Martin s.n.* (UBC); Gold Fish Lake, *A. Szczawinski 174* (UBC); Duckling Creek, Germansen Landing, *G. Noel 158* (UBC); Mt. Semour, *V. Krajina 333* (UBC); Beatton River, *H. M. Raup and D. Correll 10066* (GH); Glacier Nat. Park, *E. Haber 1508* (CAN); mi. 85 Haines Rd., *C. Clarke 442* (CAN); White Pass, *M. Malte 364* (CAN); Tunjony Lake, *R. Pilfrey 21* (DAO); Yanks Peak, *Calder et al 18083* (DAO); Alpine Mt., 12 mi. NNE Nelson, *Calder and Saville 11129* (DAO); Red Rose Mine, *Calder and Saville 15190* (DAO); Mt. McLean at Lillooet, *Calder and Saville 15505* (DAO); 75 mi. S. Haines Jct., *Calder and Kukkonen 28154* (DAO); lake in Coast Range, 58°41′N, 133°04′W, *R. Pilfrey 79* (DAO). Queen Charlotte Islands: 20 mi. S. Morseby Logging Camp, *Calder et al 23046* (CAS, DAO, OSC, UBC, UC); Lake Takakia, *Calder and R. Taylor 36296* (DAO). Vancouver Island: Green Mt., *V. Krajina et al 5004* (UBC); Mt. Arrowsmith, *G. Allen s.n.* (UBC); Shaw Creek, *W. Spreadborough 96037* (CAN); Moat Lake, *J. Underhill 327* (DAO); Crest Lake, *A. Young and W. Hubbard 580* (DAO).

Figure 9. *Arnica latifolia.*

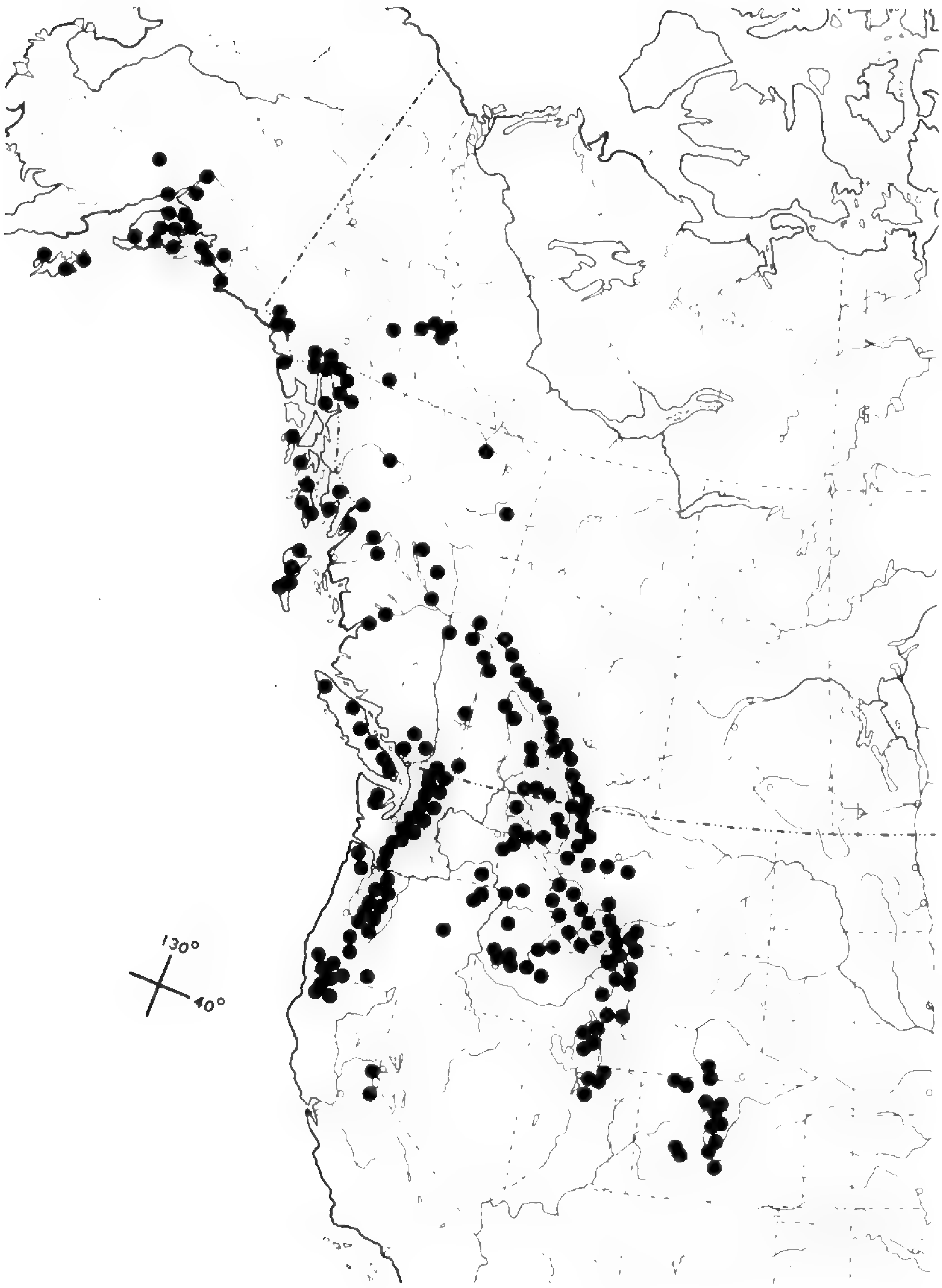

Figure 10. Distribution of *Arnica latifolia*.

NORTHWEST TERRITORIES: 62°46′N, 129°1′W, *L. Allison 29* (DAO).

YUKON TERRITORY: White Pass, *A. Eastwood 936* (UC); mi. 268, Canol Rd., *A. E. Porsild and A. J. Breitung 11374* (CAN, UC, US); mi 95, Canol Rd., *A. E. Porsild and A. J. Breitung 10228* (CAN, GH, UC, US, WTU); Upper Hyland Lake, *Calder and Kukkonen 27809* (CAS, DAO, GH); Kluane National Park, Alsek River, *G. and G. Douglas 8953* (DAO); Cassiar Mts., *W. Poole 49* (DAO); mt. 4 mi. W. Upper Hyland Lake, *Calder and Kukkonen 27909* (DAO); 62°11′N, 129°17′W, *L. Allison 40* (DAO).

United States: ALASKA: Hatcher Pass, *S. J. Wolf 503* (ALTA); Craig, *I. Norberg s.n.* (UC, US); Yakutat Bay, *F. Funston 79* (CAN, ND); Olga Bay, Kodiak Island, *S. Blake 553* (ND); Deer Mt., *F. Went 80* (UC); Yes Bay, *T. Howell 1634* (UC); Harris Peak, Prince of Wales Island, *D. Jaques 1569* (OSC); Indian River, Sitka, *L. Smith s.n.* (OSC); Duchess Mine, Latouche Island, *H. Shacklette 4704* (MICH); Cairn Ridge, near Juneau, *H. Shacklette* (MICH); Curry Lookout, *L. Jordal 2555* (MICH); Mt. Roberts, Juneau, *M. Williams 1392* (OSC); Kenai Lake, *J. Calder 6089* (CAS, DAO); Kuiu Island, *E. Walker 774* (CAS, US); 3 St's. Bay, Kodiak Island, *W. Eyerdam 602* (CAS, US); Eyak Lake, Cordova, *M. Hanna s.n.* (CAS); Skagway, *A. Eastwood 818* (CAS, US); Haines, *E. Scheuber s.n.* (US); Sitka, *C. Piper 4245* (US); Stikine Glacier, *W. Cooper 72* (US); Mt. Marathon, *J. Calder 5899* (UBC); Juneau, *E. Scamman 1123* (GH); Mt. Roberts, *A. and R. Nelson 4440* (GH); Mt. Crillion, *R. Bates 160* (GH); Barren Island, *I. Gabrielson s.n.* (GH); Alaska Range, 62°40′N, 152°30′W. *L. Viereck 5259* (CAN); Ketchican, *J. Anderson 2A691* (CAN); Orca, *I. Norbert s.n.* (CAN); Burma Rd., mi. 74, Richardson Hwy., *L. Spetzman 3319* (CAN); Palmer Creek Valley, SE Hope, *J. Calder 6233A* (DAO); Chugach Mts., Anchorage, *Dutilly et al 21143* (DAO).

CALIFORNIA: El Dorado Co.: S. side Echo Lake, *A. Heller 12544* (UC); Sugar Bowl Mt., *L. Kildale s.n.* (UC). Nevada Co.: Donner Pass, *A. Heller 7029* (MICH). Trinity Co.: Salmon Mts., Union Creek, *H. M. Hall 9648* (UC). Siskiyou Co.: Jackson Lake, *A. Alexander and L. Kellogg 183* (UC); Bolan Lake, *C. L. Hitchcock and J. Martin 5233* (UC), *S. J. Wolf 465* (ALTA); Hancock Lake Trail, Marble Mt. Wilderness, *F. Oettinger 460* (UC). Caribou Basin, Trinity Alps, *J. Howell* 13380 (CAS); 8.3 mi. from Etna on road to Sayer's Bar, *E. Balls 13942* (WTU), *S. J. Wolf 467* (ALTA).

COLORADO: Chaffee Co.: Monanos Creek, *I. Clokey 3500* (RM, UC). Clear Creek Co.: Loveland Pass, *S. J. Wolf 416* (ALTA). Gunnison Co.: Queen's Basin, *J. Langenheim 3908* (RM, UC). Lake Co.: Lake Creek, *I. Clokey 3515* (UC). Larimer Co.: Rocky Mt. National Park, Rainbow Curve Trail, *U. Waterfall 14958* (UC); Lock Vale, Estes Park, *I. Clokey 3962* (CAN, MICH, UC); Cameron Pass, *G. Osterhout 3795* (RM); Lake Helene Trail, Rocky Mt. National Park, *R. Ashton 70-g-7* (RM). Routt Co.: Hahn's Peak, *W. Weber 6929* (RM, WTU).

IDAHO: Bear Lake Co.: Bloomington Lake, *R. Davis 1613* (UC). Benewah Co.: Bald Mt., *W. Baker 13388* (OSC). Blaine Co.: 5 mi. from Alturas Lake, *C. L. Hitchcock and C. V. Muhlick 10534* (UC). Boise Co.: Jackson Peak, *C. L. Hitchcock and C. V. Muhlick 10026* (CAN, UC). Bonner Co.: Queen Mt., *W. Eggleston 9770* (US). Bonneville Co.: *E. Payson and G. Armstrong 3511* (RM). Custer Co.: 1 mi. E. Castle Peak, *C. L. Hitchcock and C. V. Muhlick 10913* (UC); Mt. Mogg, *C. L. Hitchcock and C. V. Muhlick 11236* (UC, WTU); 10 mi. S. Atlanta, *C. L. Hitchcock* *and C. V. Muhlick 10247* (RM, UC, WTU). Franklin Co.: 2 mi. SW Franklin Basin R. S., *B. Maguire 21643* (CAN, UC). Fremont Co.: Ponds Lodge, Targhee N. F., *W. Baker 9831* (OSC). Idaho Co.: Lolo Trail, 65 mi. E. Pierce, *C. L. Hitchcock and C. V. Muhlick 21921* (UC); Pilot Knob, *W. Elwood 36* (UC); Burnt Knob Lookout, *W. Baker 12638* (OSC). Lemhi Co.: 9 km S. Lost Trail Pass, *S. J. Wolf 488* (ALTA). Shoshone Co.: St. Maries River, *G. Wilson 103* (UC); 14 mi. E. Clarkia, *W. Baker 16208* (WTU). Valley Co.: Lick Creek Summit, *S. J. Wolf 357* (ALTA); Gold Fork Lookout, *J. Thompson 13745* (MICH, UC); Upper Payette Lake, *W. Baker 10357* (OSC).

MONTANA: Beaverhead Co.: Pintlar Falls, *C. L. Hitchcock and C. V. Muhlick 12784* (UC); Lake Waukena, *C. L. Hitchcock and C. V. Muhlick 13105* (OSC). Deerlodge Co.: Storm Lake, *C. L. Hitchcock and C. V. Muhlick 14830* (RM); Storm Lake Rd., *S. J. Wolf 435* (ALTA). Fergus Co.: Big Snowy Mts., 31 mi. SW Lewiston, *G. and F. Ownby 2417* (RM, UC). Flathead Co.: Bowman Lake, *R. Turley 212* (UC). Gallatin Co.: 8 mi. E. Eldridge, *C. L. Hitchcock and C. V. Muhlick 15149* (UC). Glacier Co.: Glacier National Park, *N. Carlson s.n.* (UC). Granite Co.: Burnt Fork Trail, *C. L. Hitchcock and C. V. Muhlick 14502* (WTU). Lake Co.: 10 mi. NE Polson, *J. Thomas 11051* (CAS). Lewis and Clark Co.: 25 mi. NW Agusta, *C. L. Hitchcock 17997* (RM, UC). Lincoln Co.: Mt. Marston Rd., *S. J. Wolf and P. and D. Wolf-Thompson 344* (ALTA) Madison Co.: Upper Brandon Lake, *C. L. Hitchcock 17045* (RM). Missoula Co.: 2 mi. E. Holland Lake, *C. L. Hitchcock 18357* (UC, WTU). Park Co.: 5 mi. E. Cooke City, *J. Witt 1755* (WTU). Powell Co.: 3 mi. W. Big Salmon Lake, *C. L. Hitchcock 17162* (WTU). Ravalli Co.: St. Mary's Creek, *C. L. Hitchcock and C. V. Muhlick* (CAN, UC). Stillwater Co.: Mt. Haystack, *C. L. Hitchcock and C. V. Muhlick 13429* (CAN, OSC, UC, WTU). Sweetgrass Co.: Crazy Mts., Big Timber Creek, *C. L. Hitchcock and C. V. Muhlick 13288* (OSC, UC).

OREGON: Clackamas Co.: SW. slope Mt. Hood, *H. and J. Thomas 248* (UC). Clatsop Co.: Saddle Mt., *S. J. Wolf 379* (ALTA); Onion Peak, *L. Heckard 1606* (UC), *K. Chambers 3149* (CAS, OSC, WTU); Sugarloaf Mt., *K. Chambers 3764* (OSC, WTU). Curry Co.: Iron Mt., *S. J. Wolf 457* (ALTA); above Agness, *E. Applegate 7153* (CAS). Douglas Co.: Black Rock Lookout, *D. Overlander s.n. 1944* (OSC). Grant Co.: Strawberry Mt., *W. Cusick 3565* (WTU). Harney Co.: Stein's Mt., *P. Train s.n.* (OSC). Hood River Co.: Mt. Hood, *P. Munz 14461* (UC). Jackson Co: Mt. Ashland, *M. Peck 2934* (OSC). Jefferson Co.: *J. Johnson 462* (OSC). Josephine Co.: Big Meadow, SE Oregon Caves, *E. Applegate 11243* (UC); Bolan Lake, *J. Thompson 12510* (UC, WTU); Sexton Mt., *L. Savage s.n.* (UC). Lane Co.: Fairview Mt., *L. Constance s.n.* (UC); Horse Pasture Mt., *M. Peck 23841* (OSC); Fairview Mt., *W. Baker 5565* (OSC, WTU). Linn Co.: Breitenbush, *M. Peck 18718* (UC); Mt. Jefferson, *M. Peck 9109* (OSC); Monument Peak, *A. Aller 812* (OSC). Marion Co.: 1 mi. E. Breitenbush, *M. Peck 18718* (OSC); House Mt., *M. Peck* (OSC). Union Co.: Anthony Creek, Blue Mts., *W. Cusick 3820* (WTU). Wasco Co.: 5 mi. W. Mosier, *J. Thompson 4224* (WTU). Washington Co.: Tillamook Burn, N. of Wilson River Hwy., *K. Chambers 4052* (OSC).

UTAH: Cache Co.: Tony Lake, *A. Holmgren and C. Biddulph 8172* (UC); Mt. Naomi, *B. Maguire et al 14154* (GH, UC, US). Duchesne Co.: Blind Stream Rd., NW Hanna, *S. J. Wolf 397* (ALTA). Salt Lake Co.: Big Cottonwood Canyon, *W. Cooper 329* (RM); *A. Garrett 1509* (RM). Summit Co.: Stillwater Ford, Uintah Mts., *E. and L. Payson 4995* (RM). Utah Co.: Mt. Timpanogos, *B. Maguire 17507* (UC).

WASHINGTON: Chelan Co.: Mt. Stuart, *J. Thompson 7685* (CAS, UC). Clackamas Co.: Mt. Hood, *J. Thompson 3403* (WTU). Clallam Co.: Hurricane Ridge, *W. and M. Muenscher 10004* (UC); Mt. Angeles, *J. Thompson 7522* (CAS, UC, WTU). Columbia Co.: 1.5 mi. E. Table Rock, Umatilla N. F., *A. Kruckenberg 2514* (UC). Grays Harbor Co.: Colonel Bob L. O., *J. Thompson 7245* (WTU). Jefferson Co.: Olympic Mts., Mt. Constance, *R. Rollins and T. Chambers 2654* (UC). King Co.: Goldmeyer Hot Springs, *J. Broadbent s.n.* (WTU). Kittitas Co.: Mission Peak, *J. Thompson 14913* (CAS, MICH, UC, WTU). Klickitat Co.: Mts. NE Bingen, *W. Suksdorf 2760* (WTU). Mason Co.: Mt. Ellinor, *W. Eyerdam 1276* (UC). Pierce Co.: Yakima Park, Mt. Rainier N. P., *B. Maguire 17260* (UC); Mt. Rainier, *L. Benson 2337* (UC); Chinook Pass, *W. Eyerdam s.n.* (UC); Cowlitz Pass, *J. Thompson 11102* (CAS, WTU). Skamania Co.: Big Lava Beds, *J. Franklin 448* (OSC); Mt. St. Helens, *F. Coville 747* (US, WTU). Snohomish Co.: Mt. Pugh, *J. Thompson 14351* (CAS, MICH, UC). Whatcom Co.: Mt. Baker, *W. Muenscher 8030* (UC). Yakima Co.: Chinook Pass, *J. Thompson 15136* (CAS, MICH, UC, WTU); Mt. Aix, *J. Thompson 15016* (CAS, MICH, UC, WTU).

WYOMING: Albany Co.: 7.4 mi. W. Centennial, *S. J. Wolf 422* (ALTA). Lincoln Co.: Jackson's Hole, *E. and L. Payson 2276* (UC). Sublette Co.: 26 mi. W. Big Pinney, *F. and L. Meyer 2369* (UC). Teton Co.: Skyline Trail, Teton N.P., *L. Wehmeyer et al 5450* (MICH); 1 mi. E. Togwotee Pass, *S. J. Wolf 431* (ALTA). Yellowstone National Park: Obsidian Creek, *A. and E. Nelson 6108* (UC).

Arnica latifolia is one of the most polymorphic and widely distributed of western arnicas. This taxon is common in relatively cool, montane *Picea-Abies* forests or sub-alpine meadows from Alaska through Colorado and northern California. In its most typical form *A. latifolia* is easily recognized by its sessile, ovate, glabrous leaves; very narrow heads with narrow phyllaries and rays; and glabrous, brown achenes. However, both environmentally induced morphological variability and plants with petiolate lower cauline leaves are sometimes encountered. Consequently, this taxon is sometimes confused with both *A. cordifolia* and *A. gracilis.* Plants of shaded forests represent the typical form of the species while plants of more exposed areas are usually much reduced; have thicker, smaller, more glandular leaves; have broader heads with more glandular phyllaries and are often confused with *A. gracilis.* However, they are readily separable from the latter by their broader, sessile, petiolate leaves and fewer heads. Pressed specimens of *A. latifolia* with petiolate lower leaves are sometimes confused with *A. cordifolia;* however, they can be readily distinguished by leaf shape, margin and pubescence, head and phyllary shape and achene color.

The type sheet of *Arnica betonicaefolia* consists of two collections: *C. V. Piper 2202* and *2002.* Both were collected on Mt. Steele, Washington, in August, 1895; however, the former was collected at

7000 ft. while the latter was collected at 6000 ft. Maguire (1943) reduced *A. betonicaefolia* to synonymy under *A. latifolia* and cited *2002* as the holotype while Ediger and Barkley (1978), who reduced this taxon under *A. gracilis,* cited *2202*. Both collections represent the reduced high alpine form of *A. latifolia* and have ovate, serrate, sessile leaves and solitary narrow heads typical of this taxon. There is really no question as to which collection represents the holotype of *A. betonicaefolia* since Greene (1900) clearly designated *2002*.

6. **Arnica nevadensis** A. Gray, Proc. Am. Acad. 19: 55. 1883. TYPE: Lassen's Peak, California, *R. M. Austin s.n.* (LECTOTYPE by Rydberg, GH!; SYNTYPE, Summit Valley, California, Sept. 25, 1882, *C. G. Pringle s.n.* NY!).

Arnica tomentella Greene, Pittonia 4: 166. 1900. TYPE: open woods in Middle Tule River, California, alt. 5500 ft., April–Sept. 1897. *C. A. Purpus 5625* (HOLOTYPE, US!; ISOTYPES, GH!, MO!, UC!).

Stems simple, 10–50 cm high, 1.5–2.5 mm diameter, short stipitate-glandular throughout and puberulent above, rhizomes 1–2 mm thick, with several brown scales and old leaf bases at the summit. Cauline leaves 2–3 pairs, ovate to elliptic, 3–8 cm long, 2–4 cm broad, short stipitate-glandular throughout, acute to rounded, entire to denticulate; petioles narrow to broadly winged, 1.5–4.0 cm long; upper pair of leaves sometimes reduced, sessile and lanceolate; leaves of the innovations 4–6, similar to cauline leaves. Inflorescence a single head or corymb of 3 heads, peduncle 4–15 cm long, stipitate-glandular and somewhat villous, heads radiate, campanulate-turbinate, 15–20 mm high; involucral bracts 10–16, oblanceolate, 10–17 mm long, 2–4 mm broad, stipitate-glandular, acute to acuminate. Ray florets 6–14, yellow, linear to broadly elliptic, 15–25 mm long, 4–6 mm broad, 3-dentate; disc florets 20–60, yellow, tubular, 8–10 mm long, short stipitate-glandular; pappus of both ray and disc florets white to tawny, barbellate to subplumose. Achenes dark gray, 6–9 mm long, 1 mm broad, stipitate-glandular throughtout. Figure 11. Chromosome number $2n = 76$.

ECOLOGY AND DISTRIBUTION: Relatively uncommon in fairly dry *Tsuga-Pinus* forests or exposed rocky slopes of the Sierra Nevada Mountains from south of Yosemite National Park, California and adjacent Nevada, northward irregularly to the north Cascades and Olympic Mountains of Washington. Also known from the Ruby Mountains of Nevada. Figure 12. Elevational distribution 1500–3000 m. Flowers July–August.

Figure 11. Lectotype of *Arnica nevadensis*.

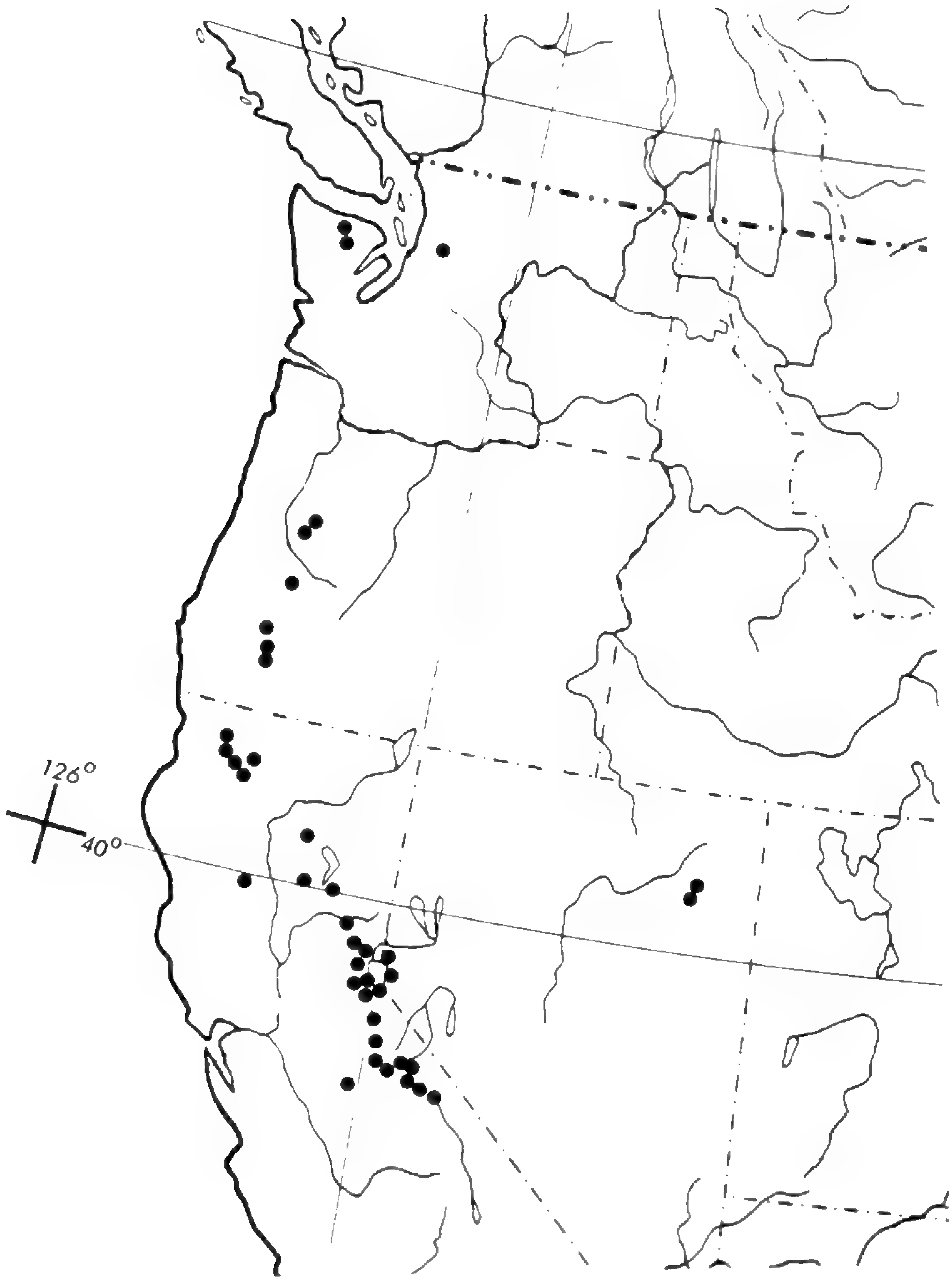

Figure 12. Distribution of *Arnica nevadensis.*

REPRESENTATIVE SPECIMENS: **United States:** CALIFORNIA: Truckee River, above Shingle Mill, *C. Sonne s.n.* (UC); open moist woods, middle Tule River, *C. Purpus 1540* (UC); Coburn Mill, *T. Brandegee s.n.* (UC); Middle Tule River, *C. A. Purpus 5625* (GH, UC, US). Amador Co.: *G. Hansen 416* (UC). Butte Co.: Jonesville, *A. Heller 12861* (OSC). El Dorado Co.: Fallen Leaf Lake, *G. L. Stebbins 2032* (UC); Angora Peaks, *H. M. Hall 8796* (UC); Velma Lakes Trail, above Eagle Lake, *G. Robbins 2054* (UC); Red Peak, *G. Robbins 1806* (CAS, UC); Fallen Leaf Lake, *M. Baker s.n.* (UC). Fresno Co.: Vidette Meadows, *J. Howell 24955* (CAS); Fish Camp, *P. Raven 5786* (CAS); Mills Creek, *P. Raven 5674* (CAS); Kip Camp, *P. Raven 7361* (CAS); Pocket Meadow, *P. Raven 6006* (CAS). Glenn Co.: Black Butte, *J. Howell 19250* (CAS). Inyo Co.: Flower Lake, *S. Austin 558* (UC); Big Pine Lakes, *J. Howell 23815* (CAS); Box Lake, *J. Howell 22445* (CAS); Rock Creek Lake, *J. Howell s.n.* (CAS). Madera Co.: Garnet Lake, *J. Howell 16479* (CAS); Shadow Lake, *P. Raven 3390* (CAS); Lake Ediya, *P. Raven 3527* (CAS). Mariposa Co.: Yosemite Park: Glacier Point, *H. M. Hall 9149* (UC); Fletcher Lake, *B. Schreiber 2013* (UC); Donohue Pass, *B. Schreiber 1787* (UC); Mt. Dana, *H. M. Hall and E. B. Babcock 3599* (UC); Lost Lake, *H. M. Hall 9068* (UC). Mono Co.: Mt. Lyell, *A. Hawbecker s.n.* (UC); Tiogo Crest, *H. Mason 11469* (UC); Harvey Monroe Hall Natural Area, *J. Clausen 1124* (UC), *P. Stockwell 1346* (CAS); Sonora Pass, *A. Eastwood* and *J. Howell 7565* (CAS). Nevada Co.: Stanford Peak, *A. Kellogg s.n.* (UC); Summit-Soda Springs, *Kennedy and Doten 274* (UC); Donner Pass, *J. Howell 18662* (CAS); S. side Donner Lake, *A. Heller s.n.* (CAS). Placer Co.: Mt. Anderson, *C. Sonne s.n.* (CAS, UC); Truckee River, *C. Sonne 7* (CH, UC); Truckee, *C. Sonne 27* (GH). Plumas Co.: Gold Lake Road, *J. Ewan 8206* (UC). Shasta Co.: Helen Mt., *G. Gillett 1078* (CAS); Lassen Peak, *R. M. Austin s.n.* (GH); Lassen National Park, *F. Hermann 11956* (UC). Sierra Co.: Gold Lake, *H. Baker 82* (CAS). Siskiyou Co.: Taylor Lake, *D. Barbe 129* (UC); Medicine Lake, *H. Baker 502* (UC); Upper English Lake, *F. Oettinger 1082* (UC); Wildcat Peak, *Alexander and Kellogg 204* (UC); Marble Mt., *H. Chandler 1615* (CAS). Tehma Co.: Brokeoff Mt., *G. Gillett 1066* (CAS). Tuolumne Co.: Elizabeth Lake, *H. Mason 692* (UC); Johnson Peak, *C. Sharsmith 217* (UC); peak between Matterhorn and Whorl Mts., *C. Sharsmith 3826* (UC). Trinity Co.: Grizzly Creek, Trinity Alps, *E. Carter 1011* (CAS).

NEVADA: Elko Co.: Three Lakes, Ruby Mts., *A. Borell s.n.* (UC). Clover Mts., near Deeth, *A. Heller 9242* (UC). Ormsby Co.: Fall Creek, *C. Baker 1432* (CAS, MICH, RM, UC, US). Washoe Co.: White Creek, E. slope Mt. Rose, *P. Train 4420* (UC).

OREGON: Douglas Co.: Mt. Bailey, *C. Geddes 18670* (OSC). Klamath Co.: Crater Lake National Park: Union Peak, *J. Simpson 9* (UC); Garfield Peak, *W. Baker 6184* (OSC, UC); *E. Applegate 9851* (CAS, OSC); W. Baker 7203 (WTU); Hillman Peak, *W. Baker 6401* (UC); *H. Sullen s.n.* (OSC). Lane Co.: N. Sister Mt., *M. Peck 14473* (CAS, OSC).

WASHINGTON: Chelan Co.: Nason Creek valley between Berne and Cascade, *I. Otil s.n.* (CAS). Clallam Co.: Mt. Angeles, *J. Flett 3325* (US). Jefferson Co.: Marmot Pass, Olympic National Forest, *J. Thompson 9907* (WTU).

Arnica nevadensis occurs mostly at high elevations in open *Tsuga–Pinus* forests or open rocky slopes of the Sierra Nevada and sparingly northward in the Cascades and eastward into Nevada. In the southern part of its range this species is quite distinct and readily recognized by its entire, elliptic to ovate leaves; oblanceolate phyllaries; white-tawny, barbellate-subplumose pappus and relatively open, high altitude habitat. However, in the northern part of its range it is often confused with dwarf, high altitude forms of *A. cordifolia*. However, the entire leaves, darker pappus with longer seta and narrower heads of *A. nevadensis* distinguish it from the latter.

In his original description of *Arnica nevadensis*, Gray (1883) did not designate a type; however, he cited two specimens he had examined: *R. M. Austin s.n.*, Lassen's Peak, California (GH) and *C. G. Pringle s.n.* 1882, Summit Valley, California (NY). In his Flora of North America, Rydberg (1927) designated the first specimen cited (Austin) as the lectotype for this species. This choice was also later accepted by Maguire (1943). However, recently Ediger and Barkely (1978) rejected Rydberg's choice as arbitrary and designated the second specimen cited (Pringle) as the lectotype "... in order to preserve the traditional application of the name." According to the rules of the International Code of Botanical Nomenclature (Stafleu *et al*, 1978) this practice cannot be accepted without proper justifiction. Both Article 8 and the Guide to the Determination of Types specifically state that the first choice of a lectotype must be followed by subsequent workers unless it can be shown that the choice was based on a misinterpretation of the protologue or if the choice was made arbitrarily and without understanding the group concerned.

Ediger and Barkley (1978) based their decision on Recommendation 7B which states "Whenever the elements on which the name of a taxon is based are heterogeneous, the lectotype should be be selected as to preserve current usage ..." Although poorly pressed, the ovate, entire leaves, as well as the broad rays and tawny, subplumose pappus of the Austin specimen are typical of *A. nevadensis*. Further, it seems clear that Gray's (1883) description was based on the Austin specimen. He made specific reference to the cinereous color in both the type description and the discussion of the Austin specimen, while noting that the Pringle specimen was a "greener form". Although Rydberg (1927) gave no reason for his choice of the Austin specimen at the Gray Herbarium, he must have given it close examination since it would have been much easier for him to cite the Pringle specimen at the New York Botanical Garden.

Rollins (1972) has stressed the importance of selecting a lectotype from the institution where the author worked. Since both specimens cited by Gray (1883) are referable to *A. nevadensis,* but the first cited (Austin s.n.) was originally chosen as the lectotype by Rydberg (1927) and later accepted by Maguire (1943), it must be retained as the lectotype for this species.

Both Maguire (1943) and Ediger and Barkley (1978) recognized the rare *Arnica tomentella* of the Sierra Nevada. Maguire (1943) considered *A. tomentella* a close relative of *A. nevadensis.* This decision is not surprising since even a casual comparison of his (Maguire, 1943) description of the two taxa indicated they are nearly identical in most respects including: stem pubescence, leaf shape and margin, head shape, phyllary and ligule shape and all characters of the pappus. Only the taller stature and tuft of hairs on the phyllary tips distinguish *A. tomentella* from *A. nevadensis. A. nevadensis* is an apomictic, polyploid complex (Barker, 1967; Straley, 1980; Wolf, 1980) and the form previously recognized as *A. tomentella* probably represents an apomictic microspecies of the former.

Three specimens (*J. P. Tracy 19273* UC, *C. F. Sonne s.n.* UC #193450 and *G. D. Butler 643* UC) previously recognized as *Arnica tomentella* are *A. cordifolia.* Other specimens previously recognized as *A. tomentella* (*Lemmon s.n.* UC #337194; *C. F. Sonne s.n.,* June 6, 1886, GH, UC; *C. A. Purpus 1540* UC; *T. S. Brandegee s.n.* UC #91026; *C. A. Purpus 5625* GH, MO. UC, US) are all treated here as *A. nevadensis.* Another collection previously identified as *A. tomentella* (*Bolander 4937* UC) is *A. mollis* Hook.

7. **Arnica spathulata** Greene, Pittonia 3: 103. 1896. TYPE: Glendale, Oregon, June 30, 1887, *T. Howell s.n.* (HOLOTYPE, NDG!; ISOTYPES, CAN!, US!).

Arnica eastwoodiae Rydb., N. Am. Fl. 34: 343. 1927. *Arnica spathulata* Greene subsp. *eastwoodiae* (Rydb.) Maguire, Brittonia 4: 458. 1943. *Arnica spathulata* Greene var. *eastwoodiae* (Rydb.) Ediger and Barkley. N. Am. Fl. II. 10: 43. 1978. TYPE: Gasquet, French Hill, Del Norte Co., California, Sept, 14, 1912, *A. Eastwood 221* (HOLOTYPE, NY!; ISOTYPES, NY!, US!).

Arnica cusickii Rydb., N. Am. Fl. 34: 343. 1927. TYPE: dry western slopes, Cascade Mountains, southern Oregon, July 11, 1902, *W. C. Cusick 2873* (HOLOTYPE, NY!; ISOTYPES, MO!, ORE!, POM!, UC!, US!).

Stems simple to several branched, 15–50 cm high, 2–3 mm diameter, sparsely to densely villous and stipitate-glandular throughout; rhizomes giving rise to several basal rosettes and flowering stems, 2–3 mm thick, covered with scales and old leaf bases at the summit. Cauline leaves 3–5 pairs, sometimes crowded towards stem base and reduced above, spathulate to elliptic-ovate, 2–8 cm long, 1–4 cm broad, sparsely to densely villous and stipitate-glandular, acute, sub-entire to mostly irregularly dentate; petioles mostly broadly winged, 1–9 cm long, 2–15 mm broad; leaves of the innovations 4–10, similar to cauline leaves. Inflorescence a solitary head or corymb of 3–9(25) heads; peduncles 2–20 cm long, sparsely to densely villous and long stipitate-glandular; heads discoid, turbinate-campanulate, 15–28 mm high; involucral bracts 8–15, broadly to narrowly lanceolate, 5–15 mm long, 1–4 mm broad, sparsely to densely villous and stipitate-glandular, acute to obtuse. Florets 15–50, yellow, tubular, 8–11 mm long, sparsely villous and glandular below; pappus white, barbellate. Achenes black, 5–10 mm long, 1 mm broad, sparsely short stipitate-glandular. Figure 13. Chromosome number $2n = 38, 76$.

ECOLOGY AND DISTRIBUTION: Relatively rare and forming small populations in dry, open *Pinus-Quercus-Pseudotsuga menziesii* forests or such disturbed areas as roadcuts. Largely restricted to serpentine soils in Curry, Douglas, Jackson and Josephine Counties, Oregon and Del Norte and Siskiyou Counties, California. Figure 14. Elevational distribution 200–1500 m. Flowers April–July.

REPRESENTATIVE SPECIMENS: **United States:** CALIFORNIA: Del Norte Co.: Douglas Park, on Smith River, *J. Thompson s.n.* (CAS, NY); Smith River Canyon, 15 mi. E. Crescent City, *Ripley and Barneby 6798* (NY); Gasquet, *A. Eastwood 2211* (NY, US); French Hill, 2 mi. S. Gasquet, *J. Tracy 11461* (UC); Smith River at 18 mi. Creek, 3 mi. E. Gasquet, *J. Tracy 12284* (UC); Old Gasquet Toll Road, *J. Tracy 11208* (UC); State Line, N. Monumental, *J. Tracy 19423* (UC); Hayne's Flat Rd. on Coon Mt., *J. Tracy 18921* (UC); Grade from Patrick Creek to Shelly Creek, *A. Eastwood and J. Howell 3667* (CAS); Gasquet, *M. Peacock s.n.* (CAS); French Hill, *A. Eastwood 2211* (CAS); Patrick Creek, *A. Eastwood 12120* (CAS); Gasquet Mt., *A. Eastwood 12155* (CAS); along Hwy. 99, 3.2 mi. N. Gasquet, *D. Breedlove 3146* (CAS); Gasquet, *Parks and Tracy 11208* (UC); French Hill, *S. J. Wolf 458* (ALTA); 10 km N. Gasquet, *S. J. Wolf 459* (ALTA); 5.8 km NW Patrick, *S. J. Wolf 387* (ALTA). Siskiyou Co.: Humbug Mt. *G. Butler 985* (UC); Raspberry Lake, *D. Kildale 8706* (CAS).

OREGON: Curry Co.: 13 mi. SE Port Orford, *M. Peck 8933* (GH, OSC); Agness, *M. Peck 2794* (OSC); Iron Mt., *W. Baker 5677* (UC); Snow Camp, *J. Thompson 31* (CAS). Douglas Co.: Glendale, *T. Howell s.n.* (CAN, NDG, US). Jackson Co.: Wimer, *E. Hammond 230* (US). Josephine Co.: Caves City, *L. Rose 34218* (CAS,

Figure 13. *Arnica spathulata.*

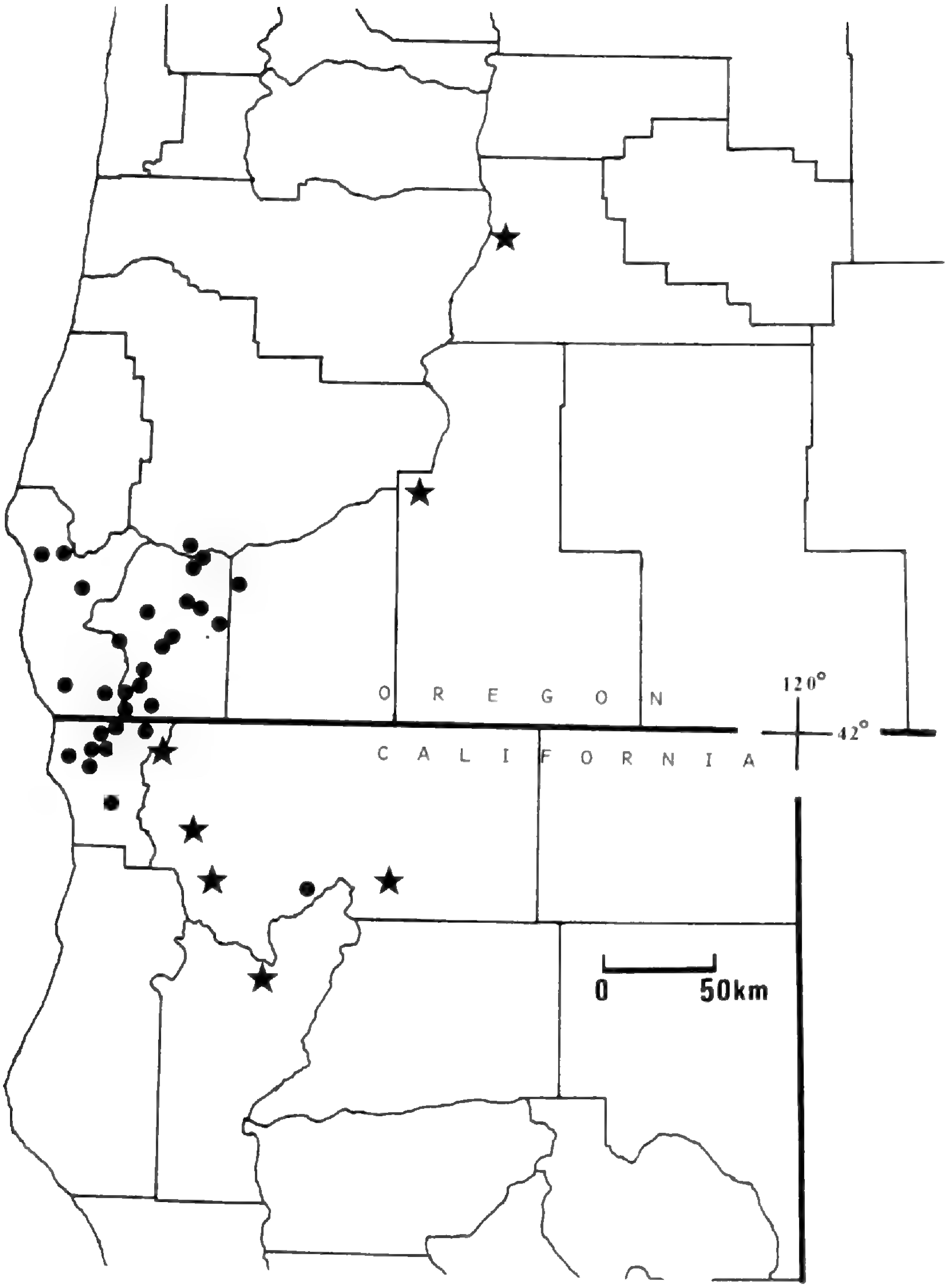

Figure 14. Distribution of *Arnica spathulata* ● and *Arnica viscosa* ★.

MICH, UC); 2 mi. S. Union Mt. Lookout, 12 mi. W. Waters Creek, *C. L. Hitchcock and J. Martin 5125* (CAS, UC, WTU); Oregon Mt., *A. Kruckeberg 1871* (UC), *A. Sweetser s.n.* (UC); Kerby, *L. F. Henderson s.n.* (OSC, UC); Grants Pass, *T. Howell s.n.* (MICH, OSC); Rough and Ready Creek, *E. Meola 99* (OSC); hwy. 99, 1 mi. N. Cave Jct., *K. Chambers 2912* (CAS, OSC); Hellgate, Rogue River, *M. Peck 8933* (OSC); Wonder Post Office, *M. Peck 23777* (OSC); 12 mi. W. Waldo, *M. Peck 2916* (OSC); Merlin, *L. Smith s.n.* (CAS); Finch Ranch, near Kirby, *L. F. Henderson 5900* (CAS); 2 mi. S. Wolfcreek, *Ripley and Barneby 9552* (CAS, NY); Waldo Jct., *D. Kildale 9623* (CAS); Selma, *N. Gale 14* (CAS), *H. and S. Parks 5947* (UC); Grants Pass, *T. Howell 131* (US), *C. Piper s.n.* (US), *Hammond 250* (NY); Caves Jct., near Kirby, *L. Rose 34218* (NY); 10 mi. S. Waldo, *J. Tracy 4617* (CAS); 17 km. N. Patrick, *S. J. Wolf 460* (ALTA); 20 km N. Patrick, *S. J. Wolf 461* (ALTA); Hugo, *S. J. Wolf 455* (ALTA); Merlin, *S. J. Wolf 456* (ALTA); Store Gulch Guard Station, *S. J. Wolf 462* (ALTA); Babyfoot Lake, *S. J. Wolf 384* (ALTA).

Arnica spathulata is a relatively rare, predominantly serpentine endemic, and occurs in dry, open forests at mid elevations in the Coast Ranges of the Klamath region. As previously noted (Wolf and Denford 1984b), this species is almost certainly derived from *A. discoidea.* However, it is readily distinguished by its spathulate, broadly winged, petiolate leaves, broader phyllaries and larger, black achenes which lack duplex hairs.

In more exposed habitats specimens of *Arnica spathulata* are often smaller, less hairy, with narrower, frequently reddish leaves crowded towards the base. Plants of this form have previously been recognized as *A. eastwoodiae* by Rydberg (1927). Maguire (1943) tentatively recognized this taxon as a subspecies of *A. spathulata* but noted it may, in fact, only represent an environmentally reduced form. These characters are probably environmentally induced and no correlations between morphology, chromosome number, geography or flavonoid chemistry could be discerned in this form (Wolf, 1981; Wolf and Denford, 1984b). Therefore it has not received formal taxonomic recognition in the present study.

In his original description of *Arnica spathulata* Greene (1896) did not designate a type or refer to any specimens examined. Maguire (1943) later designated a Howell specimen at the U.S. National Herbarium as the lectotype for this taxon (*T. Howell s.n.* Glendale, Oregon, June 30, 1887 (erroneously cited as June 3)). However, a specimen of *A. spathulata* on which Greene had written "Actual type of my *A. spathulata,* Pitt. iii, 103!" has been located in his personal herbarium at Notre Dame University. According to Article

8 of the International Code of Botanical Nomenclature (Stafleu *et al.,* 1978) this specimen supersedes Maguire's (1943) lectotype and is here treated as the holotype of *A. spathulata.* Both the U. S. National Herbarium specimen, previously chosen as lectotype, as well as a specimen at the National Museum of Canada are of the same collection as the holotype and are here recognized as isotypes.

8. **Arnica venosa** H. M. Hall, Univ. Calif. Publ. Bot. 6: 174. 1915. TYPE: Salt Creek, Shasta Co., California, alt. 430 m *H. M. Hall and E. B. Babcock 4013* (HOLOTYPE, UC!; ISOTYPES, GH!, NY!, RM!, UC!, US!).

Stems simple to 3-several branched, prominently ribbed, 20–60 cm high, 2–5 mm diameter, densely pilose and stipitate-glandular above to less so below; woody caudex 3–5 mm broad, covered with dark scales and old leaf bases. Basal rosettes lacking; cauline leaves 6–10 pairs, the middle largest, becoming reduced and bract-like above and scale-like below, broadly sessile or rarely short-broadly petiolate, ovate-elliptic to broadly lanceolate, 3–7 cm long, 1.5–4 cm broad, firm, 3–5 nerved above, strongly reticulate-veined below, glabrate to stipitate-glandular above, pilose and stipitate-glandular below, especially on veins below, acute to obtuse, irregularly and coarsely serrate. Inflorescence a solitary head on each branch, 1–7; peduncle 2–5 cm long, densely pilose and stipitate-glandular toward summit; heads discoid, turbinate-campanulate, 15–22 mm high; involucral bracts 8–19, 8–16 mm long, 3–5 mm broad, ovate to broadly lanceolate, pilose and stipitate-glandular, acute to obtuse. Florets 30–60, yellow, tubular, 8–10 mm long, densely pilose below; pappus white, barbellate. Achenes dark gray, angled and ribbed, 6–8 mm long, 1.5 mm broad, densely hirsute with duplex hairs. Figure 15. Chromosome number $2n = 38$.

ECOLOGY AND DISTRIBUTION: An extremely rare species of very dry, open *Pinus-Quercus* forests or, more commonly, of such disturbed sites as road cuts. Known from about thirty small populations, largely in western Shasta County and adjacent Trinity County, California. Figure 2. Elevational distribution 400–1400 m. Flowers May–June.

REPRESENTATIVE SPECIMENS: **United States:** CALIFORNIA: Shasta Co.: Salt Creek, *Hall and Babcock 4013* (GH, NY, RM, UC, US); Castella, *L. E. Smith 348* (CAS); Iron Mt., *L. E. Smith s.n.* (CAS, UC); road to Shasta Bally, 2.2 km S. Brandy

Figure 15. *Arnica venosa.*

Creek, S. Whiskeytown Lake, *G. Straley 1791* (UBC), *S. J. Wolf 469* (ALTA); bluff above mining road, E. of town of Iron Mt., *W. Barker 227* (WTU). Lamoine Quad: Baker Pine Plantation, W. of I-5, T36N, R5W, sec. 2, *S. Horner 112* (STNF), *G. Straley 1793* (UBC), *S. J. Wolf 468* (ALTA); Shell Mtn. Quad: 0.5 mi inside National Forest Boundary, Trinity Mt. Rd., T34N, R7W, sec. 10, *B. Williams 251* (STNF); W. of Dog Creek Rd. between Tollhouse and Grouse Springs, 7 mi. W. Delta, T35N, R6W, sec. 3, *B. Williams 369, 370, 371* (STNF), *M. Taylor 3195* (STNF); above forest service road, 1 mi. NW Damnation Peak, T36N, R6W, sec. 22, *M. Taylor 3196* (STNF). Trinity Co.: Swift Creek Rd., 0.7 mi. W. Hwy. 3, W of Trinity Center, T36N, R7W, sec. 18, *B. Williams 363* (STNF).

Arnica venosa is probably one of the rarest and most geographically restricted species of *Arnica.* It is known from about thirty populations, all within a 25 km radius, largely in western Shasta County, California. It is restricted largely to north-facing slopes, at elevations of 400–1400 m, in open *Pinus–Quercus* forests or more commonly on such disturbed sites as road cuts. Until very recently *A. venosa* was known from only six populations and, consequently, appeared on the California list of rare and endangered species (Smith *et al.,* 1980). However, based largely on the efforts of Ms. Barbara Williams of the Shasta-Trinity National Forest, many more populations have recently been discovered. The authors are greatly indebted to Ms. Williams for providing considerable information on *A. venosa* including both herbarium specimens and highly detailed and complete ecological observations.

In its typical form *Arnica venosa* is readily recognized by its rather stout, leafy stem; woody caudex; absence of innovations and broadly sessile, ovate-elliptic, reticulate-veined, coarsely dentate, very firm leaves. Since few specimens were available for examination, previous studies have concluded that this taxon exhibits little variability (Maguire, 1943; Straley, 1980). However, the availability and study of many newly collected specimens have revealed that *A. venosa,* like most other *Austromontana* species, exhibits considerable morphological variability and it appears to intergrade with *A. discoidea.* As previously noted (Wolf and Denford, 1984b), this taxon is probably derived from *A. discoidea.* At one extreme are typical forms of *A. venosa* with leafy stems and broadly sessile, veined leaves such as the type collection *Hall and Babcock 4013* (GH, NY, RM, UC, and US); *S. J. Wolf 468, 469* (ALTA) and *B. L. Williams 251* (STNF). At the other extreme are such specimens as *B. L. Williams 371* (STNF) with weakly veined, long, narrowly petiolate leaves more characteristic of *A. discoidea.* This specimen is an otherwise typical form of *A. venosa* and is characteristically highly branched above with very reduced leaves. Additionally, it was collected near a population of *A. discoidea* and may represent some introgression from that species. However, without further evidence a hybrid hypothesis would be difficult to support. Another seemingly intermediate form is represented by *B. L. Williams 250* (STNF) which has very typical upper leaves, leafy stems and floral characters but has narrowly petiolate leaves below the mid-stem.

Whether these intermediate forms represent introgression between *Arnica discoidea* and *A. venosa* or natural variability in the latter is unclear. It is clear, however, that these two species are more similar than previously demonstrated. The flavonoid profile of *A. venosa* is a subset of that of *A. discoidea* and it is hypothesized that the former is a relatively recent derivative of the latter (Wolf and Denford, 1984b).

9. **Arnica viscosa** A. Gray, Proc. Am. Acad. 13: 374. 1878. TYPE: Mt. Shasta, California, 8000′, Sept. 1877, *J. D. Hooker and A. Gray s.n.* (HOLOTYPE, GH!).

Raillardella paniculata Greene, Erythea 3: 48. 1895. TYPE: near the limit of trees on Mt. Shasta, California, Aug. 4, 1894, *W. L. Jepson s.n.* (HOLOTYPE, NDG!).
Chrysopsis shastensis Jepson, Man. Fl. Pl. Cal. 1037. 1925. TYPE: Horse Camp, Mt. Shasta, California, 1000 ft., *W. L. Jepson 59i* (HOLOTYPE, JEPS!). In his original publication Jepson cited number *51i* as the holotype; however, according to his notes (Robbins, annotation on type sheet) as well as his designation of "Type" on number *59i*, this latter specimen is the holotype, and a typographical error occurred on publication.

Stems usually several branched, prominently ribbed, 20–50 cm high, 3–5 mm diameter, strongly stipitate-glandular, also becoming densely pilose above; woody caudex 3–5 mm broad, covered with dark scales, lacking basal rosettes; leaves numerous, 5–10 pairs on main stem, 2–6 pairs on branches, sessile, ovate-oblong to obovate-oblong, (1)2–4(5) cm long, 1–3 cm broad, sparsely to densely pilose and densely stipitate-glandular, more or less acute, entire. Inflorescence of 10–20 heads, peduncles 0.5–5 cm long, stipitate-glandular and pilose; heads discoid, narrowly turbinate, 1–2 cm high; involucral bracts 10–20, 6–10 mm long, 1–3 mm broad, broadly lanceolate, stipitate-glandular and pilose below, acute. Florets 10–30, cream colored, tubular, 6–10 mm long, stipitate-glandular;

pappus white, rarely tawny, barbellate to subplumose. Achenes dark gray, ribbed 4.5–6.5 mm long, 1 mm broad, stipitate-glandular. Figure 16. Chromosome number $2n = 38$.

ECOLOGY AND DISTRIBUTION: A very rare species of dry, exposed, pumice slopes at elevations of 1750–2500 m. Known localities in Oregon include three small populations in Crater Lake National Park, Klamath County and a single collection from the Three Sisters area of Deschutes County. Also known from four populations in Siskiyou County, California, a large population on Mt. Shasta, two populations in the Marble Mountains and a single collection from Preston Peak. An additional population is known from the Trinity Alps, Trinity County, California. Figure 14. Flowers August–September.

REPRESENTATIVE SPECIMENS: **United States:** CALIFORNIA: Siskiyou Co.: Mt. Shasta, *A. Eastwood 2055* (CAS, GH, UC), *W. B. Cooke 9228* (UC), *W. L. Jepson s.n.* (ND), *R. Bohmannson s.n.* (CAS); Horse Camp, Mt. Shasta, *J. D. Hooker and A. Gray s.n.* (GH), *W. B. Cooke s.n.* (UC), *11501* (CAS, DS, GH, OSC, UC), *13833* (CAS, DS, ND, NY, OSC, UC), *17828* (CAS, WTU), *P. Kamb 1488* (UC), *W. L. Jepson 59i* (JEPS), *W. Dress 3735* (UC), *A. A. Heller 13519* (CAS, DS, NY, US, WTU), *W. Barker 232* (WTU), *G. Straley 1411* (UBC), *S. J. Wolf 391* (ALTA); S. slope above ski lodge, Mt. Shasta, *R. Thorne and F. Oettinger 39010* (NY, RSA, UC); near Wagon Camp, Mt. Shasta, *M. De'Evelyn s.n.* (CAS); between Panther Meadow and ski lift, Mt. Shasta, *P. Hutchinson 938* (JEPS, K, US); South Gate, Mt. Shasta, *W. B. Cooke 25603* (GH, NY, WTU); Medicine Mt., 41°33′48″, 121°36′30″, *G. L. Clifton, s.n.* (PUS); Devils Punchbowl, 41°48′24″, 123°40′36″, *D. V. Hemphill s.n.* (PUA); Preston Peak, *C. A. Ground s.n.* (PUA); Upper English Lake, 41°24′36.2″, 123°12′53″, *F. W. Oettinger 668* (HSC, PUA, UC); Cliff Lake, *G. Muth s.n.* (PUA); Avalanch Gulch, 41°22′10″, 122°13′39″, *W. B. Cooke 2000* (UC). Trinity Co.: Trinity Alps: Boulder Creek, *W. J. Ferlatte 1286* (HSC, NY, UC); *W. J. Ferlatte 484* (HSC); Mirror Lake, *J. P. Smith 2361* (HSC).

OREGON: Deschutes Co.: Three Sisters area, Moraine Lake, E. Rock Mesa and S. of South Sister, *G. Van Vechten 219* (GH, OSC). Klamath Co.: Crater Lake National Park: Union Peak, *J. Mees s.n.* (CLNP), *F. Colville 1420* (RM, UC), *E. Applegate 10090* (CLNP); Hillman Peak, *E. Applegate 10126* (CLNP), *10134* (CAS); shore under Watchman Peak, *E. Applegate 9218* (CAS, CLNP); Wizard Island, *A. A. Heller s.n.* (CAS), *13820* (US); Garfield Peak, *W. Baker 7201* (NY, WTU), *G. Straley 1946* (UBC), *S. J. Wolf 511* (ALTA).

Arnica viscosa is one of the rarest and probably the most distinctive species of the genus *Arnica.* This species is restricted to volcanic soils and occurs on very open, rocky slopes at high elevations in the Cascades of northern California and southern

Figure 16. *Arnica viscosa.*

Oregon. It is known from a few populations in Crater Lake National Park, Oregon; Mt. Shasta, the Trinity Alps, Marble Mountains and Preston Peak, California. An additional collection was once made in the Three Sister Area of the central Oregon Cascades (*G. van Vechten 219* OSC, GH); however, repeated attempts by several workers, including the senior author, have failed to relocate this population.

Arnica viscosa is quite distinctive and easily recognized by its woody caudex; leafy branching habit; small, sessile, entire leaves; and narrow heads with cream-colored florets. In addition, virtually all parts of the plant are densely covered with long glandular hairs, so much so that it feels slimy to the touch. Additionally, it has a very distinctive odor which is retained almost indefinitely on herbarium sheets. All known collections of *A. viscosa* have been examined and this species appears to exhibit virtually no interpopulational variation. In fact the only atypical specimens examined were from Upper English Lake, Siskiyou Co., California (*F. Oettinger 668* HSC, UC). These plants were less viscid and the upper leaves and branches had a tendency to be sub-opposite to alternate.

The underground parts of *Arnica viscosa,* including the caudex and root sytem, are quite woody. This character is probably an adaptation to its rocky, relatively disturbed habitat on very steep slopes. Much of the root system is exposed, probably due to rock movement associated with heavy winter snows and runoff.

EXCLUDED TAXA

A. latifolia Bong. var. *viscidula* A. Gray, Syn. Fl. N. Am. 1: 381. 1884. TYPE: Sierra Nevada Mts., California, Sept. 25, 1882, *C. G. Pringle 2* (HOLOTYPE US!) ≡ *A. diversifolia* Greene, Pittonia 4: 171. 1900.

A. granulifera Rydb., Fl. Rocky Mts., 978. 1917. TYPE: Long Baldy, Little Belt Mt., Montana, Aug. 19, 1896, *J. H. Flodman s.n.* (HOLOTYPE, NY!) ≡ *A. mollis* Hook., Fl. Bor.-Am. 1: 331. 1834.

A. ovalis Rydb., N. Am. Fl. 34: 338. 1927. TYPE: Crowsnest Pass, Canadian Rocky Mts., *J. M. Macoun* (*Can. Geol. Surv. No. 72719*) (HOLOTYPE, CAN!) ≡ *A. mollis* Hook., Fl. Bor.-Am. 1: 331. 1834.

ACKNOWLEDGMENTS

We thank John Bain for providing additional collections and Barbara Williams for sharing ecological and locality data for *A. venosa.* Financial support from the Boreal Institute for Northern Studies, California Native Plant Society and NSERC Canada is gratefully acknowledged. We also thank the curators and staff of the following herbaria for supplying loans and/or accommodating visits: ALA, ALTA, BM, BRY, CAN, CAS, DAO, DS, GH, HSC, JEPS, K, LCU, LE, MICH, MO, MONT, ND, NDG, NY, ORE, OSC, POM, PUA, RENO, RM, RSA, UBC, UC, UCSB, US, UTC, WISC, WS, WTU, Crater Lake National Park (here designated CLNP), Shasta-Trinity National Forest (here designated STNF).

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A SYNOPSIS OF THE GENUS *HALENIA* (GENTIANACEAE) IN MEXICO

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ABSTRACT

An abbreviated revision of the Mexican representatives of the genus *Halenia* Börckh. (Gentianaceae) is provided. Descriptions, comments and distribution data with citation of some of the examined specimens is presented for the twelve species known to occur in Mexico. Two new species, *Halenia alleniana* and *H. crumiana*, are validated.

Key Words: *Halenia*, Gentianaceae, Mexico

The genus *Halenia* Börckh. is an almost exclusively American genus belonging to the Gentianaceae—Gentianeae and comprised of perhaps as many as seventy species according to the most recent revision of the genus (Allen, 1933). Allen's studies indicate that more than seventy percent of the species are restricted to Andean South America and most of the remainder are found in the mountains extending from the southwestern United States to western Panama. Apparently a single species ranges across most of the northern United States and Canada from Newfoundland to British Columbia. The type of the genus, *H. corniculata* (L.) Cornaz, is one of the very few non-American species in the genus and that Asian species ranges from the Urals to eastern Siberia and south into Manchuria and Mongolia. A second Asiatic species, *H. elliptica* D. Don ex G. Don, was described from the Himalayas and apparently extends north into Soviet Central Asia and China.

The genus has proven to be a difficult one owing at least in part to the considerable plasticity of the plants involving even the most fundamental diagnostic characters used in distinguishing the various taxa, the corolline spurs. Opportunity for extensive observations on the plants in their natural habitats seems a prerequisite for understanding much of the puzzling variation encountered within the genus and both the present study and the previous study by Allen (1933) suffer from the fact that they have been almost exclusively based upon herbarium investigation. It would also seem that the genus would yield results of greatest biological interest from an investigation of pollination biology of the various species since much of the most conspicuous variation is based in nectariferous spurs which vary strikingly in size, shape and posture. Unfortunately this paper is not a report of such a study. Instead of these promising approaches to the considerable and puzzling variation that exists within the genus, the present report is the result of study of approximately two thousand specimens of *Halenia*, from Mexico and Central America. In the more than half century that has elapsed since Allen revised the American species in her doctoral dissertation, Mexico has been the site of considerable collecting and as a consequence there is now a far more ample series of specimens than what was available to her. Still, it would be very much a mistake to conclude that botanical collecting in Mexico is approaching the point of adequacy, and that collectors might be well advised to abandon general collecting and concentrate their efforts almost exclusively upon their own special group. In fact the evidence seems to me conclusive that there has been far too much emphasis by "collectors" on the intensive study of their narrow special interest and a neglect of general collecting, except by those who are preparing regional or state floras. Careful, critical collecting is very much needed in most parts of Mexico and will be necessary for decades to come. The present synopsis is offered to provide a more realistic account of the genus and consequently prove useful to those who might be tempted to work with these most interesting plants living as they do in some of the most scenic areas in Mexico.

GENERIC DESCRIPTION

Halenia Börckh., Arch. Bot. (Leipzig) 1: 25. 1796. *nom. cons.* TYPE: *Halenia sibirica* Börckh., *nom. illeg.* [= *Swertia corniculata* L., *Halenia corniculata* (L.) Cornaz].

Tetragonanthus Gmel., Fl. Sibirica 4: 114, *pl.* 53. 1769. *nom. illegit.* (Art. 34.1d).

Ceratia Pers., Syn. Pl. 1: 287. 1805, non Adans., Fam. 2: 319, 535. 1763 (= *Ceratonia* L.)

Exadenus Griseb., Gen. Sp. Gentian. 322. 1838. LECTOTYPE: *E. brevicornis* (H.B.K.) Griseb.

Annual, biennial or perennial, glabrous, caulescent herbs. Leaves decussate, opposite or rarely whorled, entire, membranous to fleshy, sessile or petiolate, usually 3-5-veined. Inflorescence a terminal or axillary, subumbellate or rarely racemose to spicate cyme. Calyx deeply 4-parted with the lobes only basally united and often bearing squamellae internally at the base of each lobe, the lobes somewhat inconspicuous to foliaceous, linear, lanceolate or ovate to spatulate, often marginally papillate. Corolla 4-parted, usually greenish yellow or rarely whitish or purplish, marcescent; lobes dextrorsely convolute, elliptic to ovate, obtuse to acute or acuminate, entire to erose, often marginally papillate. Stamens 4, inserted on the corolla-tube and alternating with the lobes; filaments linear or occasionally basally dilated; anthers versatile, ovate, oblong or subtriangular. Pistil bicarpellary; stigma sessile with 2, oblongish lobes 3–4 times as long as thick and these receptive on the inner surface; style lacking; ovary sessile, 1-celled with two parietal placentae bearing numerous ovules. Capsule compressed, septicidally dehiscent from the apex; seeds globose to elliptic and slightly flattened with a granular to reticulate surface.

A genus of perhaps 70 species with most of the American species found in Andean South America with a smaller center of variation in Central America and Mexico.

Allen (1933) recognized two formal sections within the American species of the genus *Halenia: Swertiella* and *Haleniastrum* (= *Halenia*). These were distinguished by her diagnostic key as follows:

Plants usually coarse with fleshy leaves, rarely slender with thin, herbaceous leaves; stem usually leafy; spurs absent, or present as very small inconspicuous protuberances, frequently obscured by calyx; distribution chiefly South America .... 1. *Swertiella*

Plants usually slender, with thin, herbaceous leaves, stems leafy or scapose; spurs present; distribution North and South America .... 2. *Haleniastrum*

According to Allen, *Halenia alata* and *H. brevicornis* are the two species from North of South America belonging to her section *Swertiella,* while the remaining species belong to what we would call section *Halenia* and which she designated as section *Haleniastrum*. I am not convinced that the late Caroline K. Allen has delimited natural subgeneric groupings within the genus *Halenia* but am unable to suggest a more meaningful grouping or infrageneric classification at this time.

KEY TO THE MEXICAN SPECIES OF *HALENIA*

1. Plants annual or biennial .... (2)
   2. Corolline protuberances either lacking or less than 2 mm long

and not developed into conspicuous nectariferous spurs or horns .... 1. *H. brevicornis.*

2. Coralline protuberances well-developed and usually represented by nectariferous spurs 3 mm long or longer.
   3. Coralline spurs either strongly divergent or at least spreading outwardly and distally arching outwardly.
      4. Coralline spurs so strongly divergent as to be horizontal or nearly so; corolla lobes ± acute; midcauline leaves mostly linear, usually less than 4 mm wide .... 2. *H. recurva.*
      4. Coralline spurs diverging especially distally but not more than 30°; corolla lobes rounded to obtuse; midcauline leaves elliptic, usually 4 mm or more wide .... 3. *H. crumiana.*
   3. Coralline spurs ± pendent and often distally inwardly curved.
      5. Midcauline leaves linear, mostly 10 or more times as long as wide .... 4. *H. palmeri.*
      5. Midcauline leaves oblong to lanceolate or broadly elliptic or ovate, much broader than 6 times as long as wide.
         6. Calyx lobes spatulate, obtuse..................... .... 5. *H. conzattii.*
         6. Calyx lobes oblong to lanceolate or elliptic, acute.
            7. Midcauline leaves ovate to broadly lanceolate, clearly slenderly petiolate with the petioles 3–12 mm long; basal leaves with petioles 10–30 mm long and about as long or even longer than the blades; capsules 15 mm long or less .... 6. *H. schiedeana.*
            7. Midcauline leaves oblong to oblanceolate; tapering to a rather broad base or at most very indistinctly winged-petiolate; capsules (12) 15–25 mm long . ... 7. *H. alleniana.*

1. Plants perennial.
   8. Coralline nectaries merely pouch-like or at least not developed into spurs more than 1.5 mm long.
      9. Calyx lobes obtuse; corolla 6 mm long or less; coralline nectaries pouch-like, drying dark brown .... 8. *H. alata.*

9. Calyx lobes acute to acuminate; corolla 6 mm long or longer; corolline nectaries never drying as dark brown circular patches .... 9. *H. pringlei.*

8. Corolline nectaries typically spur-like and longer than 2 mm.
   10. Corolline spurs strongly divergent or outwardly spreading.
      11. Plants usually 1–5 dm tall or less; corolline spurs horizontally spreading or at least very strongly divergent; cauline leaves mostly linear to oblanceolate, mostly 6 mm wide or less ..... 9. *H. pringlei.*
      11. Plants 1.5 dm tall or more; corolline spurs slender and more than 4 times as long as the diameter and these more or less descending or if moderately spreading never approaching the horizontal; cauline leaves mostly broadly elliptical, about 1 cm wide........ .... 10. *H. hintonii.*
   10. Corolline spurs ± pendulous and neither divergent nor conspicuously outwardly curved, often distally straight.
      12. Basal rosette absent or at least the leaves mostly cauline....................... 11. *H. decumbens.*
      12. Basal rosette present and cauline leaves few or none.
         13. Spurs distally incurved, less than half the length of the corolla.
            14. Flowers more than 10 mm long; corolline spurs usually 1/3–1/2 the length of the corolla, 3–7 mm long ....12. *H. plantaginea.*
            14. Flowers less than 10 mm long; corolline spurs rudimentary and usually 2.5 mm long or less . ... 13. *H. nudicaulis.*
         13. Spurs ± straight or distally slightly outwardly curved, about half the length of the corolla............ .... 11. *H. decumbens.*

TREATMENT OF INDIVIDUAL TAXA

1. **Halenia brevicornis** (H.B.K.) G. Don, Gen. Hist. 4: 177. 1838.

Swertia brevicornis H.B.K., Nov. Gen. et Sp. Pl. 3: 174. 1818. TYPE: Ecuador; Quito, *Humboldt & Bonpland s.n.*

Swertia parviflora H.B.K., Nov. Gen. et Sp. Pl. 3: 174. 1818. TYPE: Mexico; Guanajuato, *Humboldt & Bonpland,* photo of type at Paris seen at US.

Swertia parviflora var. *α angustifolia* Schlect. & Cham., Linnaea 5: 122. 1830.

Swertia parviflora var. *β latifolia* Schlect. & Cham., Linnaea 5: 122. 1830.
Halenia parviflora (H.B.K.) G. Don, Gen. Hist. 4: 177. 1838.
Exadenus brevicornis (H.B.K.) Griseb., Gen. et Sp. Gent. 323. 1839.
Exadenus parviflorus (H.B.K.) Griseb., Gen. et Sp. Gent. 322. 1839.
Exadenus parviflorus var. *β latifolius* (Schlecht. & Cham.) Griseb., Gen. & Sp. Gent. 322. 1839.
Halenia multiflora Benth., Pl. Hartw. 24. 1839. Mexico: in pinetis Bolaños, *Hartweg 210* (K, HOLOTYPE, photo!; NY! ISOTYPE).
Exadenus paucifolius Mart. & Gal., Bull. Acad. Brux. 11: 372. 1844. TYPE: Se trouve avec l'espeèe prècèdente [*E. alatus* Mart. & Gal.] de 9 a 12,000 pieds ["du pic d'Orizaba"], *Galiotti 7219* (BR, HOLOTYPE, photo!).
Halenia paucifolia (Mart. & Gal.) Hemsl., Biol. Centr. Amer. Bot. 2: 352. 1882.
Halenia parviflora var. *latifolia* (Schlect. & Cham.) Hemsl., Biol. Centr. Amer. Bot. 2: 351. 1882.
Tetragonanthus paucifolius (Mart. & Gal.) Kuntze, Rev. Gen. Pl. 2: 431. 1891.
Tetragonanthus parviflorus (H.B.K.) Kuntze, Rev. Gen. Pl. 2: 431. 1891.
Tetragonanthus brevicornis (H.B.K.) Kuntze, Rev. Gen. Pl. 2: 431. 1891.
Swertia cucullata Sessè & Mocino, Fl. Mex. ed. 2 p. 73. 1894. TYPE: Mexico, *Sessè & Mocino s.n.* (MA, HOLOTYPE, photo at MO!).
Halenia erythraeoides Gilg, Engler Bot. Jahrb. 54: Beibl. 118, p. 105. 1916. TYPE: Venezuela: "Auf den Hochanden von Merida", *Linden 456* (B, HOLOTYPE).
Halenia micranthella Briq., Candollea 4: 320. 1931. TYPE: Mexico; Hidalgo, wet meadows, Sierra de Pachuca, alt. 2450 m, *Pringle 6964* [as *1964*] (G, not seen, HOLOTYPE; ENCB! F! MICH! MO! MSC! NY! PH! US! ISOTYPES).
Halenia tuerkheimii Briq., Candollea 4: 317. 1931. TYPE: Guatemala; Alta Verapaz, "Fichtenwälder bei San Joaquin" 1000 m, *von Tuerckheim 2041* (G, HOLOTYPE; F! GH! NY! US! ISOTYPES).
Halenia brevicornis var. *multiflora* (Benth.) C. K. Allen, Ann. Missouri Bot. Gard. 20: 142. 1933.
Halenia brevicornis var. *micranthella* (Briq.) C. K. Allen, Ann. Missouri Bot. Gard. 20: 143. 1933*Halenia brevicornis* var. *divergens* C. K. Allen, Ann. Missouri Bot. Gard. 20: 144. 1933. TYPE: Mexico; Michoacán, vicinity of Morelia, near La Huerta, 1950 m, 1 Sept. 1910. *Arsène* s.n. (MO! HOLOTYPE; US! ISOTYPE).
Halenia brevicornis var. *chihuahuensis* C. K. Allen, Ann. Missouri Bot. Gard. 20: 144. 1933. TYPE: Mexico; Chihuahua, pine plains, base of the Sierra Madre, *Pringle 1664* (MO! HOLOTYPE; CAS! MSC! ISOTYPES).
Halenia brevicornis var. *ovata* C. K. Allen, Ann. Missouri Bot. Gard. 20: 145. 1933. TYPE: Mexico; Nayarit, Tepic, Jan 5–Feb 6, 1892, *Palmer s.n.* (US! HOLOTYPE).
Halenia brevicornis var. *tuerckheimii* (Briq.) C. K. Allen, Ann. Missouri Bot. Gard. 20: 145. 1933.

Annual herbs (0.5)1.5–4(9) dm high from a slender tap root; stems slender, strongly angled to even quadrate, striate, usually branched only above the base. Leaves mostly cauline, thinly membranous, sessile or only the lowermost petiolate (the petioles in these 0.5–1.5(3.0) cm long), the blades linear to lanceolate or elliptic, mostly 2–3.5(5) cm long and (1)2–10(18) mm wide. Inflorescence cymosely racemiform to paniculate, compactly congested to loosely arranged; pedicels 1–12(25) mm long. Calyx tube shallowly turbinate to campanulate, 0.3–0.6(0.8) mm high, the lobes linear to lanceolate or more rarely oblong or narrowly spatulate, 1/2–3/4 the length of the corolla, mostly (1.5)2–4 mm long and 0.2–0.6 mm wide, usually faintly 3-nerved, marginally often minutely papillate; corolla green to greenish yellow, 4–8 mm long, the tube 3–4.5 mm long, the lobes broadly to narrowly ovate to deltoid-oblong, apically acute to acuminate and basally somewhat auriculate, 2–3 mm long, spurs lacking or marked by slight protuberances or represented by readily detected, pendant to divergent spurs 0.5–1.0(2.0) mm long; stamens 2–4 mm long, the filaments attached near the middle of the corolla-tube. Capsule compressed, lanceolate, 5–9(–14) mm long; seeds ovoid to subglobose, 0.4–0.6 mm long, reticulate.

Distribution. Dry, grassy slopes and open woods from n. Mexico south through Central America into northwestern South America.

This species has been divided by Allen (1933) into eight varieties thought by Williams (Fieldiana Bot. 24: 317. 1969) "to have slight if any systematic importance." My own findings are in agreement with those of Williams. Allen, although stating "that environment is in a large measure responsible for the variation found within the species," keyed what she treated as varieties as follows:

a) Leaves not ovate, longer than 1.2 cm long.
  b) Pedicels stouter than filiform, shorter than 1.2 cm long.
    c) Corolla without distinct spurs.
      d) Inflorescence compact.
        e) Leaves linear, slender .... var. *brevicornis*
        e) Leaves ovate to lanceolate, coarse .... var. *latifolia* (Schlecht. & Cham.) C. K. Allen
      d) Inflorescence strict ....var. *micranthella* (Briq.) C. K. Allen
    c) Corolla with small but distinct spurs.
      f) Spurs thick, conical, more or less pendulous .... var. *multiflora* (Benth.) C. K. Allen
      f) Spurs blunt, spreading squarrose.................... ....var. *chihuahuensis* C. K. Allen
      f) Spurs slender, divergent.... var. *divergens* C. K. Allen
  b) Pedicels filiform, slender, elongate; habit decidedly

spreading .... var. *tuerckheimii* (Briq.) C. K. Allen
a) Leaves ovate, shorter than 1.2 cm ... var. *ovata* C. K. Allen

Naturally with so much described variation and so many formally named varieties of *Halenia brevicornis,* the suspicion is great that the easiest path has been followed in not recognizing any of them in this synopsis. Considerable opportunity to observe the plants in the field in a wide variety of habitats and throughout its range ought to help sort out at least some of the environmentally induced plasticity. The opportunity to grow the plants under controlled environmental conditions also gives promise of resolving this problem. But until such steps are taken, I believe it best to treat the species broadly as the problem seems not to lend itself well to analysis based upon the more traditional morphological-geographical analysis. I have not found Allen's treatment helpful in sorting out the populations into meaningful taxa and believe that much of the difficulty is traceable to the extreme plasticity of individuals responding to differences in light, available moisture and seasonality.

REPRESENTATIVE MEXICAN COLLECTIONS: **Baja California:** locality uncertain, "Lower California", *Orcutt s.n.* (NY). **Sonora:** pine slopes, La Mesa Colorado, 14 Oct 1933, *Gentry 542M* (DS, MICH, US); open pine forests, Saguaribo, Río Mayo, 5500 ft, 2 Nov. 1935, *Gentry 2099* (F, GH, MO, PH, US); slopes in oak forest on W slope of the Sierra Madre, 35 miles SW of Chuhuichupa on trail to Río Bonito, 2 Oct 1939, *Muller 3606* (GH, LL, MICH). **Chihuahua:** along arroyo just NW of Cusarare church, 2200 m, 14 Oct 1977, *Bye & Weber 8112* (LL, GH); Sierra Madre Mts., Mesa, W of Hop Valley, 6500 ft, 17 Sept 1903, *M. E. Jones s.n.* (F, MICH, MO, US); stony pineland, Madera, 2150–2200 m, Sierra Madre Occidental, 25 Sept 1934, *Pennell 19235* (PH, US); pine plains, base of the Sierra Madre, 4 Oct 1887, *Pringle 1330* (F, MICH, NY, PH, US). **Nuevo Leon:** open chaparral, upper west slope of Sierra de la Cebolla, 21 Aug 1939, *Muller 2898* (GH—a mixed sheet). **Sinaloa:** Sierra Surutato, 0.5 mi N of Los Ornos, 5800 ft, 1 Nov 1969, *Breedlove & Kawahara 16742* (CAS, MICH); steep moist slope, Sierra Surutato, 3 miles N of Los Ornos along road to Ocurahui, 2 Oct 1970, *Breedlove & Thorne 18338* (CAS, MICH). **Durango:** steep moist ravine 2 miles W of Revolcaderos along Mexican Hwy 40, 7100 ft, 8 Nov 1970, *Breedlove 18921* (CAS, MICH); open oak-pine woodland Sierra Madre Occidental about 50 km W of Ciudad Durango, 2550 m, 27 Sept 1962, *McVaugh 21661* (CAS, ENCB, LL, MICH, NY); dryish cliffs, 11.2 miles NE of El Paraiso (Sinaloa) on road between Villa Union and El Salto, 7800 ft, 29 Sept 1953, *Ownbey 1970* (F, GH, MICH, NY, US); rocky pineland canyon, El Salto (Aserraderos), 2500 m, 31 Aug 1934, *Pennell 18510* (GH, NY, PH, US); pumice gravel in dry pine-oak forest, 8600 feet, Sierra Madre, W slope, 17.5 miles, W of El Salto, 18 Oct 1965, *Ripley & Barneby 14176* (CAS, NY, US). **Zacatecas:** Sierra de Los Morones, near Plateado, 1 Sept 1897, *Rose 2732* (GH, US); about 38 km al W de Jalpa, sobre la carretera a Tlaltenango, bosque de *Quercus,* 21–23 Oct 1973.

Rzedowski & McVaugh 975 (ENCB, MICH). **Aguascalientes:** moist N facing slopes near summits, Sierra del Laurel, about 10 miles SE of Calvillo, 2500 m, 4 Nov 1959, *McVaugh & Koelz 206* (MICH). **San Luis Potosi:** Alvarez, 28 Sept–3 Oct 1902, *Palmer 160* (F, GH, MO, NY, US); San Luis Potosi, 6000–8000 ft, 1878, *Parry & Palmer 600* (F, GH, MO, NY, PH, US). **Nayarit:** Tepic, *Palmer s.n.* (US). **Jalisco:** grassy slopes 12 km NW of Los Volcanes, 1900 m, 30 Oct 1973, *Breedlove 35772* (CAS, MICH); pine forest, Sierra de Manantlán, 15–20 miles SE of Autlán, about 1700 m, *McVaugh 13962* (MICH); in pine-oak woodland 5 miles NE of San Miquel de la Sierra, 1950 m, 2 Nov 1962, *McVaugh 22014* (MICH, NY); Río Blanco, Oct 1886, *Palmer 680* (GH, MICH, NY, US); banks of ravines near Guadalajara, 5000 ft, 21 Oct 1903; *Pringle 11636* (F, GH, US). **Guanajuato:** second growth oak forest on steep rocky mountainsides about 8 km NE of Santa Rosa, 2400 m, 10 Nov 1970, *McVaugh 24178* (MICH). **Hidalgo:** mountain meadows, El Chico near Pachuca, Sept 1905, *Purpus 1761* (F, GH, MO, NY, US). **Veracruz:** ladera de cerro en parcela de cultivo abandonado, 1700 m, 6 July 1970, *Ventura 1526* (DS, F, MICH, MO). **Michoacan:** llano about 4 km SW of Cerro San Andres about 10 km N of Ciudad Hidalgo, about 2930 m, 6 Sept 1960 Beaman 4251 (GH, MSC): Zitácuaro—Las Cañoas, 2600 m, 4 Nov 1938, *Hinton 13412* (GH, LL, MICH, NY, PH, TEX, US); Zitácuaro—Guanoro, 1875 m, 11 July 1938, *Hinton 13424* (GH, ILL, LL, NY, PH, TEX, US); pine forest, Tancitaro, 2250 m, 22 Nov 1940, *Hinton 15558* (DS, F, MICH, NY, US); pine-covered slopes and meadows about 18 miles S of Pátzcuaro, 8900–9000 feet, 20–25 Nov 1961, *King & Soderstrom 5156* (MICH, NY, TEX, US). **Mexico:** grassy hill, Tequesquipán, Dist. Temascaltepec, 2800 m, 28 Oct 1932, *Hinton 2316* (F, GH, LL, NY, PH, US); hill, Ocotepec, Dist. Temascaltepec, 1500 m, 9 Dec 1932, *Hinton 2905* (F, GH, LL, MO, NY, PH, US); pine forest, Nanchtitla, Dist. Temascaltepec, 16 Dec 1938, *Hinton 5354* (ENCB, F, MO, NY, US); llano, Sierrita, Dist. Temascaltepec, *Hinton 8311* (ENCB, F, GH, LL, MO, NY, PH, TEX, US); pine forest, Mezón Viejo, Dist. Temascaltepec, 11 Oct 1935, *Hinton 8345* (F, GH, MO, NY, US); near Ozumba, 8000 ft, 3 Nov 1902, *Pringle 11329* (CAS, ENCB, F, GH, MICH, MO, MSC, US); cool slopes, Sierra de las Cruces, 9500 ft, 12 Sept 1904, *Pringle 13120* (CAS, F, GH, MICH, US); open woods, Salto de Agua, Nov 1905, *Purpus 1762* (F, GH, MO, NY, US); **Distrito Federal:** open grassy roadbank, at La Cima Station between Mexico and Cuernavaca, 3035 m, 25 Sept 1961, *Beaman & Andresen 4534* (GH, TEX, US); Sierra de Ajusco, 9 Nov 1903, *Pringle 11842* (CAS, F, GH, MICH, MO, MSC, US); alrededores de la Estación La Cima, Serraniá del Ajusco, 3000 m, 25 Nov 1966, *Rzedowski 23192* (DS, ENCB, MICH, MSC, TEX) **Morelos:** pine forest, Sierra de Morelos near Cuernavaca, 2100 m, 25 Dec 1969, *Hinton 17427* (DS, ENCB, MICH); **Tlaxcala:** Cerro La Hoyanca, cerca de Calpulalpán, 9 Sept 1956, *Paray 2102* (ENCB). **Puebla:** open volcanic slopes, San Manuel de la Sierra, 9300 ft, 19 Aug 1938, *Balls 5296* (GH, MSC, US); Esperanza, Aug. 1907, *Purpus 2697* (F, MO, US); roadside bank between La Venta and San Martin, 8200 ft, 15 Nov 1944, *Sharp 441638* (GH, MO, NY). **Guerrero:** forests N slope of Cerro Alquitran, 10–14 km by road W of Mexican Hwy 95 and Mazatlán, 2250–2450 m, 6 Dec 1966, *Anderson & Laskowski 4407* (DUKE, ENCB, GH, MICH, NY, US); pine forests, Pilas, Dist. Mina, 1500 m, 22 Nov 1936, *Hinton 9886* (GH, NY, US); pine forests, San Antonio—Buenos Aires, Dist. Montes de Oca, *Hinton 11695* (GH, LL, NY, PH, US); open pine forests, Teotepec, Distr. Mina, 3600 m, 17 July 1939, *Hinton 14463* (DS, ENCB, F, GH, MICH, NY); pine forest slope, Petlacala, Distr. Mina, 1820 m, *Mexia 8963* (CAS, F, GH, MO, NY, US); Chichihualco, El Asoleadero, 15 km al oeste de Camotla, 2650 m, 2 Dec 1963, *Rzedowski 18055* (DS, ENCB, MICH, MSC).

Oaxaca: grassy ridge and meadow in pine forest, 26 miles SSE of Miahualtán, 2600 m between Oaxaca and Suchixtepec on road to Puerto Angel, 7 Nov 1966, *Anderson & Laskowski 4156* (DUKE, ENCB, GH, MICH); SW slope of Cerro Zempoaltepetl along trail from Tlahuitoltepec to Santo Domingo Alberradas, oak forests, about 2000 m, 14 Aug 1950, *Hallberg 967* (ENCB, MICH, US); Sierra de San Felipe, 8000 feet, *Smith 665a* (F, MICH, MO, NY, US). **Chiapas:** on steep moist slope along Mexican Hwy 190, 2 km W of Navenchauk, 6000 ft, 19 Dec 1964 *Breedlove 7974* (DS, ENCB, F, MICH); steep slope, barrio de Tuk paraje of Matsab, Municipio Tenejapa, 7500 ft, 30 Sept 1965, *Breedlove 12517* (DS, ENCB, LL, MICH, US); Mt. Tacaná, 1000–2000 m, Aug 1938, *Matuda 2473* (F, GH, LL, MICH, NY); grassy slope S of the center of Amatenango del Valle, 6100 feet, 11 Nov 1966, *Alush Shilom Ton 1508* (DS, ENCB, MSC, NY, US).

2. **Halenia recurva** (J. E. Sm.) C. K. Allen, Ann. Missouri Bot. Gard. 20: 161. 1933.

Swertia recurva J. E. Smith, Rees' Cyclopedia 34: [under *Swertia.*] 1819. TYPE: Mexico: locality unknown, *Escalante s.n.* by *Mutis 38* (LINN, not seen).

Halenia rothrockii A. Gray, Proc. Amer. Acad. 11: 84. 1876. TYPE: Arizona; Mount Graham, at 9000 ft, *Rothrock s.n.* (GH, HOLOTYPE, not seen).

Tetragonanthus rothrockii (A. Gray) Heller, Catalogue N. Amer. Pl. 6. 1898.

Annual herbs with quadrate, narrowly winged stems basally unbranched although often branched above, (1.2)2.5–6.5 dm tall. Basal leaves (0.8)1–2.5(3.0) cm long, 3–6 mm wide, elliptic or elliptic-lanceolate to spatulate; cauline leaves remote, lance-linear to linear, 1.5–4(–7) cm long and 1–3(4) mm wide, obscurely 3-nerved above and only the midvein prominently elevated beneath. Inflorescence a loosely flowered, sub-umbellate cyme; pedicels slender, 0.5–3 cm long. Calyx-tube campanulate to turbinate, 1–1.4 mm high; calyx-lobes lanceolate to linear, acute, 4–8 mm long and 0.8–1.2(–1.5) mm wide, marginally very minutely papillate; corolla bright yellow, about 0.8–1.2 cm long, tube less than half the length of the corolla, lobes ovate, acute to subacuminate, delicately veined, papillate, spurs strongly outwardly curved, mostly horizontal but distally strongly ascending, 0.8–1.6 cm across from spur-tip to tip or each spur mostly (4–)6–8 mm long; filaments slightly obovate, anthers broadly oblong, mucronate, papillate. Capsule lance-ovoid (8–)10–16 mm long; seeds yellow-brown, subglobose-ovoid, granular.

DISTRIBUTION: mountains of the southwestern United States (Arizona and New Mexico) and Mexico (Sonora, Chihuahua, Coahuila and Durango) apparently above 7500 ft (= c. 2300 meters).

One is startled to read in Allen's revision of the genus (1933, p. 162) that the type of *Swertia recurva* J. E. Smith is a "specimen collected by Mutis and sent to Linnaeus, now preserved in the herbarium of the Linnaean Society..." Since there is no evidence that Mutis ever collected in Mexico, suspicion is aroused that the Mutis collection upon which *Swertia recurva* is based belongs in all probability to a South American species. There is, however, a specimen "*Mutis 38*" at US which was obtained from the Madrid Botanic Garden in 1932. J. E. Smith originally reported that the plants were collected in Mexico by Escallon and a specimen sent to Linnaeus by Mutis. This seems to be a plausible explanation of how a specimen from northwestern Mexico was described by J. E. Smith as *Swertia recurva* at such an early date.

REPRESENTATIVE MEXICAN COLLECTIONS: **Coahuila:** 25 km NW of Fraile on top of mountain covered with *Abies, Pseudotsuga* and *Pinus*...3550 m, 16 July 1941, *Stanford et al 453* (DC, GH, MO, NY). **Chihuahua:** open pine slope, 69 miles from Parral along road to El Vergel, 8200 feet, 7 Oct 1959, *Correll & Gentry 22882* (ENCB, LL, MO); pine woods, Cajurichi, Río Mayo, 7200 ft, 13 Sept 1936, *Gentry 2711* (F, GH, MO); stony pine woods near First Meadow, Sierra Madre Occidental, 2250–2300 m, 23 Sept 1934 (F, GH, MICH, NY, US); cool slopes, Sierra Madre, 24 Sept 1887, *Pringle 1329* (DS, F, GH, NY, PH, US); Sierra Madre near Colonia Garcia, 8000 ft, 6 Sept 1899, *Townsend & Barber 309* (F, GH, MO, NY, US). **Sonora:** pine zone, Las Tierritas del Temblor, region of Río de Bavispe, 20 Aug 1940, *Phillips 648* (GH, LL, MICH). **Durango:** barranca below Sandia Station, 6500 ft, 13 Oct 1905, *Pringle 13588* (CAS, F, GH, LL, MICH, MSC, TEX, US).

3. **Halenia crumiana** Wilbur, *sp. nov.*

Herba annua vel biennis, 3–4.5 dm alta. Radix palaris. Folia basalia ± rosulata; lamina lance-elliptica vel elliptica, 3–4 cm longa et 6–10 mm lata, petioli 1–1.5 cm longi. Folia caulina elliptica 1.5–3.5 cm longa et ca. 4 mm lata, internodiis 1–5-plo longioribus. Lobi calycis lineares vel anguste oblanceolati, acuti, 4–6 mm longi et 0.8–1 mm lati. Lobi corollae oblongi vel ovati vel orbiculares, 4–6 mm longi et 0.8–2(2.2) mm lati; calcaria corollae 5–7 mm longa, ± pendula, paulo divergentia.

TYPE: MEXICO: Jalisco; cypress-pine forest in mountains E of Manantlán about 15 miles SSE of Autlán by way of Chanté. 30 July 1949. *R. L. and C. R. Wilbur 1981* (MICH; 6 duplicates were also collected but were not encountered during this study).

Probably an annual herb from a strong taproot 4–5 mm in diameter and with a weakly 4-angled stem 3–4.5 dm tall and this either little-branched or branching from near the base or even sparingly branched throughout with the stems very slightly winged. Basal leaves apparently at least sometimes rosulate or with internodes only 2–3 mm long and these leaves lance-elliptic to elliptic with a petiole 1–1.5 cm long and a blade 3–4 cm long and 6–10 mm wide; cauline leaves rather remote with the internodes 1–5 times as long as the leaves, narrowly elliptic, 1.5–3.5 cm long and about 4 mm wide, 3-nerved but only the midvein prominently elevated beneath. Inflorescence of subumbellate cymes terminating the main stem and the lateral branches (and these often very much foreshortened); pedicels stiff, ± 4-angled and very narrowly winged, ascendent, 5–10 mm long. Calyx-tube campanulate, about 1–1.5 mm high; calyx-lobes linear to narrowly oblanceolate, acute, 4–6 mm long and 0.8–1 mm wide, microscopically marginally papillate; corolla greenish distally but yellowish below including the spurs, 8–12 mm high, the tube about 1/3 the height of the corolla, the lobes broadly oblong to ovate or almost orbicular, broadly rounded to obtuse but occasionally shortly apiculate, marginally erose, the spurs outwardly divergent especially distally but still ± pendent, slender, medially usually less that 0.5–0.8 mm in diameter, mostly 5–7 mm long; anthers yellow, broadly oblong, about 1 mm long, the filaments green, linear, slender, spreading ciliate for the basal half. Capsule lance-ovoid, 9–12 mm long; seeds yellowish, subglobose to oblongoid, smoothish.

DISTRIBUTION. Known only from the higher mountains of the state of Jalisco, Mexico at an elevation of above 2500 m in rather open forests of pine, fir, cypress, oaks and various other hardwoods.

This species has in the past been identified with *Halenia recurva* (J. E. Sm.) C. K. Allen (= *H. rothrockii* A. Gray), a species found high in the mountains of southern New Mexico and Arizona as well as the Mexican states of Sonora, Chihuahua, Coahuila and Durango. *Halenia recurva* differs in its narrowly linear leaves and widely divergent corolline spurs that are often ± horizontal. The cauline leaves of *H. crumiana* are narrowly elliptic and the spurs, although divergent, never approach being horizontal.

The species is named in honor of the accomplished bryologist Howard A. Crum, a much-admired friend. He was a companion on a collecting trip in the summer of 1949 spent in the vicinity of Autlán in the Mexican state of Jalisco. The summer apparently was not bryologically richly rewarding but he endured it in good humor or at least what passed for such among those gifted complainers, the Wilbur brothers. The mountains in which this species of *Halenia* grows are (or were) clothed in some of the most handsome forests in that part of Mexico with large fir, cypress and pines. We spent a most delightful week collecting in then relatively undisturbed forest.

SPECIMENS EXAMINED: **Jalisco:** Volcán Tequila, due S of Tequila, woods of *Quercus*, and also *Pinus* and *Arbutus*, 1.1 miles from summit on road from Tequila, 2610 m, occasional in shade, 11 Aug 1968, *W. R. & C. Anderson 5125* (DUKE, ENCB, MICH); Sierra de Manantlán (15–20 miles SE of Autlán) near Aserradero El Cuartón, 2500 m; steep slopes near summits, in pine-oak-fir forests, 2 Nov 1952, *McVaugh 13844* (MICH); Sierra de Tequila, 8000 ft, 5 July 1893, *Pringle 5465* (GH); hardwood pine-fir forest in mountains E of Manantlán about 15 miles SSE of Autlán by way of Chante; about 8300 ft, 25 July 1949, *R. L. & C. R. Wilbur 1834* (MICH), *1872* (MICH), 30 July 1949, *R. L. & C. R. Wilbur 1981* (MICH).

4. **Halenia palmeri** A. Gray, Proc. Amer. Acad. 21: 401. 1886. TYPE: MEXICO; Chihuahua, mountain summits above Batopilas, 8850 feet, *Palmer 359* (GH, HOLOTYPE, not seen; NY! PH! US! ISOTYPES).

Tetragonanthus palmeri (A. Gray) Kuntze, Rev. Gen. Pl. 2: 431. 1891.

Annual herb; stems simple or little branched and then mostly above and only occasionally from the base, striate, more or less terete, 3–7.7 dm tall. Cauline leaves linear, acute, sessile, faintly 3-nerved, mostly 2–4.5(7) cm long and 2–4 mm wide; lower leaves oblanceolate to linear-lanceolate, acute to obtuse. Inflorescence racemosly cymose, loosely few- to many-flowered. Calyx lobes (4–)7–12 mm long and 1–2.5 mm wide, lanceolate to long-triangular, acute, 3-nerved with the midrib prominent, marginally minutely papillate; corolla 1.0–1.8(–2.2) cm long, deeply yellowish, the tube 7–10 mm long, the lobes broadly ovate, acute, slightly auriculate, papillate and the spurs pendulous, tapering, distally incurved, 1/4 length of the corolla, about 4–5(–7) mm long. Filaments linear; anthers oblong. Capsules 12–15(–22) mm long, ellipsoidal, attenuate, subfalcate; seeds globose, dark brown, granular.

DISTRIBUTION: mountains of northern and central Mexico (Chihuahua and Durango).

Halenia palmeri is one of the most easily recognized and distinctive endemic Mexican species.

REPRESENTATIVE MEXICAN COLLECTIONS: **Chihuahua:** La Rocha, along tributary of Río del Soldado, on N-facing conifer slope, Sierra Mohinora, 14–15 Oct 1959, *Correll & Gentry 23120* (ENCB, LL); Memilichi, Río Mayo, on drier slopes, 11 Sept 1936, *Gentry 2686* (F, GH, MO, US); Marsh Lake, Sierra Madre Mts., 7000 ft, 19 Sept 1903, *M. E. Jones s.n.* (DS, GH, MO, US); Madera Municipio, scattered in open pine forest, Arroyo Negro, 7 miles SW of Chuhuichupa, 8 Oct 1939, *Muller 3705* (GH, LL, MICH); Sierra Madre 60 miles S of Guadelupe y Calvo, 7500–8500 ft, 20 Aug 1898, *Nelson 4798* (GH, US); Sierra Madres near Colonia Garcia, 7500 ft, 4 Sept 1899, *Townsend & Barber 303* (F, GH, MICH, MO, NY, US). **Durango:** common in wet meadow and into pine woods about 2 km E of La Ciudad, 8300 ft, 5 Oct 1970, *Bates, Blanchard & Fryxell 1527* (CAS, ENCB, MICH); high mountain meadows 6 miles E of La Ciudad, W of El Salto, ca. 9000 feet, 20 Oct 1964, *Bratz M680* (GH); steep slope with *Pseudotsuga, Abies, Pinus, Quercus, Arbutus* and *Juniperus*, 54 miles N of Estación Coyotes along a lumber road just NW of Guachichilas, 9000 ft, *Breedlove 18799* (CAS, MICH); steep moist slope with *Pinus, Quercus, Arbutus* and *Juniperus* along Mexican Hwy. 40, 6 miles W of La Ciudad, 8800 ft., 7 Nov 1970, *Breedlove 18866* (CAS, MICH, MO); Sierra Madre Occidental, Mex. Highway 40 12.9 km WSW of El Salto, 2.4 km W of Lecherias (23° 43′ N, 105° 29′ W), 2520 m, 6 Sept 1975, *N. H. Holmgren & Lowrey 8073* (NCU, NY); Sierra Madre Occidental, about 10 mi W of El Salto on the Durango-Mazatlán Hwy., rocky rhyolitic hillsides and wet depressions in open rolling pine woodlands, abundant in meadows and occasional in forests 2650 m, 2 Oct 1962, *McVaugh 21741* (CAS, LL, MICH, NY); common in wet meadows 2 miles E of La Ciudad on road from Durango to Mazatlán, 8400 feet, *Mason 2934* (F, NCU, NY, PH, TEX); in the more moist openings of the pine forest, about 9100 ft, 30 Sept 1953, *Ownbey 1991* (F, GH, MICH, NY, US); grassy edge of marsh, El Salto (Aserraderos) Sierra Madre Occidental, 2530–2540 m, 28 Aug 1934, *Pennell 18286* (F, GH, MICH, NY, PH, US); marshy glade in pineland, El Salto (Aserraderos), 2600–2650 m, 1 Sept 1934, *Pennell 18551* (GH, NY, PH, US); moist grassy flats along a brook in the forest belt of the Sierra Madre 5 mi W of El Salto, 7800 ft, *Ripley & Barneby 13987* (CAS, NY).

5. **Halenia conzattii** Greenm., Fieldiana Bot. 2: 335. 1912. LECTOTYPE: MEXICO: Oaxaca, Cerro San Felipe, Distrito del Centro, 2000 m, 20 Sept 1918, *Conzatti 2295* (F!).

Erect, usually branching above, probably biennial herbs with rather coarse angular, striate or very slightly winged stems 2.0–3.5(5.0) dm tall. Basal leaves ovate-elliptic with petioles nearly as long as the blade or even longer; cauline leaves shortly winged petiolate or sessile, elliptic, lanceolate, ovate, acute to obtuse, 1–4 cm long and 0.5–1.3 cm wide, 3-nerved, marginally papillate. Inflorescence terminal or terminating axillary branches; pedicels 3–15(–20) mm long, 4-angled, smooth to inconspicuously but copiously papillate. Calyx lobes spatulate, obtuse to rounded, 3-nerved, marginally papillate, 4–6.5(8.0) mm long and 2–3 mm wide; corolla 8–12 mm long and 4–7 mm in diameter, green or yellowish green, the lobes 3–5 mm long, ovate, acute, papillate; spurs slender, pendulous and distally incurved, 1.5–3 mm long. Stamens 2–5 mm long, the filaments linear, the anthers broadly ovate. Capsule 1–1.8 cm long, lanceolate, subfalcate; seeds globose to ovoid, yellow-brown, granular.

DISTRIBUTION: Common in the higher mountains of Oaxaca, Mexico.

This distinctive species is readily identified by its broadly spatulate calyx lobes.

REPRESENTATIVE SPECIMENS: **Oaxaca:** pine-oak forest along road from Oaxaca to Guelatao de Juárez and Tuxtepec, 11.2 miles N of intersection with Mexican Hwy. 190, 2410 m, 18 July 1968, *W. R. & C. Anderson 4826* (ENCB, MICH); Cerro Grande de Huancliela, Dist. de Nochixtlán, 2520 m, 13 Oct 1921, *Conzatti 4265* (US); between Mitla and Cuesta, 30 Jan 1966, *Ernst 2365* (US); S facing slopes along Hwy from Oaxaca to Tuxtepec in pine and madrone forest with *Lupinus*, 12.3 miles N of Jct. 190 & 175 on 175, 15 Aug 1975, *LeDoux, Dunn & Wallace 2233* (ENCB, MO, NY); vicinity of Cerro San Felipe, 9500–11000 ft, *Nelson 1115* (GH, US); 18 miles SW of the city of Oaxaca, 7500–9500 ft, 10–20 Sept 1894, *Nelson 1340* (US); Sierra de San Felipe, 10,000 ft, 15 Sept 1894, *Pringle 4908* (ENCB, GH, MICH, MO, MSC, NY, PH, US); Sierra de San Felipe, 10,000 ft, 1 Sept 1894, *C. L. Smith 236* (MO) and also *664* (F, NY) and *665* in part (MO).

6. **Halenia schiedeana** Griseb., Gen. & Sp. Gent. 327. 1839.

Swertia Michauxiana sensu Schlecht. & Cham., Linnaea 5: 122. 1830 but not Schultes, Syst. Veg. 6: 130. 1820.

Tetragonanthus Schiedeanus (Griseb.) Kuntze, Rev. Gen. Pl. 2: 431. 1891.

Halenia chlorantha Greenm., Proc. Amer. Acad. 41: 240. 1905. TYPE: Mexico; Hidalgo, wet woods near Trinidad Iron Works, 5700 ft, *Pringle 8939* (F! HOLOTYPE; CAS! ENCB! MO! MSC! NY! PH! US! ISOTYPES).

Annual herb with erect, striate to narrowly winged, terete to weakly 4-angled stems 2–6.5 dm tall, frequently branched above but simple below. Basal leaves with ovate to broadly elliptic blades about 2–3 cm long and 10–18 mm wide with petioles 1–3 cm long or about as long or longer than the blades; cauline leaves ovate to broadly lanceolate, 3–6 cm long and 1.5–2 cm wide, acute to strikingly apiculate, 3–5 nerved, shortly to moderately petiolate with the petioles mostly 3–12 mm long. Inflorescence cymose, terminating the main stem and the axillary branches; pedicels erect, 7–15 mm long, narrowly winged and minutely papillate. Calyx lobes lance-elliptic, marginally densely but microscopically papillate, about 3–5 mm long and 1.5–2.5 mm wide, 3-nerved, acute to even strikingly apiculate, usually strongly reflexed; corolla 8–11 mm long, greenish, the tube almost equaling the obovate, abruptly acuminate, often papillate lobes, the spurs 2–3 mm long, pendulous, tapering, nearly parallel with the tube, distally slightly incurved. Anthers 2 mm long; filaments linear. Capsule oblong, subfalcate, about 10–15 mm long; seeds globose, yellow-brown, granular.

DISTRIBUTION: Moist montane forests of Central Mexico.

REPRESENTATIVE SPECIMENS: **Durango:** steep slopes at base of Espinazo del Diablo, 4 km NW of Los Angeles along road between Mazatlán and Durango, 2500 m, 28 Oct 1973, *Breedlove 35749* (CAS); Arroyo del Infierno, deep, well-watered, rough rocky canyon west of Santa Barbara, about 20 km S of El Salto, 2550–2650 m, 23 Aug 1963, *Gordon 54* (MICH); 78.8 miles E of Villa Union, El Espinazo del Diablo, rocky hillsides with pines, about 7400 feet, 3 Sept 1967, *Oliver, Austin, MacBryde 807* (MO); Metates, N of Cueva, Sierra Madre Occidental, along stream, 2600–2650 m, 29–30 Aug 1934, *Pennell 18448* (GH, PH, US). **Hidalgo:** wet woods near Trinidad Iron Works, 5700 ft, 11 July 1904, *Pringle 8939* (CAS, ENCB, F, MO, MSC, NY, PH, US). **Veracruz:** in the pedrigal of Las Vegas but near La Joya, 7000 ft, 25 June 1945, *Sharp 45563* (GH); Plan de Cedeño, Municipio de Acajete, 1750 m, 25 Feb 1981, *Ventura A. 18240* (ENCB).

7. **Halenia alleniana** Standl. ex Wilbur, *sp. nov.*

Herba annua vel biennis, 3–5 dm alta. Folia basalia oblonga vel oblanceolata, 3–5 cm longa et 8–18 mm lata; petioli indistincti, ± alati, 1–1.5 cm longi. Folia caulina oblonga vel oblanceolata; lamina 3–5 cm longa; petioli indistincti, alati, 1–1.5 cm longi. Lobi calycis lance-lineares vel late elliptici, 4–7 mm longi et 2–4 mm lati, acuti, erecti. Lobi corollae late oblongi, acuti; calcaria corollae 2–4 mm longa pendula, distaliter incurva.

TYPE: MEXICO: Nuevo Leon; Cerro Potosí, NE side of mountain at abandoned sawmill site, about 2800 m, in open pine forest, 13 Sept 1960, *Beaman 4481* (GH, HOLOTYPE; MSC & US, ISOTYPES).

Annual herb with an erect, ridged to very narrowly winged, weakly 4-angled stem 3–5 dm tall, usually branched above but not below. Basal leaves with oblong to oblanceolate blades 3–5 cm long and 8–18 mm wide and gradually tapering to the stem or with rather indistinct winged petioles 1–2 cm long; cauline leaves oblong to oblanceolate with the blade 3–5 cm long and tapering to the rather broad base or very indistinctly petiolate and the petiole strongly winged and about 1–1.5 cm long, the blade apically acute and conspicuously veined when dry with 3–5 veins arising from near the base. Inflorescence cymose, terminating the main stem and the axillary branches; pedicels strongly ascendent, mostly 1–3 cm long, narrowly winged and microscopically papillate. Calyx lobes lance-linear to more typically broadly elliptic, marginally minutely papillate, about 4–7 mm long and 2–4 mm wide, acute, erect; corolla 10–14 mm long, broadly cylindric, the tube about half as long as the entire corolla, the lobes broadly oblong, acute, the spurs 2–4 mm long, pendent to somewhat divergent, conical, occasionally distally slightly incurved. Anthers 1.5–2 mm long; filaments 5–7 mm long, slender. Capsule ellipsoidal, subfalcate, about (12)15–25 mm long, tapering to the 2–3 mm apex from the 6–8 mm base; seeds oblongoid, turgid, about 0.8–1 mm long and slightly less, yellowish to pale reddish brown, smooth.

DISTRIBUTION. Oak and pine forests in the high mountains of the Mexican states Nuevo Leon, Morelos and Michoacán.

Halenia alleniana has had a confused history in the Mexican flora as the relatively few collections made have been attributed to *H. brevicornis* var. *latifolia, Halenia deflexa* (J. E. Sm.) Griseb. which is otherwise known only as a transcontinental species across southern Canada and the northern United States, and to an indicated but unpublished species by Paul Standley. More recent collections, especially those made by John Beaman on Cerro Potosí in Nuevo Leon, have convinced me that Standley was correct. Careful and extensive collecting is very much needed in much of Mexico.

This species is named in memory of Dr. Caroline K. Allen who published a revision of this most difficult genus fifty years ago and thus provided the basis for this and all subsequent investigations.

SPECIMENS EXAMINED: **Nuevo Leon:** Cerro Potosí; NE side of mountain at abandoned sawmill site, about 2800 m, in open pine forest, 13 Sept 1960, *Beaman 4481* (GH, HOLOTYPE; MSC & US, ISOTYPES); on moist gravelly arroyo bank, the Cañon below Las Cañoas on Cerro Potosí, Municipio de Galeana, 20 July 1935; *Mueller 2233* (F, GH, MICH); in ponderosa pine forest near microwave station on Cerro Potosí N of Galeana, Sept 1970, *Norris 17610* (CAS); **Morelos:** Valle del Tepeite, 16 Oct 1937, *Lyonnet & Elcoro 1796* (US); Tres Marias Mts, 9500 ft, 16 Dec 1907, *Pringle 13971* (GH, US); **Michoacan:** Morelia, Rincón, 2300 [meters], IV 1909, *Arsène* 37 (US).

8. **Halenia alata** (Mart. & Gal.) Hemsl., Biol. Centr. Amer. Bot. 2: 351. 1882.

Exadenus alatus Mart. & Gal., Bull. Acad. Brux. 11: 372. 1844. TYPE: Mexico; Vera Cruz, "Se trouve dans les forêts et sur les rochers trachytiques du pic d'Orizaba, de 9 a 11,000 pieds *Galeotti 7221* (BR, HOLOTYPE, not seen; photo of holotype seen at MO).

Tetragonanthus alatus (Mart. & Gal.) Kuntze, Rev. Gen. Pl. 2: 431. 1891.

Perennial herbs from a thickened caudex with 1–several, simple, erect, slightly winged and often quadrate stems (0.3)1–1.5(2.4) dm tall. Basal leaves numerous and crowded, mostly 2–5 cm long and 3–4 mm wide, obtuse, very narrowly oblanceolate, 3-nerved, tapering basally into an elongate, slender petiole; lower cauline leaves subsessile and almost twice as long as the basal, upper cauline leaves linear, obtuse, sessile, 1–1.8 cm long and mostly 1–3 mm wide. Inflorescence an umbellate cymose cluster of slightly nodding flowers; pedicels 4-winged or angulate, (1)4–12(15) mm long. Calyx tube turbinate to shallowly campanulate, 0.4–0.6(1.0) mm long, 4-angled; calyx lobes slightly shorter than the corolla, oblong, 3-nerved, occasionally minutely but inconspicuously papillate, acute, 3–4.2(5.5) mm long and 1–1.8(–2.2) mm wide; corolla yellow, almost rotate, 4.5–6 mm long, the tube about 1/3–1/2 as long as the corolla, the lobes ovate to oblong, obtuse but often apiculate, erose, 3–4.5 mm long; spurs lacking but represented by short pouch-like glandular protuberances and these basal nectariferous pouches slightly protruding and drying darkish brown; filaments linear, the anthers ovate to oblong. Capsule broadly ovoid to lance-elliptic, (4.5)6–7(9) mm long; seeds yellow-brown, globose, granular.

DISTRIBUTION. High alpine meadows of Mexico and Guatemala

Halenia alata is a most distinctive species with short pouch-like nectariferous protuberances instead of spurs.

MEXICAN COLLECTION: Mt. Orizaba, 3000–3125 m, Aug 1839, *Linden 934* (MICH).

9. **Halenia pringlei** B. L. Robinson & Seaton, Proc. Amer. Acad. 28: 113. 1893. TYPE: Mexico, springy meadows, Sierra de las Cruces, *Pringle 4209* (GH! HOLOTYPE; CAS! F! G! GH! MO! MSC! NY! PH! US!. ISOTYPES).

Halenia crassiuscula B. L. Robinson & Seaton, Proc. Amer. Acad. 28: 113. 1893. TYPE: Mexico; bare alpine summits, Nevado de Toluca, 14,000 ft, *Pringle 4229* (GH! HOLOTYPE; ENCB! MSC! PH! US! ISOTYPES).

Halenia candida Ramirez, Inform. Secret. Foment. Mexico 34. 1895. TYPE: Sierra de Las Cruces, June 1895, *Altarmirano s.n.* (US! ISOTYPE).

Perennial herbs with simple to much-branched, ± narrowly 4-angled, erect, slender to compactly bushy stems (2)5–15(27) cm tall from a fleshy taproot 3–4 cm long and 3–6 mm in diameter. Basal leaves present with the blade from narrowly to broadly elliptic to narrowly oblanceolate to even somewhat oblong, about 1–3.5 cm long and mostly 4–9 mm wide, apically acute to obtuse, faintly to distinctly 3-nerved, tapering into a petiole from about as long as the blade to as short as 1 cm; cauline leaves 1–3 pairs, ± linear to narrowly oblanceolate to oblong or elliptic, sessile to basally narrowed, mostly 1.5–3 cm long and 2–5(8) mm wide. Inflorescence a terminal or occasionally also lateral, loose to dense umbellate cyme with ± ascendent flowers occasionally slightly nodding after anthesis; pedicels 2–10(20) mm long. Calyx lobes linear to narrowly oblong to oblanceolate (3)4–6 mm long, acute to obtuse; indistinctly 3-nerved and marginally microscopically papillate; corolla white 6–10(15) mm long with the tube 3–4 mm long and the lobes elliptic to oblong-elliptic, acute to acuminate, occasionally slightly erose, the spurs when present 1.5–7 mm long usually strongly divergent and often mostly horizontal with distally upturned tips but often completely lacking or very nearly so especially in late-developing flowers; stamens 2–3.2 mm long, the filaments linear, the anthers ovate to oblong, 0.3–1(1.2) mm long. Capsules lanceolate, frequently subfalcate, acute, exserted beyond the marcescent corolla; seeds ± globose, light yellowish brown, granular.

DISTRIBUTION. Bare volcanic central Mexican alpine summits and meadows.

Within my concept of *H. pringlei,* as is shown by its very brief synonymy, two long-recognized species have been combined in the present treatment. Both were described by the same authors at the same time and the numerous specimens in the type collections are so dissimilar that one can certainly understand their original decision to recognize two species. The extremes, as is admirably demonstrated by the fine series of specimens collected by Pringle, are so unlike that no one would place them together unless confronted by the specimens that have since accumulated. It must be admitted that the number of recent collections is far less than would be desirable to resolve the question and an opportunity to carefully observe the plants in the field is very much needed. Still I believe that there is no other course now but to combine the two names since I am unable to find even strong tendencies let alone consistent differences to distinguish them.

Halenia crassiuscula was described from specimens gathered on "bare alpine summits, Nevado de Toluca, 14,000 ft." and the plants were as described *i.e.* much-branched, depressed ("2–4 inches in height") and altogether of the dwarfed aspect that alpine plants often possess. In contrast the type collection of *H. pringlei* is ±

unbranched and slender. The basal leaves of *H. crassiuscula* are described as oblanceolate and 3-nerved while those of *H. pringlei* are narrowly elliptic to lanceolate and apparently 1-nerved. The difference in venation is one of degree and the distinction disappears when one examines a larger series of specimens. The original descriptions and Allen's key depended greatly upon the supposed obtuseness of the calycine lobes of *H. crassiuscula* in contrast to their acuteness in *H. pringlei* but this distinction is completely blurred when a larger series of specimens is examined. In summary, none of the differences noted or observed holds up. In spite of the striking differences in the extremes, my study has convinced me that at present there is no way in which the two species can be maintained. A larger series of specimens is very much needed and it is surprising how little additional material has accumulated in the past fifty years or since Allen examined the available specimens for her dissertation.

The Flora of Guatemala attributes *Halenia crassiuscula* to the high volcanoes of western Guatemala but I believe that the specimens upon which its presence in that country rests are all stunted or grazed specimens of *Halenia decumbens,* a species which is common there. The corolline spurs of *H. crassiuscula* tend to be much more strongly divergent than the ± pendent spurs of *H. decumbens.* The stunted alpine specimens annotated as *H. crassiuscula* in the Flora of Guatemala and illustrated there (Fieldiana Bot. 24(8): 318, fig. 87. 1969) possess the normal corolla of *H. decumbens* which differ markedly from the strongly divergent spurs of *H. pringlei* (including *H. crassiuscula*). The variation of corolline spurs within *H. pringlei* is remarkable. Even in the type of *H. pringlei* the corollas vary from spurless to so strongly divergent as to be mostly horizontal with distally upturned tips but its variability does not extend to the elongate pendent spurs of *H. decumbens* (*s.l.*) so aptly illustrated in the above mentioned figure.

REPRESENTATIVE MEXICAN COLLECTIONS: **Veracruz:** in turf, Cofre de Perote, 14000 ft, 25 May 1938, *Balls 4610* (GH, US); open slopes, Apitza Ixtaccihuatl, 12700 ft, *Balls 5123* (US); in wet meadow E side of Cofre de Perote about 3860 m, 6 Aug 1958, *Beaman 2184* (GH, MSC, US). **Mexico:** Ojos de Agua, Nevado de Toluca, 12500 ft, 9 July 1938, *Balls 4964* (GH, MICH, MSC, US); bog in open sunny glades in forest of *Abies,* El Ricón de Selgado, Nevado de Toluca, 10,000 ft, 13 July 1938, *Balls 5200* (US); shore of large lake in the crater of the Nevado de Toluca, about 4140 m, 26 July 1958, *Beaman 1883* (GH, MICH, MSC, TEX, WIS, US); alpine meadow, S side of

Ixtaccihuatl, 3950–4000 m, 30 July 1958, *Beaman 1953* (MSC); in gravelly soil on rock slide of S wall of the crater of Nevado de Toluca about 4230 m, 2 July 1960, *Beaman 3454* (DUKE, GH, MSC, TEX, US); grassy alpine meadow on W slope S side of Ixtaccihuatl, 6 July 1960, *Beaman 3485* (GH, MSC, TEX); Amecameca, slopes of Popocatepetl between 10,000 and 12,000 ft, 4 July 1943, *Gilly & Dodds 23* (MICH, MSC); alpine zone on SW slope of Volcán Ixtaccihuatl 5–6 km N of Paso de Cortez, *Iltis, Koeppen & Iltis 1009* (MICH, WIS); springy alpine meadows, Sierra de las Cruces, 9800 ft, 28 Aug 1904, *Pringle 13121* (GH, MO, US); wet meadows, Ixtaccihuatl, 12–13000 ft, 1903, *Purpus 318* (MO, US); Palomas, Municipio de Iturbide, 3400 m, 18 July 1968, *Rzedowski 25930* (ENCB, MICH, MSC). **Tlaxcala:** turfy slopes, Mt. Malinche, above San Francisco, 22 June 1938, *Balls 4887* (US). **Distrito Federal:** in alpine meadow top of Cerro Ajusco, 3937 m, 12 July 1959, *Beaman 2776* (MSC).

10. **Halenia hintonii** Bullock, Hooker's Icon. Plant. 34: *tab. 3399.* 1939. [as *Hintoni*]. TYPE: MEXICO: Mexico; Distr. de Temascaltepec, Cumbre Trojes in *Pinus* and *Alnus* forest. *Hinton 8273* (K, HOLOTYPE; ENCB! F! GH! UTD! MO! NY! PH! ISOTYPES).

Perennial herb 1.2–3 dm tall with 4-sided, striate to narrowly winged stems. Basal leaves scarcely rosulate, the lowermost long petiolate, spatulate to oblanceolate or elliptic with the blades about 1.5–3(4.5) cm long and 1–1.5(2) cm wide with a rounded apex and tapering into a winged petiole 2–3.5 cm long; cauline leaves either sessile or tapering into an indistinct winged petiole, oblanceolate-elliptic or elliptic or somewhat lanceolate, (2)3–4.5 cm long and about 1 cm wide, apically acute to obtuse or somewhat rounded. Inflorescence a terminal or axillary, 3–7-flowered, umbellate cyme with pedicels quadrate and slightly wing-angled, 0.5–1.5 cm long. Calyx lobes erect, oblong or oblong-spatulate, 3–4 mm long and 1.5–2 mm wide, apically rounded or obtuse, marginally minutely papillate, 3-nerved; corolla white, about (6–)7–9 mm long, the tube 3–4 mm long, the lobes erect, ovate to oblong, 3–5 mm long, 2–2.5 wide, apically often shortly apiculate or occasionally broadly rounded, the spurs about 5–7 mm long, acute, slender, outwardly spreading or very strongly divergent and distally outwardly curved. Stamens included; filaments linear, about 1.5 mm long; anthers reniform-sagittate, about 1 mm long. Capsule thinly cartilaginous, about 1.2 cm long and 4 mm wide, apically often somewhat arcuate, apiculate; seeds ovoid, 16–20 in number, about 1.5 mm long and 1 mm in diameter, smooth, pale yellow.

DISTRIBUTION. Known only from the type locality in the state of Mexico.

11. **Halenia decumbens** Benth., Pl. Hartw. 67. 1840. TYPE: MEXICO; Oaxaca, "in monte Pelado," *Hartweg 494* (K, HOLOTYPE; G, photo! NY! W, photo! ISOTYPES).

Halenia longicornu Mart. & Gal., Bull. Acad. Brux. 11: 370. 1844. TYPE: Mexico; Oaxaca, Croît dans les endroits humides des forêts de pins, chênes et arbousiers du Cerro de San Filipe, pres d'Oaxaca, de 8,500 a 9,500 pieds," *Galeotti 7166* (BR, HOLOTYPE, photo!, MO-fragment!).

Halenia apiculata Mart. & Gal., Bull, Acad. Brux. 11: 371. 1844. TYPE: Mexico; Oaxaca, Se trouve avec l'*Halenia longicornu* au Cerro San Felipe, de 8 a 9,000 pieds, *Galeotti 7166* (G, HOLOTYPE).

Halenia plantaginea [var.] *apiculata* (Mart. & Gal.) Griseb., Linnaea 22: 45. 1849.

Tetragonanthus decumbens (Benth.) Kuntze, Rev. Gen. Pl. 2: 431. 1891.

Tetragonanthus longicornis (Mart. & Gal.) Kuntze, Rev. Gen. Pl. 2: 431. 1891.

Halenia guatemalensis Loesener, Verhandl. Bot. Vereins. Brandenb. 55: 182. 1913. TYPE: Guatemala; Huehuetenango, Todos Los Santos, road near Chiantla, 3000 m, *Seler & Seler 2728* (B, not seen, probably destroyed).

Halenia plantaginea var. *latifolia* Loesener, Verhandl. Bot. Vereins. Brandenb. 55: 182. 1913. TYPE: Guatemala; Huehuetenango, Todos Los Santos, Bergwald Oberh., 2800–3000 m, *Seler & Seler 3086* (B, not seen, probably destroyed).

Halenia shannonii Briq., Candollea 4: 320. 1931. TYPE: Guatemala; Sacatepéquez, Volcán de Agua, 12,400 ft. *Shannon* [J. Donnell Smith #] *3613* (G, HOLOTYPE; GH! MO! NY! US! ISOTYPES).

Halenia shannonii f. *compacta* C. K. Allen, Ann. Missouri Bot. Gard. 20: 178. 1933. TYPE: Guatemala; Huehuetenango, mountains above Chinantla, *Cook 45* (US! HOLOTYPE).

Halenia guatemalensis var. *latifolia* (Loesener) C. K. Allen, Ann. Missouri Bot. Gard. 20: 180. 1933.

Halenia caleoides C. K. Allen, Ann. Missouri Bot. Gard. 20: 173. 1933. TYPE: Guatemala; vicinity of Agua, 2700–3000 m, *Maxon & Hay 3675* (US! HOLOTYPE).

Halenia platyphylla C. K. Allen, Ann. Missouri Bot. Gard. 20: 173. 1933. TYPE: Guatemala: Sacatepéquez, Volcán Agua, 2875 m, *J. Donnell Smith 2170* (GH! HOLOTYPE; US! ISOTYPE).

Perennial herb (0.5)1.5–3(4.5) dm tall with 1 to several terete to quadrate, often slighlty winged stems commonly arising from a basal cluster of leaves and occasionally with elongate leafy offsets. Basal leaves elliptical to broadly oval or lanceolate to oblanceolate or even linear, long petiolate, acute to obtuse, typically 3-nerved but usually only the midvein prominent, (2–)3–6(12) cm long and (3–)6–12(–18) mm wide, acuminate to more typically acute to even obtuse; petiole usually sharply delineated from the blade and often comprising half the length of the leaf; cauline leaves 1–6 pairs, sessile to more typically the lower tapering into a petiole, 3-nerved although only the midvein prominent, (1.5–)2–4(–12) cm long and 5–15(–20) mm wide, elliptic to oblong-lanceolate or lanceolate, acute to acuminate. Inflorescence an axillary and terminal, umbelliform cyme with usually ascendent to erect pedicels 1–2 cm long. Calyx lobes erect, mostly oblong-elliptic to oblong or rarely oblanceolate, acute to acuminate and occasionally even apiculate, marginally minutely papillate, mostly half to three-fourths as long as the corolla but occasionally as long, 4–7 mm long and 2–2.5 mm wide; corolla mostly (1.0–)1.2–1.8(2.0) cm long, the lobes 1.5–3 mm long, yellowish to yellowish green or even green, broadly ovate to deltoid, usually acute but occasionally acuminate or sometimes obtuse, about as long as the tube, entire to erose, the spurs pendent to moderately divergent, slender, 4–7(10) mm long. Capsule exserted, elliptic to more typically lanceolate, 8–12(–18) mm long and (3–)4–6 mm wide.

DISTRIBUTION. grassy alpine slopes, talus slides and open montane woods from southern Mexico (Guerrero, Oaxaca and Chiapas) and western Guatemala (Chimaltenango, Huehuetenango, Quetzaltenango, Quiche, Sacatepéquez, San Marcos, Sololá, Totonicapán) reportedly ranging from 2000–4000(4200) m.

REPRESENTATIVE MEXICAN COLLECTIONS: **Guerrero:** open pine forest, Mina, Teotepec, 3600 m, 17 July 1939, *Hinton 14463* (MICH, US). **Oaxaca:** abundant on steep hillside in open *Pinus hartwegii* forest on Cerro Pelong, 25.5 miles E of Ixtlán along the Oaxaca-Valle Nacional Hwy about 2950 m, 21 July 1960, *Beaman 3672* (DUKE, GH, MSC, TEX, US); middle to upper slopes, Zempoaltepetl, Feb 1937, *Camp 2631* (ENCB, F, MICH, NY); in open pine woodland, about 3396 m, vicinity of Cerro Zempoaltepetl, 23 July 1950, *Hallberg 738* (MICH); Cerro de Humo at 10,000 ft, Comaltepec, 19 May 1971, *MacDougal s.n.* (F, NY); in pine and oak forest, Cerro Zempoalteptl, 9500 ft, 6 Aug 1963, *Molseed & Hallberg 300* (MICH); above road on rocky hill, 40 miles S of Valle Nacional, 22 Mar 1978, *Poole, Bain & Kerr 1287* (TEX); floor of dry oak forest, Cerro Cusimulco on northern slope near San Pedro Yolox, 2100 m, 24 June 1939, *Schultes 676a* (GH, MO); rich cloud forest about 29 miles N of Ixtlán de Juárez on Hwy 175 about 2800 m, 18 July 1976, *Stevens, Donoghue & Scott 2475* (ENCB, GH, MSC); Sierra Madre del Sur, cloud forest near top of Cerro Pilon c. 70 mi from Oaxaca, 9000–9100 ft, 20 June 1962, *Webster, Hallberg & K. & L. Miller 11558* (CAS, DUKE, F, GH, MSC, TEX). **Chiapas:** flat meadow and steep slopes on the SE side of the summit of Volcán Tacaná, 3600 m, 3 Mar 1972, *Breedlove 24313* (DS); small meadow near the summit of Volcán Tacaná, 30 July 1972 *Breedlove 26707* (DS); steep dry slope on the SE side of Volcán Tacaná above Talquian, 3500 m, 11 Nov 1972, *Breedlove 29406* (ENCB, DS, LL); steep slope on the N and W slope of Cerro Mozotal below microwave tower along road from Huixtla to El Porvenir and

Siltepec, 3000 m, 19 Sept 1976, *Breedlove 40311* (DS); slopes 5 km N of Mexican Hwy 190 on a logging road from Laguna Chamula microwave station, 2400 m, 15 Oct 1976, *Breedlove 40808* (DS); Siltepec, 9 Aug 1937, *Matuda 1596* (F, GH, LL, MICH, MO, NY, US); in pinelands, Mt. Tacaná, 2000–4038 m, Aug 1938, *Matuda 2346* (F, GH, LL, MICH, MO, NY, US); Mt. Male near Porvenir, 3200 m, 6 July 1941, *Matuda 4706* (GH, LL, MO, NY).

12. **Halenia plantaginea** (H.B.K.) G. Don, Gen. Hist. 4: 177. 1838.

Swertia plantaginea H.B.K., Nov. Gen. & Sp. Pl. 3: 175. 1818. TYPE: Mexico; in Andibus Mexicanis, *Humboldt & Bonpland s.n.* (P, photograph seen at MO, US).

Halenia elongata D. Don ex G. Don, Gen. Hist. 4: 177. 1838. TYPE: Mexico, (K, not seen. Described as an annual).

Halenia nudicaulis Mart. & Gal., Bull. Acad. Brux. 11: 371. 1844. TYPE: Mexico; Veracruz, Croît dans les forets humides du haut pic d'Orizaba, de 9 à 11,000 pieds d'élévation absolue Orizaba, *Galeotti 7220* (BR, HOLOTYPE; G, W, ISOTYPES, not seen).

Halenia nutans Mart. & Gal., Bull. Acad. Brux. 11: 371. 1844. TYPE: Mexico; Vera Cruz, Croît dans les forêts humides du haut Pic d'Orizaba, de 9 à 11,000 pieds d'élévation absolue *Galeotti 7222* (BR, HOLOTYPE; photograph seen, MO).

Tetragonanthus plantagineus (H.B.K.) Kuntze, Rev. Gen. Pl. 2: 431. 1891.

Halenia purpusi Brandegee, Zoe 5: 235. 1906. TYPE: Mexico; meadows above timberline, Ixtaccihuatl, *Purpus 1760* (CAS, HOLOTYPE not seen; F! MO! NY! US! ISOTYPES).

Halenia scapiformis Briq., Candollea 4: 322. 1931. SYNTYPES: Mexico: Sierra San Pedro Nolasco, Talla, etc. 1843–44, *C. Jurgensen 811 & 812* (G, not seen; photo of *812* seen (MO).

Halenia plantaginea f. *grandiflora* C. K. Allen, Ann. Missouri Bot. Gard. 20: 176. 1933. TYPE: Mexico: Nevado de Toluca, *Pringle 4224* (MO! HOLOTYPE; CAS! F! GH! MO! PH! NY! US! ISOTYPES).

Perennial herb with 1-several, striate to very narrowly winged, ± quadrangular, erect stems (0.8)1.5–3.0(4.5 dm tall, usually simple below and often with short, floriferous branches above, arising from a thick fleshy caudex. Basal leaves numerous, rosulate, the blades lanceolate or elliptic to ovate, 3-nerved, 3–10(15) cm long and 0.5–1.5 cm wide, obtuse to acute or even apiculate and with slender petioles (1)2–5 cm long, the cauline leaves 1–2 pairs, sessile, linear to lanceolate or broadly elliptic, (1–)2–3(–4.5) cm long. Inflorescence a terminal or axillary umbellate cyme with slightly curved or nodding slender pedicels (2–)8–18(–22) mm long. Calyx lobes lance-elliptic to oblong to even narrowly spatulate, 2.5–6 mm long, obtuse to acute or rarely even abruptly acuminate, 1/3–1/2 as long as the corolla, 3-nerved, microscopically marginally papillate; corolla yellow, (0.7–) 1–1.7 cm long, the tube slightly shorter than the ovate to oblong, obtuse to acute lobes, the spurs very slender, pendulous, distally slightly incurved, mostly 1/3–1/2 length of corolla, (2)3–5(7) mm long. Filaments linear; anthers ovate. Capsule elliptic to lanceolate in outline, subfalcate, (0.7–) 1.2–1.8 cm long and about 5 mm wide, exserted; seeds subglobose, brown, granular.

DISTRIBUTION. Mountains of central and southern Mexico (Vera Cruz, Hidalgo, Mexico, Tlaxcala, Puebla, Michoacán, Morelia and Oaxaca).

The merit of *H. nudicaulis* as a distinct species separate from *H. plantaginea,* although not accepted in this treatment, is still deserving of critical study. The differences noted to differentiate *H. nudicaulis* from its nearest congener are all quantitative. The size of the plant as well as its leaves, corolla and spur length and the size of the capsules are all smaller in *H. nudicaulis* than in *H. plantaginea* and the suspicion is natural that this might well be environmentally induced. Specimens of *Halenia nudicaulis* all come from the upper altitudinal limits of *H. plantaginea s.l.* Opportunity to study populations of these plants in the field might do much to resolve this question. In any event the two are very closely related to one another and my expectation is that further study will demonstrate that *H. nudicaulis* is not specifically distinct.

Specimens thought to be representative of *H. nudicaulis* seemingly were separable from *H. plantaginea* by the following key:

a) Corolla less than 10 mm long; corolline spurs less than 2.5(–3) mm long; capsule less than 10(–13) mm long .... *H. nudicaulis.*

a) Corolla 10 mm long or longer; corolline spurs (2–)3–5(7) mm long; capsule 1.2–1.8 mm long .... *H. plantaginea.*

I believe the available collections suggest that the specimens referred to *H. nudicaulis* are merely smaller plants usually found in less favorable sites usually at the upper altitudinal range of *H. plantaginea s.l.*

Allen (1933, p. 177) stated in regard to f. *grandiflora* that it "appears to be only a variation due merely to habitat, moisture, or some nutritional factor" and that "it has no distinctive geographical distribution." From her own observations one would conclude that this variant did not deserve a formal rank. This apparently represents the opposite extreme of variation within *H. plantaginea* than *H. nudicaulis.* Specimens of f. *grandiflora* are seemingly from the more favorable habitats within the range of *H. plantaginea.*

REPRESENTATIVE SPECIMENS: **Tamaulipas:** open rocky slopes of Cerro Linadero [near] Dulces Nombres, Nuevo Leon and just E of border of Tamaulipas-Nuevo Leon, 2450 m, 10 Aug 1948, *Meyer & Rogers 2917* (MO). **Nuevo Leon:** open pine woods, Cerro del Viejo, 15 mi W Dulces Nombres, 18 Aug 1948, *Meyer & Rogers 2971* (MO). **Queretaro:** bosque de Abies, 1 km al SW de la cumbre, Cerro Zamorano, 3100 m, 13 Nov 1971, *Rzedowski & McVaugh 404* (ENCB, MICH). **Hidalgo:** Mt. Orizaba among thin grass in open forests of *Pinus*, 10,500 ft, 18 Aug 1938, *Balls 5281* (GH, MICH, MSC, US). Sierra de Pachuca, 10,000 ft, 22 Aug 1902, *Pringle 11033* (F, GH, MICH, MO, NY, US); S slopes Cerro Jihuingo (19° 49–50′ N, 98° 33–34′ W), 2750–3250 m, 26 July 1966, *West T-16* (MICH, WIS). **Veracruz:** Los Pescados, Cofre de Perote, 9500 ft, 12 Sept 1938 *Balls 5434* (MSC, US); pine forests, Citlaltepetl, 11–12000 ft, *Purpus 2766* (F, GH, MO, NY). **Mexico:** open pine woods, Ojos de Agua, Nevado de Toluca, 12500 ft, 9 July 1938, *Balls 4963* (ENCB, GH, MICH, US); upper pine belt, Volcán de Zinantecatl near Toluca, about 10,000 ft, 23 Aug 1947, *Barkely, Webster & Westlund 44* (F, TEX, US); open pine forest, NW side of Nevado de Toluca between Loma Alta and Cerro Gordo, 3450 m, 7 Sept 1957, *Beaman 1678* (GH, MSC, TEX, US); in grassy meadow under open pine forest, Telapon N of Iztaccihuatl, S side of mountain, 3450–3650 m, 4 Sept 1958, *Beaman 2435* (GH, MSC, US); forest of pine and fir, Las Cruces, Temascaltepec, 3350 m, 13 July 1932, *Hinton 1034* (F, LL, MO, NY, PH, US); under thick pine, Monte de Río Frio, km 49 road from Mexico City to Pueblo, 4000 m, 31 July 1929, *Mexia 2693* (CAS, MICH, MO, NY, US); springy alpine meadows, Sierra de las Cruces, 9800 ft, 28 Aug 1904, *Pringle 13121* (CAS, MICH, MO); subalpine meadow, Popocatepetl, Sept 1908, *Purpus 3070* (F, GH, MO, NY, US). **Distrito Federal:** Río Frío, 27 Aug 1930, *Russell & Souviron 74* (CAS, GH, US). **Tlaxcala:** in pine and fir forest on N slope of Cerro Matlalcueyetl, 26 Sept 1953, *Sohns 680* (MICH, US). **Michoacan:** in open pine forest, summit of Cerro San Andres, about 12 km N of Ciudad Hidalgo, 3589 m, 6 Sept 1960, *Beaman 4271* (GH, MSC, US); pine forest, Zitacuaro-Cacique, 3325 m, 29 Aug 1938, *Hinton 13175* (F, GH, ILL, LL, MICH, NY, PH, TEX, US); only under pines, summit of Cerro Tancitaro, 12,600 ft, 17 July 1940, *Leavenworth 277* (F, GH, ILL, NY). **Morelos:** pine-fir forest, Lagunas de Zempoala, 29 July 1957, *Straw & Gregory 1071* (MICH). **Puebla:** open forest of Pinus, Tesmalaquilla, Mt. Orizaba, 10,500 ft, 18 Aug 1938, *Balls 5281* (GH, MICH, MO, US); in grassy pine forest about 3 miles SE of Villa Hidalgo, Pico de Orizaba, about 3780 m, 15 July 1960, *Beaman 3648* (GH, MSC, TEX, US); in pine forest about 2 km NE of the Paso de Cortez Monument, about 3700 m, 10 Sept 1960, *Beaman 4445* (GH, MSC, US); Mt. Orizaba, 12,000 ft, 6 Aug 1891, *Seaton 205* (F, GH, NY, US). **Oaxaca:** vicinity of Cerro Zempoaltepetl on SE slopes of peak, 2900–3100 m, 10 Aug 1950, *Hallberg 919* (MICH); vicinity of Cerro San Felipe, 9500-11000 ft, *Nelson 1096* (GH, US); Sierra de San Felipe, 10,000 ft, 23 June 1894, *Pringle 4720* (ENCB, GH, MICH, MO, MSC, NY, PH, US).

ACKNOWLEDGMENTS

Grateful acknowledgment is made to the National Science Foundation for a grant to Duke University (DEB-76-10185) that made this study possible. I am also very grateful to the curators of the herbaria listed below whose loans provided the basis for this study: CAS, DUKE, DS, ENCB, F, GH, ILL, MICH, MO, MSC, NY, PH, TEX, US, WIS.

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A REVISION OF THE MEXICAN AND CENTRAL AMERICAN SPECIES OF *CERASTIUM* (CARYOPHYLLACEAE)

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ABSTRACT

Eighteen species of *Cerastium* are known to occur in Mexico and Central America, including 16 native and two alien species. The limits of these species are described and their taxonomy is revised. Three species are newly described.

Key Words: *Cerastium*, Caryophyllaceae, Mexico, Central America, systematics, taxonomy

INTRODUCTION

Cerastium, known commonly as "mouse-eared chickweed", is of virtually worldwide distribution with its center of diversity in Eurasia. The number of species included varies (Pax and Hoffmann, 1934; Lawrence, 1951; Willis, 1973). The genus is represented in Mexico and Central America by 18 species, all but two of which are native.

While the taxonomy and relationships within *Cerastium* are not well understood anywhere, this situation is particularly true in Latin America. It was in order to improve the understanding and facilitate the identification of species in Latin America that this study was conducted. In looking for diagnostic characters, only externally visible characters were used. Neither cytological nor biochemical characters were investigated; work in these areas may further improve the systematics of *Cerastium*.

Since only morphological features were available for analysis, the species concept employed is necessarily typological. I have tried to be conservative in assigning taxonomy. Hence, in such variable species as *Cerastium nutans* and *C. sinaloense*, I have not tried to give specific or varietal status to forms which may warrant it but for which insufficient material is available.

Cerastium is in many ways a difficult genus. Species are often poorly delimited, resulting in the publication of many names which have since been reduced to synonymy. Relationships among species

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have also been poorly understood. Pax and Hoffmann (1934) described a system of subgeneric classification based primarily on style number and capsule morphology, and included the Mexican and Central American species in their subgenus *Cerastium*. While they listed none of these species in their discussion of sections, it is clear from character descriptions that all of them, with the possible exceptions of *C. sinaloense, C. sordidum,* and *C. texanum,* belong to the section *Orthodon*. Robinson (1894) included *C. texanum* in the section *Strephodon* (*C. sinaloense* and *C. sordidum* were as yet undescribed), but the presence of revolute capsule teeth makes this inclusion unlikely since Pax and Hoffmann (1934) stated that its members never have this character.

The literature concerning Mexican and Central American species of *Cerastium* consists primarily of lists of species collected on a single expedition, by a particular collector on several expeditions, or by several collectors from a single region (Schlechtendal and Chamisso, 1830; Presl, 1831; Schlechtendal, 1838; Schultz, 1862; Hemsley, 1878; Britton, 1888; Watson, 1888; Sessé and Mociño, 1894; Robinson, 1900, 1904; Greenman, 1904; Briquet, 1911; Standley, 1937; Standley and Steyermark, 1940, 1944). More recently floras have appeared, some of which treat species of *Cerastium*. These include Sanchez S. (1968) and Beaman (1979) for the Valley of Mexico, Shreve and Wiggins (1964) for the deserts of Sonora and Baja California, Standley (1937) for Costa Rica, and Standley and Steyermark (1946) for Guatemala.

CHROMOSOME VARIATION IN *CERASTIUM*

Published chromosome counts for species of *Cerastium* range from $2n = 34$ to $2n = 180$. By far the majority of these are multiples of $n = 18$ ($2n = 36$, 54, 72, 90, 108, 126, 144, 162, and 180). Brett (1952) stated that $2n = 36$ is probably tetraploid, although $2n = 18$ is unknown, and she concluded that, for the section *Orthodon,* the basic chromosome number is probably $n = 9$. She also stated that the species in the section *Strephodon* are mostly $2n = 38$ or multiples thereof and that the basic number for these is probably $n = 19$. Many of the species from Mexico and Central America seem to be $2n = 34$ (Beaman et al., 1962), but she made no mention of any of these.

Known chromosome numbers for the Mexican and Central American species are listed following the individual species descriptions below. The native species can readily be separated into two groups, those with $2n = 34$ and those with $2n = 36$. Some question arises as to the position of *Cerastium nutans* in this scheme since Söllner (1952, 1954) listed the chromosome number as $2n = 35–36$, while Beaman et al. (1962) counted $2n = 34$ for a *Cerastium* sp. which, upon further examination of the voucher specimen, turned out to be *C. nutans.* Söllner, however, did not use Mexican material for his count and it is possible that the species is geographically variable in chromosome number.

Beaman et al. (1962) published the only chromosome counts for several of the Mexican and Central American species of *Cerastium.* After study of the voucher specimens for these counts, it has become apparent that some revisions of their determinations are in order. *Beaman 3745* and *Beaman 3896,* recorded as *C. brachypodum,* are specimens of what is here recognized as *C. cuchumatanense. Beaman 3436* and *Beaman 3508,* reported as *C. orithales,* are *C. ramigerum. Beaman 3711,* listed as *Cerastium* sp., is *C. nutans.*

KEY TO THE SPECIES

1. Capsules straight, teeth revolute; rosette leaves absent, lower leaves large, crowded and broadly spatulate, upper leaves few (2–25, usually fewer than 10), smaller and lanceolate .. (2)
  2. Petals large, 10.0–17.5 mm long, usually greater than 14.0 mm; Pacific side of the Sierra Madre Occidental....... .... 13. *C. sinaloense*
  2. Petals smaller, not more than 8.0 mm long; Chihuahuan-Sonoran Sierra Madre and Baja California .... (3)
    3. Stems very slender; stems, leaves and sepals soon turning light orange-brown with age; cyme 8–25 flowered; flowers small, petals 4.0–5.5 mm long; capsules short, 4.0–7.0 mm long, barely exserted beyond the calyx; Baja California ....15. *C. texanum*
    3. Stems not particularly thin; stems, leaves and sepals remaining green; cyme 3–10 flowered; flowers larger, petals 5.5–8.0 mm long; capsules longer, 8.0–13.5 mm long, well exserted beyond the calyx; mainland .... 14. *C. sordidum*

1. Capsules curved, teeth not revolute; spatulate lower leaves sometimes present, but usually as rosette leaves .... (4)
 4. Lanate pubescence present (at least some), usually best seen at the nodes and on the rosette leaves (when present) and lower cauline leaves (this character is sometimes hard to see in old specimens of *C. vulcanicum*) .... (5)
  5. Sepals, pedicels and usually the upper parts of the stem glandular-pubescent .... (6)
   6. Plants regularly branching above the base; basal rosette usually lacking; cymes usually more or less many flowered; petals usually less than, equal to, or only slightly exceeding the sepals in length; annual .. (7)
    7. Plants usually fairly large (over 25 cm tall); internodes longest just below the inflorescence, becoming shorter toward the base; pedicels fairly long, 18.0–30.0 mm long; petals usually equal to or only slightly exceeding the calyx in length, white; seeds 0.7–1.0 mm in diameter .... 9. *C. nutans*
    7. Plants smaller (6–30 cm tall); internodes more or less equal throughout; pedicels short, 5.0–15.5 mm long; petals shorter than the sepals (except on Pico de Orizaba and Cofre de Perote and sometimes on Ixtaccihuatl and Popocatepetl), white or more often pale green; seeds 0.5–0.7 mm in diameter .... 18. *C. vulcanicum*
   6. Plants branching usually only at the base; basal rosette almost always present; cyme relatively few (1–13) flowered; petals usually well exceeding the sepals in length; perennial .... (8)
    8. Plants usually fairly large (15–35 cm tall); cauline leaves few (usually 2–3 pairs); pedicels longer, the lower ones 18.0–32.0 mm long; sepals lanceolate; seeds 0.9–1.3 mm in diameter; Sierra Madre of Chihuahua and Durango .... 8. *C. madrense*
    8. Plants smaller, usually less than 20 cm tall; cauline leaves numerous, closer together (though still usually shorter than the internodes); pedicels shorter, though sometimes to 25.0 mm long; sepals elliptic; seeds 0.7–0.9 mm in diameter; volcanoes of central Mexico

(Distrito Federal, Mèxico, Michoacan and Puebla) .... 16. *C. tolucense*

5. Plants nowhere glandular-pubescent................ (9)
   9. Plants low, caespitose; internodes usually shorter than the leaves; cymes dense, flowers crowded at the apex of each fertile branch; pedicels usually shorter, less than 10.0 mm long; capsules broader .... 11. *C. purpusii*
   9. Plants not very caespitose; internodes usually longer than the leaves; cymes looser; pedicels usually longer, to 25.0 mm long; capsules less broad ..... 16. *C. tolucense*

4. Lanate pubescense lacking .... (10)
   10. Plants glabrous or only *very* sparsely pilose, hairs on the pedicels subreflexed .... 2. *C. barberi*
   10. Plants more or less densely pubescent............ (11)
      11. Pedicels short, the lowermost (longest) usually less than 10.0 mm long .... (12)
         12. Glandular hairs few or lacking; flowers usually many, very densely crowded at the apex of each fertile branch; introduced species .... (13)
            13. Bracts scarious margined; flowers larger, sepals usually 4.5–6.5 mm long; capsules longer, 7.0–11.5 mm long; seeds larger, 0.5–0.7 mm in diameter; perennial............ 17. *C. triviale*
            13. Bracts herbaceous; flowers smaller, sepals 3.0–4.5 mm long; capsules shorter, 5.0–9.0 mm long; seeds smaller, 0.3–0.4 mm in diameter; annual .... 5. *C. glomeratum*
         12. Glandular hairs predominant, at least on the sepals and pedicels; flowers not densely crowded, or if crowded, then flowers few; native species... (14)
            14. Petals shorter than the sepals .... (15)
               15. Plants larger, usually over 10.0 cm tall; leaves more or less similar throughout; lowermost flower well above the ground .... 3. *C. brachypodum*
               15. Plants smaller, usually less than 10.0 cm tall; lower leaves often more or less spatulate; lowermost flowers near ground level .... 1. *C. axillare*

14. Petals longer than the sepals .... (16)
    16. Leaves often more or less erect, close to the stem; pedicels with short, dense, subreflexed hairs; flowers nodding; petals larger, 6.5–10.5 mm long, well exserted beyond the calyx; perennial; volcanoes of central Mexico (México, Puebla, Tlaxcala, and Veracruz) .... 12. *C. ramigerum*
    16. Leaves more spreading; pedicel hairs not reflexed; flowers not nodding; petals shorter, capsules 4.0–7.0 mm long, often barely exserted beyond the calyx; annual; Sierra de los Cuchumatanes and various Guatemalan volcanoes .... 4. *C. cuchumatanense*

11. Pedicels longer, usually more than 10.0 mm long .... (17)
    17. Cymes few (1–8) flowered; flowers large, sepals 6.0–7.5 mm long, petals 9.5–18.5 mm long; capsules longer, 12.0–17.0 mm long .... (18)
        18. Plants very slender, propped up by the surrounding vegetation; pedicels with short, dense, subreflexed hairs; volcanoes of central Mexico (México, Puebla, and Veracruz) .... 10. *C. orithales*
        18. Plants more or less free-standing; pedicel hairs not reflexed; Sierra de los Cuchumatanes, Guatemala .... 7. *C. juniperorum*
    17. Cymes usually many (to 40 but usually somewhat fewer) flowered; flowers smaller, sepals 3.0–6.0 mm long; capsules shorter, 6.0–10.5 mm long ... (19)
        19. Leaves acuminate; leaves more or less similar in size throughout; perennial; volcanoes of Guatemala .... 6. *C. guatemalense*
        19. Leaves not acuminate (except in a form found in central Mexico); leaves largest at the base, smaller upward; annual......... 9. *C. nutans*

TAXONOMIC TREATMENT

GENERIC DESCRIPTION

Cerastium Linnaeus, Sp. Pl., ed. 1, p. 437. 1753.

TYPE SPECIES: *Cerastium arvense* L., lectotype of Britton and Brown (1913).

Centunculus Adanson, Fam. 2: 256. 1763.
Prevotia Adanson, Fam. 2: 256. 1763.
Moenchia Ehrhart, Beitr. 2: 177. 1788.
Quaternella Ehrhart, Beitr. 4: 149. 1789.
Doerriena Borkhausen *in* Rhein, Magaz. 2: 528. 1793.
Myosotis Tournefort *ex* Moench, Meth., p. 224. 1794.
Esmarchia Reichenbach, Fl. Germ. Excurs., p. 793. 1832.
Dufourea Grenier, Act. Soc. Linn. Bord., p. 25. 1837.
Doerriera Steudel, Nom., ed. 2, 1: 522. 1840.
Prevotia Steudel, Nom., ed. 2, 2: 394. 1840.
Dichodon Bartling *ex* Reichenbach, Nom., p. 205. 1841.
Pentaple Reichenbach, Ic. Fl. Germ. 37: 227. 1841.
Leucodonium Opiz, Seznam, p. 59. 1852.

(Synonymy according to Jackson, 1895; and Pax and Hoffman, 1934).

Plants herbaceous, low and caespitose to fairly tall and erect, often decumbent; annual or perennial; stems almost always pubescent, either glandular or not; leaves variously linear to elliptical or spatulate, opposite, exstipulate, entire, acuminate, acute or obtuse, variously pubescent, usually without a petiole; basal rosette present or lacking; cauline leaves few to many, usually shorter then the rosette leaves when the latter are present; inflorescence a cyme, either compact or loose; flowers various in size, from very small (sepals 2.5 mm long) to larger (sepals over 8 mm long); petals shorter than to more than twice as long as the sepals; sepals 5, rarely 4, lanceolate to elliptic, acute, scarious margined, usually pubescent; petals 5, rarely 4 or absent, usually white, variously bifid; stamens 10, rarely 5 or 4, shorter than the petals; ovary superior, carpels 5, rarely 4 or 3; styles 5, rarely 4 or 3, opposite the sepals; capsules usually well exserted beyond the calyx at maturity, opening apically by twice as many teeth as there were styles; seeds many, small (0.3–1.2 mm in diameter), variously tuberculate.

In Mexico and Central America only the most frequent numbers of flower parts are found: 5 sepals, 5 petals, 10 stamens, and 5 styles.

The name *Cerastium* is derived from the Greek "cerastes" meaning "horned", in reference to the shape of the capsule.

TREATMENT OF INDIVIDUAL TAXA

1. **Cerastium axillare** Correll, Brittonia 18: 308. 1966. TYPE: UNITED STATES. Texas: Jeff Davis Co., Little Aguja Canyon, Buffalo Trail Scout Camp Area, Davis Mountains, *Correll & Ogden 25069* (HOLOTYPE: LL).

Plant annual; branches few, usually erect; stems short (usually less than 10 cm tall), often more or less caespitose, glandular-pilose; lower leaves somewhat spatulate, those above lanceolate to elliptic, 7.0–20.0 mm long, 1.0–6.0 mm wide, acute to obtuse, more or less glandular-pilose; basal rosette lacking; cymes 5–20 flowered, bracts not scarious margined, lowermost flowers often close to the ground; pedicels short, 2.0–5.0 mm long, glandular-pilose; sepals lanceolate, 3.0–5.0 mm long, 1.0–1.5 mm wide, acute, scarious-margined except at the apex, viscid-glandular; petals shorter than the sepals, 3.0–4.5 mm long, bifid about 1/4 of their length, white; filiments 2.5–3.0 mm long, anthers 0.3 mm long; styles 1.0–1.2 mm long; capsules 6.0–11.7 mm long, 2.0–2.6 mm wide; seeds 0.4–0.7 mm in diameter, light brown, tuberculate; chromosome number unknown.

DISCUSSION: *Cerastium axillare* is known in the United States only from the Trans-Pecos of Texas. In Mexico it has been collected in Chihuahua, Coahuila, and Durango (Figure 1A). No habitat information is given on any of the Mexican specimens but Correll and Johnson (1970) listed "open forested slopes, rocky hills and grasslands in the mountains."

SPECIMENS EXAMINED: **Mexico.** CHIHUAHUA: 10–15 mi southwest of Nueva Casas Grandes, *Correll & Johnston 21694* (LL); Puerta de San Diego, alt. ca. 6500 ft, *Hartman 637* (GH, NY, US). COAHUILA: 45 mi east of Saltillo, *Palmer s.n.* (GH). DURANGO: Otinapa, *Palmer 375* (F, GH, MO, NY, UC, US). **United States:** TEXAS: Jeff Davis Co., Little Aguja Canyon, Buffalo Trail Scout Camp Area, Davis Mountains, *Correll & Ogden 25069* (LL, holotype).

2. **Cerastium barberi** Robinson, Proc. Boston Soc. Nat. Hist. 31: 266. 1904. TYPE: MEXICO. Chihuahua: In the Sierra Madres near Colonia García, 27 June 1899, *Townsend & Barber 453* (HOLOTYPE: GH; ISOTYPES: MO, US).

Plant perennial; stems 10–35 cm tall, sometimes branched basally; branches erect, glabrous or only extremely sparsely pilose; internodes quite long just below the inflorescence, grading to very short at base; leaves linear to lanceolate, 8.0–20.0 mm long, 1.0–3.5 mm wide, acute, virtually glabrous; cymes 1–6 flowered, bracts not scarious-margined; pedicels 2.0–14.6 mm long, hooked in fruit, almost glabrous or with only very short reflexed hairs; sepals lanceolate to ovate, 4.5–5.0 mm long, 1.1–1.7 mm wide, acute, scarious-margined, glabrous or with a few ciliate hairs on the margin at the base; petals 5.5–6.5 mm long, bifid about 1/4 of their length, white; filaments 5.0–6.5 mm long, anthers 0.7 mm long; styles 2.0–2.2 mm long; capsules 8.0–10.0 mm long, 2.3–3.1 mm wide, curved; seeds 0.8–1.0 mm in diameter, tuberculate; chromosome number unknown.

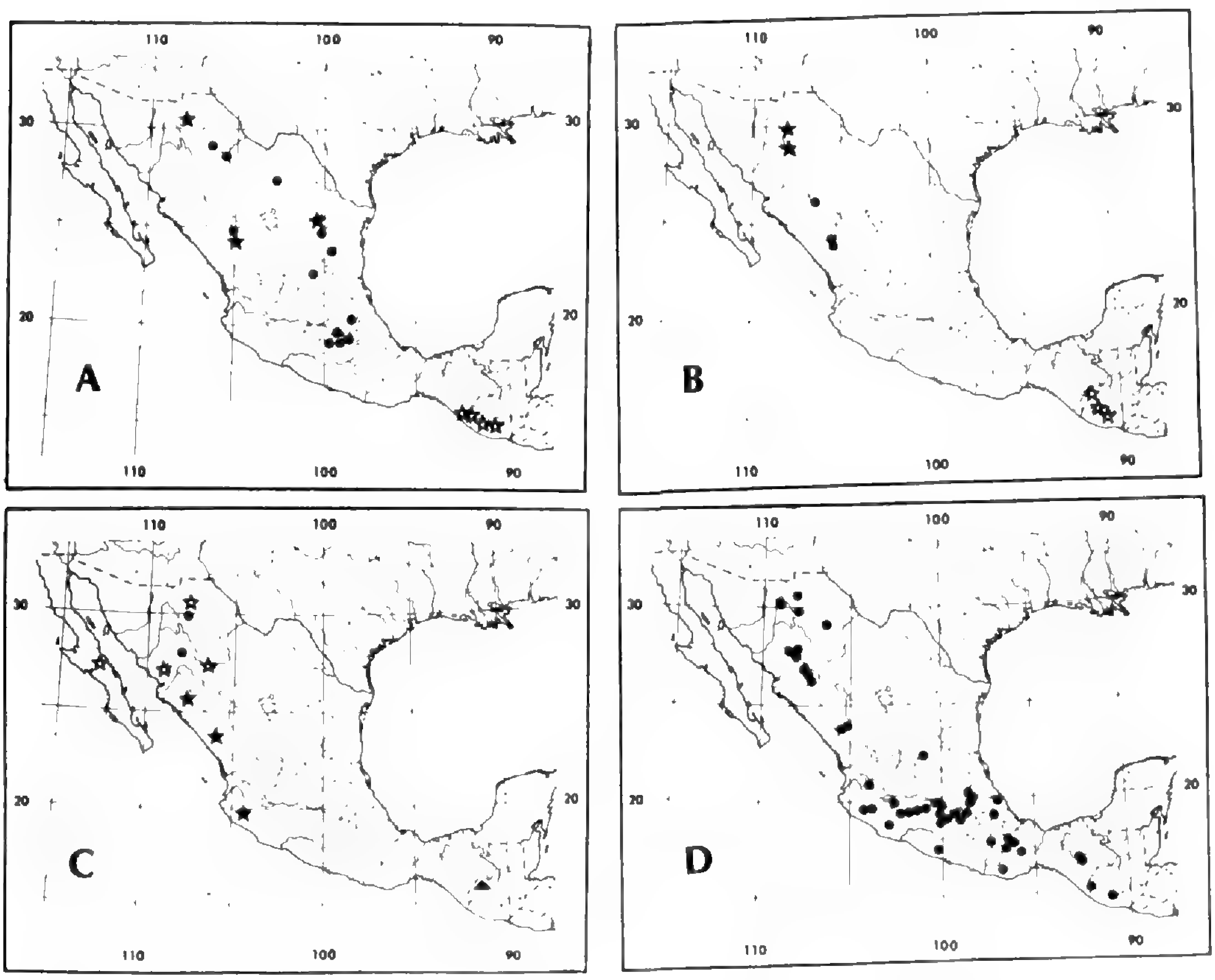

Figure 1. Distribution in Mexico and Central America of *Cerastium*. **A.** *C. axillare* (closed stars), *C. guatemalense* (open stars), and *C. brachypodum* (closed circles); **B.** *C. barberi* (closed stars), *C. cuchumatanense* (open stars), and *C. madrense* (closed circles); **C.** *C. juniperorum* (triangle), *C. sinaloense* (closed stars), *C. texanum* (open stars), and *C. sordidum* (closed circles); and **D.** *C. nutans*. There is also a single specimen of *C. guatemalense* from Costa Rica.

DISCUSSION: *Cerastium barberi* is known primarily from two collections both apparently made on the same expedition and in the same place; in the Sierra Madre Occidental near Colonia García, Chihuahua (Figure 1B). The elevation was about 2290 m, but no other habitat information is available. Another specimen, collected at Yepáchic, Chihuahua, also appears to be referable to *Cerastium barberi* although it is slightly more pubescent.

SPECIMENS EXAMINED: **Mexico.** CHIHUAHUA: Near Colonia García, *Nelson 6167* (GH, US); Yepáchic, *Pennington 49* (TEX); In the Sierra Madres near Colonia García, alt. ca. 7500 ft, *Townsend & Barber 453* (GH, holotype; MO, US, isotypes).

3. **Cerastium brachypodum** (Engelmann *ex* Gray) Robinson, Proc. Amer. Acad. Arts 29: 277. 1894. TYPE: "w. Illinois and southwestward" (not seen).

Cerastium nutans var. *brachypodum* Engelmann *ex* Gray, Man., ed. 5, p. 94. 1867. TYPE: same as above.

Cerastium nutans var. *genuinum* (lusus 2) Rohrbach, Linnaea 37: 289. 1873. TYPE: "Habitat in media parte totus fere Americae borealis usque ad finis Mexicanos" (not seen).

Plant annual; usually diffuse, branches few to many, usually more or less erect but sometimes decumbent; stems to 40 cm high but usually less than 20 cm, very small in alpine and other harsh environments, glandular-pilose, often very viscid; leaves usually similar throughout, lanceolate to elliptic, 7.0–21.0 mm long (usually shorter than the adjacent internode), 1.2–5.0 mm wide, acute, rarely obtuse, more or less glandular-pilose; basal rosette lacking; cymes 5–30 flowered, bracts not scarious-margined; pedicels short, 2.1–5.8 mm long, glandular-pilose; sepals lanceolate, 3.2–5.8 mm long, 1.0–1.8 mm wide, acute, scarious-margined except at the apex, viscid-glandular; petals shorter than the sepals, 3.0–4.5 mm long, bifid about 1/4 of their length, white; filaments 2.6–3.2 mm long, anthers 0.3 mm long; styles 1.0–1.2 mm long; capsules 6.3–12.8 mm long, 2.0–2.8 mm wide; seeds 0.4–0.7 mm in diameter, light brown, tuberculate; chromosome number unknown.

DISCUSSION: *Cerastium brachypodum* is a species of varied habitat. In Mexico it has been collected at elevations from 2000 to over 3800 m in such habitats as *Pinus* and *Populus* woodlands and alpine and subalpine meadows. It is often a species of disturbed areas such as trails and roadsides. Found in the United States and Canada north to southeastern Virginia, Illinois, North Dakota, Alberta, and Washington (Fernald 1950), it ranges into Mexico as far south as the state of México. It has been collected in the states of Chihuahua, Coahuila, Durango, Hidalgo, México, Nuevo Leon, Queretaro, San Luis Potosí, Tamaulipas, and Zacatecas (Figure 1A).

Cerastium brachypodum is often considered to be a form of *C. nutans* and many recent floras and checklists have listed it as such. However, at least in the area covered by the present work, the two forms are sympatric and easily distinguishable. I therefore retain their specific status.

Representative specimens: **Mexico.** CHIHUAHUA: Majalca, *LeSueur 624* (F, GH, MO, TEX, UC, US). COAHUILA: Municipio de Ocampo, Sierra Maderas del Carmen, at Ojo del Negro below and west of Campo 0, alt. ca. 2100 m, *Riskind & Patterson 1801* (LL). DURANGO: Tejamen, *Palmer 542* (GH, US). HIDALGO: Sierra de Pachuca, alt. ca. 10,000 ft, *Pringle 11321* (ENCB, F, GH, US). MEXICO: Cañada Alcalicán, La Joya side of Ixtaccihuatl, alt. ca. 3850 m, *Murry 47* (MSC); on road to Nevado de Toluca, alt. ca. 3540 m, *Murray 52* (MSC). NUEVO LEON: Peña Nevada, alt. ca. 3200 m, *Good 1006* (MSC); Cerro Potosí, just above timberline, *Mueller 2245* (F, GH, MICH, MO); QUERETARO: Cerro Zamorano, 1 km southwest of the cumbre, alt. ca. 3100 m, *McVaugh 466* (ENCB). SAN LUIS POTOSI: Sierra de Alvarez, cerca de Puerto Huerta, alt. ca. 2300 m, *Rzedowski 4118* (ENCB, MSC). TAMAULIPAS: between Marcella and Hermosa, *Stanford et al. 2650a* (NY, US). ZACATECAS: Alt. 7000–8000 ft, *Purpus 415* (MO, UC, US).

4. **Cerastium cuchumatanense** D. A. Good, *sp. nov.* Type: Guatemala. Huehuetenango: Sierra de los Cuchumatanes, immediately north of Tojiah at km. 322 on Ruta Nacional 9N, alt. ca. 3200 m, 1 August 1960, *Beaman 3891* (holotype: MSC; isotypes: GH, TEX, US) (Figure 2).

Planta annua. Caules usque ad 25 cm alti sed plerumque minus quam 10–15 cm, plerumque basi ramosi, rare superne. Rami erecti vel saepius ascendentes, glanduloso-pilosi. Folia omnia similaria, anguste ad late lanceolata, foliis in ramis sterilibus saepe ovatis vel leviter spathulatis, 6.0–11.2 mm longa (internodiis contiguis longiora vel breviora), 1.8–3.0 mm lata, acuta vel obtusa, interdum plus minusve ad apicem rotundata, plus minusve dense pilosa. Rosula

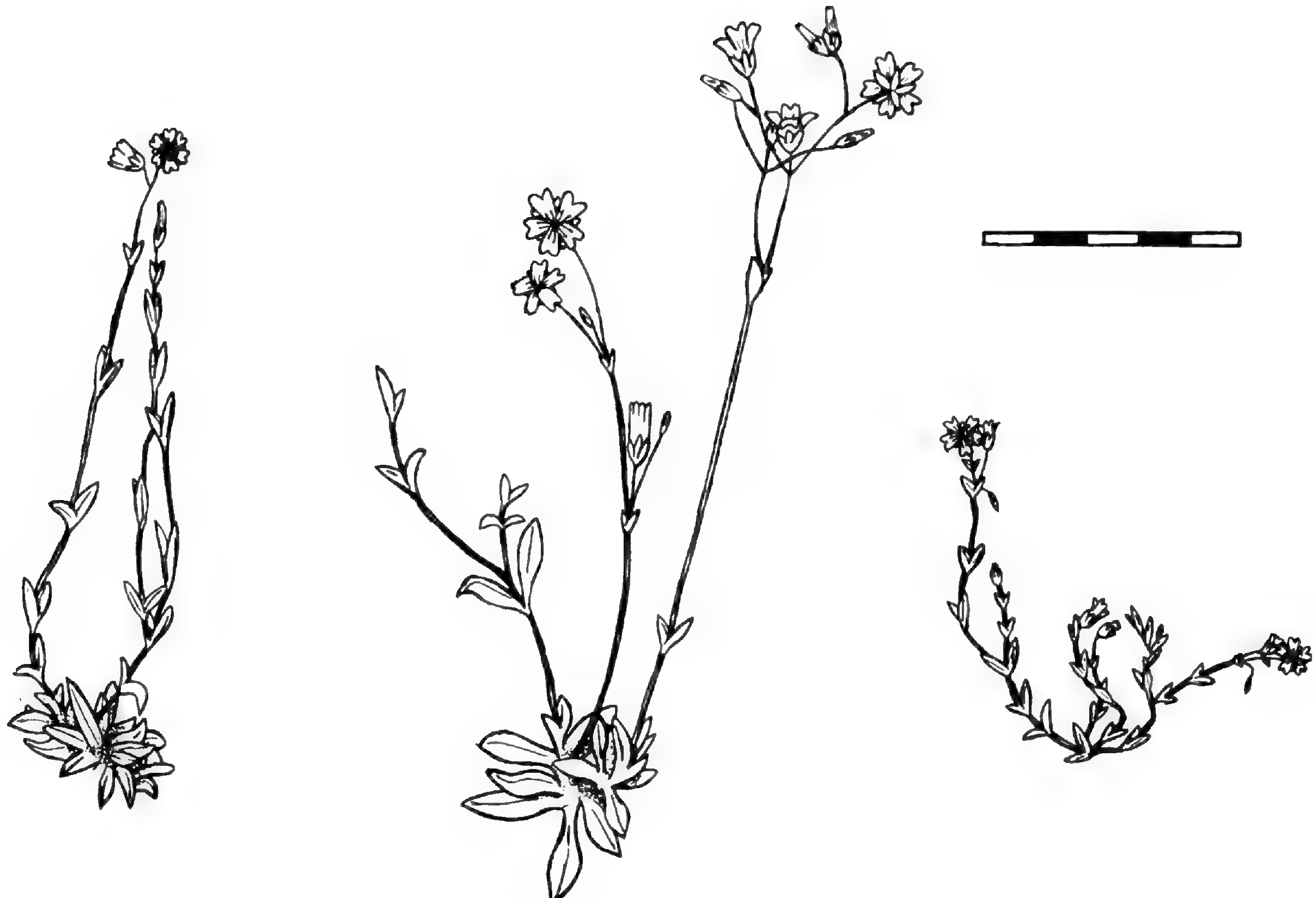

Figure 2. Illustrations of *Cerastium*. (Left to right) *C. tolucense*, *C. sinaloense*, and *C. cuchumatanense*. The scale in the upper right represents 5 cm.

basalis absens. Cymae plerumque 3–8 floribus, floribus ad apicem uniuscujusque rami fertilis aggregatis. Pedicelli brevissimi, 1.2–5.0 mm longi, glanduloso-pilosi. Sepala lanceolata usque ovata, 3.0–5.0 mm longa, 1.1–1.6 mm lata, glandulifera, praeter apicem anguste scarioso-marginata. Petala 4.2–6.2 mm longa, quam sepala longiora, bifida per circa 1/4 longitudinem, alba. Filamenta 3.0 mm longa. Antherae 0.3 mm longae. Styli 1.3 mm longi. Capsulae plerumque tantum vix ultra calycem exsertae, 4.0–7.0 mm longae, 1.6–2.2 mm latae, curvae. Semina 0.6–0.9 mm diametro, aurantiaca usque rubro-brunnea, dense tuberculata. Chromosomatum numerus $2n = 34$ (Beaman et al., 1962).

Cerastium cuchumatanense is characterized by the following set of characters: basal rosette lacking; cauline leaves not ascending; pubescence present, glandular, not lanate; pedicels short, with hairs not reflexed; flowers not nodding; petals longer than the sepals; capsules curved, usually only barely exserted beyond the calyx.

DISCUSSION: *Cerastium cuchumatanense* is a species primarily of the high llanos of the Sierra de los Cuchumatanes, Guatemala, but is also found on the Tecum Umán Ridge and above timberline on Volcán de Agua and Volcán Acatenango, also in Guatemala (Figure 1B). It is restricted to the subalpine meadows above about 2700 m. There may be some preference for slightly moist sites.

The consensus to date (Standley and Steyermark, 1946; Beaman et al., 1962; Beaman, 1979) has been that the specimens here referred to as *Cerastium cuchumatanense* are *C. brachypodum*. This consensus seems to be based primarily on the fact that both *C. brachypodum* and *cuchumatanense* have small flowers and unusually short pedicels. Standley and Steyermark, however, stated that "more ample specimens may show the Guatemalan plant to be an undescribed species, since it does not appear to be referable to any other species known from Mexico."

There is a gap of approximately 980 km between the southern limit of *Cerastium brachypodum* near Nevado de Toluca, México, and the Sierra de los Cuchumatanes, Guatemala, the northermost locality for *C. cuchumatanense*. Ecologically, while the distributions of the two species overlap with both being found in high mountain meadows, *C. brachypodum* has a much broader range of habitats, often occurring in woodlands and other situations in which *C.*

cuchumatanense has never been collected. For these reasons and because of the morphological differences obvious when descriptions of the two species are compared, there is no doubt that the Guatemalan specimens are indeed distinct from *Cerastium brachypodum.*

SPECIMENS EXAMINED: **Guatemala.** CHIMALTENANGO: Volcán Acatenango, northwest side of peak, alt. ca. 3825 m, *Beaman 3271* (MSC). HUEHUETENANGO: Sierra de los Cuchumatanes, at Chémal at km. 316.8 on Ruta Nacional 9N, alt. ca. 3310 m, *Beaman 3089* (GH, MSC); Sierra de los Cuchumatanes, between Tojiah and Chémal at km. 319.5 on Ruta Nacional 9N, alt. ca. 3380 m, *Beaman 3745* (MSC); Sierra de los Cuchumatanes, immediately north of Tojiah at km. 322 on Ruta Nacional 9N, alt. ca. 3200 m, *Beaman 3891* (GH, MSC, TEX, US); Sierra de los Cuchumatanes, immediately north of Tojiah at km. 322 on Ruta Nacional 9N, alt. ca. 3200 m, *Beaman 3896* (MSC, holotype; GH, TEX, US, isotypes); Sierra de los Cuchumatanes, large meadow 7 mi north of Santa Eulalia along road to San Mateo Ixtatán, Municipio de Santa Eulalia, alt. ca. 9100 ft, *Breedlove 11521* (DS, LL, MICH, US); Sierra de los Cuchumatanes, on road from Huehuetenango to San Juan Ixcoy, south of road to Todos Santos Cuchumatanes, alt. ca. 3450 m, *Good 1022* (MSC); Sierra de los Cuchumatanes, open llano to the west of road to San Juan Ixcoy, alt. ca. 3600 m, *Good 1026* (MSC); Sierra de los Cuchumatanes, between Paquix and Llanos San Miguel, road to San Juan Ixcoy, alt. ca. 3300 m, *Molina R. 21242* (F, NY); Chémal, Sierra de los Cuchumatanes, alt. ca. 4000 m, *Molina R. & Molina 26415* (F); between Capzin and km. 143 on way to San Juan Ixcoy, Sierra de los Cuchumatanes, alt. ca. 3100 m, *Molina R. & Molina 26446* (F); Region of Chémal, Sierra de los Cuchumatanes, alt. ca. 3300 m, *Standley 81085* (F); between Tojquia and Chémal, Sierra de los Cuchumatanes, alt. 3700–3750 m, *Steyermark 50237* (F, US). SACATEPEQUEZ: Volcán de Agua, summit of the south rim of crater, alt. ca. 3750 m, *Beaman 2918* (MSC);Volcán de Agua, on floor of crater, alt. ca. 3670 m, *Beaman 2946* (GH, MSC); upper slopes of Volcano Agua, near crater, alt. ca. 3600 m, *Harmon 3669* (ENCB). TOTONICAPAN: on the Tecum Umán Ridge at km. 154 on Ruta Nacional 1, ca. 20 km east of Totonicapán, alt. ca. 3340 m, *Beaman 4183* (GH, MSC, UC, US); 4.5–5 mi southeast of Totonicapán, alt. 9600–9800 ft, *Webster et al. 11781a* (F).

5. **Cerastium glomeratum** Thuillier, Fl. Paris, ed. 2, p. 226. 1799. TYPE: FRANCE: "Se treuve dans le bois de Boulogne; à Vinncennes et ailleurs" (not seen).

Cerastium viscosum Linnaeus (*nom. ambig.*), Sp. Pl., ed. 1, p. 437. 1753. TYPE: "Habitat in Europae pratis macilentis" (photograph seen).

Plant annual; stems decumbent or erect, sometimes caespitose, 2.5–30 cm tall, very much branched at the base, little otherwise; branches pilose; internodes usually longer distally than basally, longer or shorter than the leaves; leave more or less similar throughout, perhaps slightly smaller above, broadly elliptic to orbicular or spatulate, 5.0–20.0 mm long, 3.0–12.0 mm wide, obtuse, pilose; basal rosette lacking; cymes many flowered, flowers very crowded terminally; pedicels very short, 1.0–5.0 mm long, pilose, sometimes slightly glandular; sepals lanceolate, 2.8–5.1 mm long, 0.5–1.6 mm wide, acute, scarious margined, pilose, sometimes glandular; petals shorter than or equal to the sepals, bifid about 1/4 of their length, white; filaments 1.8–2.3 mm long, anthers 0.1 mm long; styles 0.8–1.1 mm long; capsules 5.0–8.8 mm long, 1.3–1.8 mm wide, curved; seeds 0.3–0.4 mm in diameter, finely tuberculate; chromosome number $2n = 72$ (Rohweder, 1937, 1939; Heiser and Whittaker, 1948; Brett, 1952, 1955; Söllner, 1952, 1954; Löve and Löve, 1956; Blackburn and Morton, 1957; Huynh, 1965; Gadella and Kliphius, 1966; Favarger, 1969; Löve and Kjellquist, 1974). No counts have been published for Mexican or Central American material.

DISCUSSION: *Cerastium glomeratum* and *C. triviale* are the only two introduced species of *Cerastium* in Mexico or Central America. While native to Europe, *C. glomeratum* has become established almost worldwide and is found in North America from Florida, Texas, and California north to southeastern Massachusetts, New York, Ohio, Illinois, South Dakota, and British Columbia (Fernald, 1950), as well as in central Mexico (Distrito Federal, Hidalgo, México, Michoacan, and Veracruz), southern Mexico (Chiapas), Guatemala (Alta Verapaz, Chimaltenango, Guatemala, Huehuetenango, Jalapa, Quetzaltenango, Quiche, Sacatépequez, San Marcos, and Sololá), Honduras (Itibucá), Nicaragua (Matagalpa), Costa Rica (Alajuela, Cartago, and San José), and Panama (Chiriquí) (Figure 3A). It is found in a variety of habitats at elevations from 1200 to 3700 m. Such habitats include roadsides, fields, woodlands, volcanic rocks, cornfields, gardens, etc.

Cerastium glomeratum was originally described in 1753 by Linnaeus as *C. viscosum*. However, examination of photographs of the type specimen and that of *C. vulgatum*, described by Linnaeus in 1762, indicate that these specimens were somehow reversed in the Linnaean herbarium (i.e. the type description of one matches the type specimen of the other). This mixup has resulted in enough confusion to warrant declaring both names ambiguous. Many recent workers (cf. Jalas et al. 1964) have taken this position.

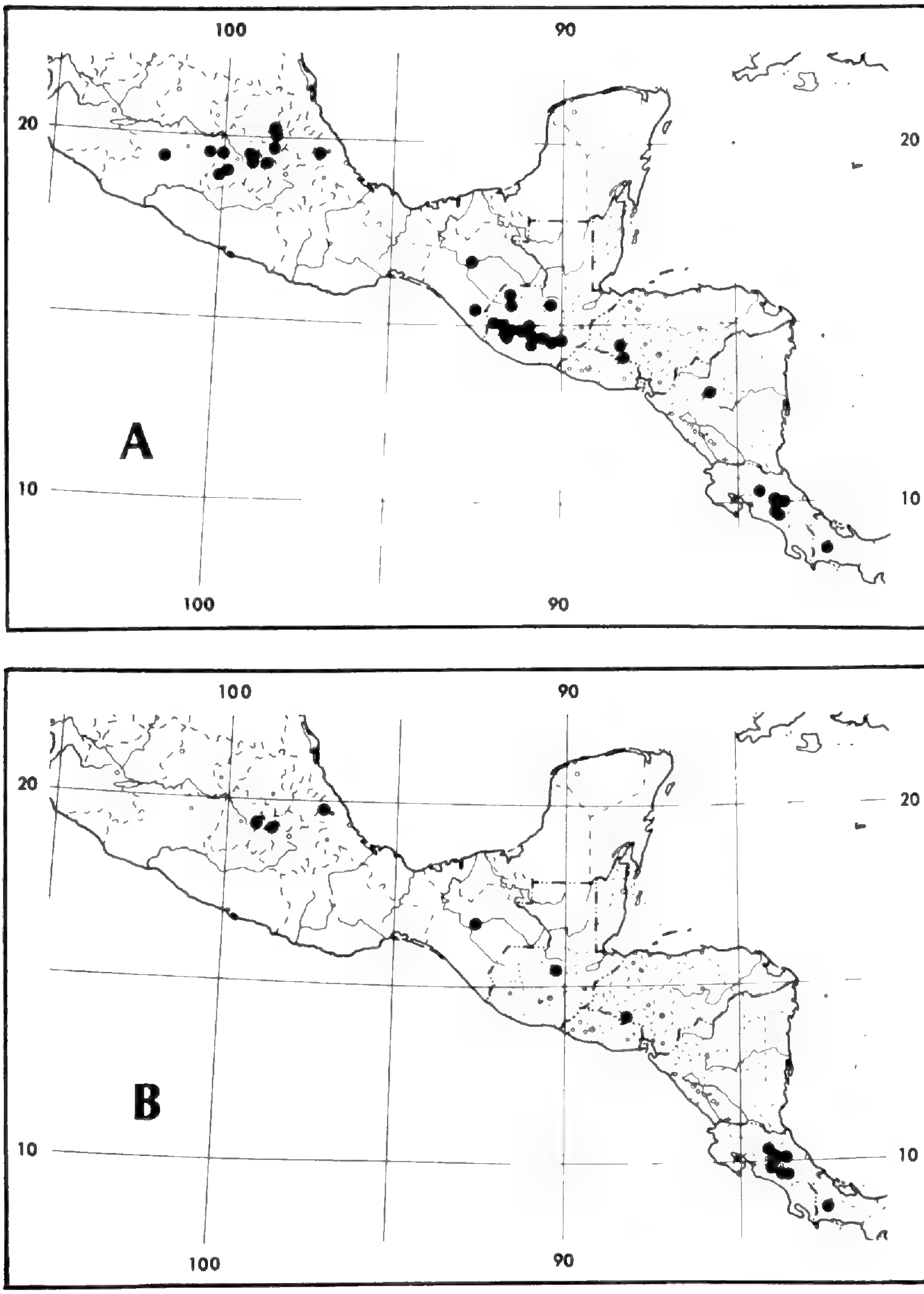

Figure 3. Distribution in Mexico and Central America of *Cerastium*. **A.** *C. glomeratum;* and **B.** *C. triviale*.

Cerastium viscosum then becomes *C. glomeratum* and *C. vulgatum* becomes *C. triviale* (or *C. fontanum* subsp. *triviale;* see below).

REPRESENTATIVE SPECIMENS: **Costa Rica.** ALAJUELA: Region of Zaracero, Guadeloupe de Zaracero, alt. ca. 4500 ft, *Smith A366* (F). CARTAGO: Volcán de Turrialba, alt. ca. 2600 m, *Pittier 7556* (NY, US); Birris, south slope of Volcán de Irazú, *Standley 35438* (US); SAN JOSE: La Palma, alt. ca. 1600 m, *Standley 38043* (US); near Laguna de Escuandra, northeast of El Copey, alt. 2000–2200 m, *Standley 41996* (US). **Guatemala.** ALTA VERAPAZ: Coban, *von Tuerckheim 1334* (GH, NY, US). CHIMALTENANGO: Cerro de Tecpam, region of Santa Elena, alt. ca. 2700 m, *Standley 58679* (F). GUATEMALA: Volcán de Pacaya, above las Calderas, alt. 1800–2400 m, *Standley 58364* (F). HUEHUETENANGO: Sierra de los Cuchumatanes, between Paquix and Llanos San Miguel, road to San Juan Ixcoy, alt. ca. 3300 m, *Molina R. 21235* (F, NY). JALAPA: on the summit of Montaña Miramundo, between Jalapa and Mataquescuintla, alt. 2000–2500 m, *Steyermark 32611* (F). QUETZALTENANGO: Cerro la Pedrera, south of Quetzaltenango, alt. ca. 2400 m, *Standley 65520* (F); Olintepeque, alt. ca. 2415 m, *Standley 66002* (F). QUICHE: south of Chichicastenango, alt. 1830–1880 m, *Standley 62390* (F). SACATEPEQUEZ: Volcán de Agua, above Santa María, alt. 7000–8000 ft, *Bell & Duke 16969* (MO). SAN MARCOS: Barrancas south and west of town of Tajumulco, northwest slopes of Volcán Tajumulco, alt. 2300–2500 m, *Steyermark 36535* (F); *Steyermark 35673* (F). SOLOLA: near María Tecum, Sierra Madre Mountains, ca. 10–12 km northwest of Los Encuentros, alt. ca. 3000 m, *Williams et al. 27319* (F). **Honduras.** INTUBUCA: vicinity of La Esperanza and Intubucá, alt. 1500–1600 m, *Standley 25434* (F). **Mexico.** BAJA CALIFORNIA NORTE: Guadeloupe Island, alt. ca. 700 m, *Moran 17304* (ENCB, LL). CHIAPAS: north and west slope of Cerro Mozotal below the microwave tower along the road from Huixtla to El Porvenir and Siltepec, Municipio de Motozintla de Mendoza, alt. ca. 3000 m, *Breedlove 40319* (DS,MP); north end of San Cristóbal las Casas, alt. ca. 7100 ft, *Breedlove & Raven 8264* (DS). DISTRITO FEDERAL: ladera oriental del Cerro Ajusco, alt. ca. 3250 m, *Arrendondo 69* (ENCB); along the road up the Cañada del Río Magdelina near the 4th dynamo, alt. ca. 3000 m, *Murry 11* (MSC); MEXICO: Ocotepec, Distrito Temascaltepec, alt. ca. 1500 m, *Hinton 2888* (GH, MO, NY, US). MICHOACAN: near the microwave tower on Cerro Burro, 7 km south of Opopeo, alt. ca. 3170 m, *Murry 58* (MSC). VERACRUZ: La Joya, alt. ca. 2100 m, *Ventura A. 11061* (ENCB). **Nicaragua.** MATAGALPA: road to La Fundadora, cloud forest area north of Santa María de Ostuma, Cordillera Central de Nicaragua, alt. 1300–1500 m, *Williams et al. 24948* (F, NY). **Panama.** CHIRIQUI: vicinity of Boquete, Finca Collins, "El Vilo", alt. ca. 6150 ft, *Stern et al. s. n.* (MICH, US).

6. **Cerastium guatemalense** Standley, Field Mus. Nat. Hist., Bot. Ser. 17: 244. 1937. TYPE: GUATEMALA. Chimaltenango: Volcán de Agua, 22 July 1937, *Johnson 816* (HOLOTYPE: F).

Plant perennial; stems to 45 cm tall, often more or less much ·ranched basally and above; branches erect or decumbent, densely glandular-pilose; internodes more or less equal except at the base, where shorter; leaves more or less similar throughout or the lower ones somewhat shorter, linear to lanceolate, long, widest at the base, narrowing to an attenuate tip, 15.0–48.0 mm long, 2.0–5.0 mm wide, glandular-pilose, particularly on the lower surface; basal rosette lacking; cymes 3–40 flowered, usually 3–15; bracts not scarious-margined; lowermost (longest) pedicels 14.0–35.0 mm long, upper ones shorter, all more or less hooked in fruit, glandular-pilose; sepals lanceolate, 4.4–6.0 mm long, 1.0–1.7 mm wide, acute, scarious-margined except at the apex, glandular; petals 6.0–7.1 mm long, bifid about 1/8 of their length, white; filaments 3.2–3.5 mm long, anthers 0.3 mm long; styles 1.9–2.1 mm long; capsules 7.8–11.8 mm long, 2.0–2.8 mm wide, curved; seeds tuberculate, 0.8–1.0 mm in diameter; chromosome number unknown.

DISCUSSION: *Cerastium guatemalense* is known from open pine forests and adjacent subalpine meadows between 2130 and 4600 m elevation on the following Guatemalan volcanoes: Acatenango, Agua, Fuego, Santa María, Santo Tomas, Tacaná, and Tajumulco. Outside of Guatemala three collections have been made: *Stevens et al. 2427* from the Chiapas side of Volcán Tacaná, *Breedlove 40315* from nearby Cerro Mozotal, Chiapas, and *Burger & Gomez P. 8216* from the Department of San José, Costa Rica. This last specimen is considerably disjunct from the known range of *Cerastium guatemalense* (Figure 1A).

REPRESENTATIVE SPECIMENS: **Costa Rica.** SAN JOSE: along the trail to the Valle de los Conejos along the upper Río Talari, alt. 3250–3450 m, *Burger & Gomez P. 8216* (F, MO). **Guatemala.** CHIMALTENANGO: Volcán de Fuego, north side of mountain on Meseta, alt. ca. 3500 m, *Beaman 4041* (GH, MSC); slopes of Volcán de Acatenango, above Las Calderas, alt. 2700–2900 m, *Standley 61893* (F). QUETZALTENANGO: summit of Volcán Santa María, alt. ca. 12,400 ft, *Skutch 834* (F, GH, US); Volcán Santo Tomas, alt. 3000–3300 m, *Steyermark 34882* (F). SACATEPEQUEZ: Volcán de Agua, *Johnson 816* (F, holotype). SAN MARCOS: Volcán Tajumulco, east side of peak, at timberline, alt. ca. 4050 m, *Beaman 3176* (GH, MSC); between Sibinal and summit of Volcán Tacaná, lower slopes above ridge of La Vega, alt. 2500–4400 m, *Steyermark 36088* (F). **Mexico.** CHIAPAS: on the north and west slope of Cerro Mozotal below the microwave tower along the road from Huixtla to El Porvenir and Siltepec, Municipio de Motozintla de Mendoza, alt. ca. 3000 m, *Breedlove 40315* (DS); on southeast slope of Volcán Tacaná, alt. ca. 3550 m, *Stephens et al. 2427* (MSC).

7. **Cerastium juniperorum** Standley & Steyermark, Field Mus. Nat. Hist., Bot. Ser. 23: 51. 1944. TYPE: GUATEMALA. Huehuetenango: alpine areas in the vicinity of Tuminá, Sierra de los Cuchumatanes, alt. 3400–3500 m, 7 July 1942, *Steyermark 48413* (HOLOTYPE: F).

Plant perennial; stems to 40 cm tall with little branching except sometimes at the base; branches densely glandular-pilose, almost villous in places; leaves more or less similar throughout, lanceolate to almost ovate, 10.0–33.0 mm long, 1.5–9.0 mm wide, acute, densely pilose tending toward villous when young; upper few internodes much longer than the leaves, gradually shortening to much shorter below, creating, in some cases, a basal cluster; basal rosette lacking; cymes 3–8 flowered, bracts not scarious-margined; pedicels 10.2–36.0 mm long, the lower ones being the longer, very densely glandular-pilose, somewhat hooked in fruit; sepals lanceolate to ovate, 5.8–7.6 mm long, 1.8–2.2 mm wide, acute, scarious margined except at the apex, sparsely glandular-pilose; petals large, 9.5–14.5 mm long, bifid about 1/4 of their length, white; filaments 5.5–6.0 mm long, anthers 0.9 mm long; styles 3.7–4.0 mm long; capsules 12.0–16.1 mm long, 2.0–2.4 mm wide, curved; seeds dark red-brown, tuberculate, 1.0–1.2 mm in diameter; chromosome number $2n = 34$ (Beaman et al., 1962).

DISCUSSION: *Cerastium juniperorum* has perhaps the most limited range of any species of *Cerastium* in Mexico or Central America. As far as is known, it is restricted to a few square kilometers in the Sierra de los Cuchumatanes, in west-central Guatemala, where it is not uncommon in pine and juniper woodlands at elevations of between 3050 and 3700 m (Figure 1C.)

Standley and Steyermark (1944), in their original description of the species, stated that it is perhaps only an extreme form of *Cerastium guatemalense* but that the latter has a much smaller calyx and that its cauline leaves are much narrower. Indeed, these are two outstanding differences between the species, but they are only two of many. Others can be seen when the respective descriptions are compared.

SPECIMENS EXAMINED: **Guatemala.** HUEHUETENANGO: Sierra de los Cuchumatanes at km. 311 on Ruta Nacional 9N (between Paquix and Chémal), alt. ca. 3360 m, *Beaman 2973* (GH, MSC, TEX, UC, US); Sierra de los Cuchumatanes, between Tojiah and Chémal at km. 320 on Ruta Nacional 9N, alt. ca. 3365 m, *Beaman 3748* (ENCB, GH, MSC, TEX, UC, US); Sierra de los Cuchumatanes, ca. 3 km south of road between Llano San Miguel and Todos Santos, from a point 2.5 km west of Llano San Miguel, near highest point in Cuchumatanes, alt. ca. 3680 m, *Beaman 3974* (MSC); Sierra de los Cuchumatanes, side of cliff 2 km north of km. 299 on road to San Juan Ixcoy, alt. ca. 3350 m, *Good 1024* (MSC); Sierra de los Cuchumatanes, along road to Todos Santos, alt. ca. 3050 m, *Good 1025* (MSC); along road in region of Chémal, Sierra de los Cuchumatanes at km. 36, alt. ca. 3300 m, *Standley 81687* (F); near Tunimá, Sierra de los Cuchumatanes, alt. 3300–3500 m, *Steyermark 48262* (F); alpine area in vicinity of Tunimá, Sierra de los Cuchumatanes, alt. 3400–3500 m, *Steyermark 48413* (F, holotype); between Tojquia and Caxin bluff, summit of Sierra de los Cuchumatanes, alt. ca. 3700 m, *Steyermark 50192* (F).

8. **Cerastium madrense** Watson, Proc. Amer. Acad. Arts 23: 269. 1888. TYPE: MEXICO. Chihuahua: On cool summits of the Sierra Madre, 7 October 1887, *Pringle 1504* (HOLOTYPE: GH).

Plant perennial; stems 15–35 cm tall, much branched from the base, not so above, erect, glandular-pilose, often more or less lanate near the base; basal rosette prominent. Basal and sterile leaves oblanceolate, obovate or spatulate, 10.0–60.0 mm long, 4.0–12.0 mm wide, acute, lanate, particularly basally and beneath; cauline leaves much smaller, 8.0–20.0 mm long, 2.0–5.0 mm wide, lanceolate, acute, pilose, tending toward lanate particularly toward the base of the plant, much shorter than the rather long internodes (upper internodes 29.0–85.0 mm long); cymes 4–13 flowered, large, open; bracts not scarious-margined; pedicels very long, the lowermost (longest) 18.0–32.0 mm long, the upper ones 5.0–10.0 mm long, glandular-pilose, apically hooked when in fruit; sepals lanceolate, 4.5–6.2 mm long, 1.2–1.8 mm wide, acute, scarious-margined except at the apex, glandular-pilose; petals large, 7.8–11.1 mm long, bifid about 1/5 of their length, white; filaments 6.0–6.2 mm long, anthers 0.8 mm long; styles 4.0–4.2 mm long; capsules 7.6–11.9 mm long, 2.1–3.0 mm wide, curved; seeds dark brown, 0.9–1.3 mm in diameter, densely tuberculate; chromosome number unknown.

DISCUSSION: As far as can be discerned from the specimens examined, *Cerastium madrense* is found in moist *Pinus* and *Quercus* forests at elevations of between 2900 and 3200 m in the states of Chihuahua and Durango (Figure 1B).

Specimens Examined: **Mexico.** CHIHUAHUA: cool summits of the Sierra Madres, *Pringle 1504* (GH, holotype). DURANGO: north slopes of Cerro Huehueto (Huehuento), south of Huachicheles, ca. 75 mi west of C. Durango, alt. 2900–3150 m, *Maysilles 7241* (MICH); north slopes of Cerro Huehueto (Huehuento), ca. 75 mi west of C. Durango, alt. 2900–3150 m, *Maysilles 7250* (MICH); north slopes of Cerro Huehueto (Huehuento), south of Huachicheles, ca. 75 mi west of C. Durango, alt. 2900–3150 m, *Maysilles 7276* (DS, MICH, TEX); San Luis del Río, 51 road miles northwest of Coyotes, *Maysilles s.n.* (F, GH, NY, US).

9. **Cerastium nutans** Rafinesque, Prec. Decouv., p. 36. 1814. Type: united states. "en Pensylvanie" (not seen).

Cerastium nutans var. *genuinum* Rohrbach (lusus 1), Linnaea 37: 289. 1873. Type: same as above.

Cerastium longepedunculatum Muhlenberg (nom. nud.), Cat., p. 47. 1813. Type: united states. "Pens." (not seen).

Cerastium apricum Schlechtendal (with varieties *angustifolium* and *brachycarpum*), Linnaea 12: 208. 1838. *Cerastium nutans* var. *apricum* Rohrbach, Linnaea 37: 1873. *Cerastium longepedunculatum* var. *apricum* Briquet, Ann. Conserv. Jard. Bot. Genève 13 & 14: 381. 1911. Type: mexico. state unknown: "Jalapam", May, June (year not known), *Schiede s.n.* (holotype: hal?), (not seen).

Cerastium ripartianum Schultz, Flora 45: 458. 1862. Type: mexico. state unknown: "Hab. in Mexico, unde cl. *Schaffner,* absque nomine, misit", (not seen).

Cerastium cuspidatum Hemsley, Diag. Pl. Nov., p. 21. 1878. Type: mexico: state unknown: "in Convalli Mexici", *Schaffner 60* (holotype: k) (not seen).

Cerastium sericeum Watson, Proc. Amer. Acad. Arts 20: 354. 1885. Type: united states. Arizona: "Huachuca Mountains, 8000 ft", *Lemmon & Lemmon s.n.,* 1882, and "Santa Rita Mountains", *Pringle s.n.,* 1884 (not seen).

Plant annual; stems 15–50 cm tall, often much branched; branches erect or decumbent, pilose, usually more or less glandular-pilose, sometimes more or less lanate below; internodes longest just below the inflorescence, gradually shorter toward the base, usually longer than, though sometimes shorter than, the leaves; leaves largest near the base of the plant, gradually smaller upward, lanceolate to ovate or spatulate, 7.0–60.0 mm long, 2.0–25.0 mm wide, acute or obtuse, often somewhat thin, pilose or glandular-pilose; basal rosette lacking; cymes 2–25 flowered, bracts not scarious-margined; the lowermost pedicels the longest, 11.0–37.0 mm long, upper ones shorter, distally hooked when in fruit, glandular-pilose; petals shorter than to much longer than the sepals (the petal/sepal ratio being 0.95–1.95), 3.6–10.3 mm long, bifid about 1/4 of their length, white; filaments 2.5–4.0 mm long, anthers 0.3 mm long; styles 2.0–3.0 mm long; capsules 6.0–13.2 mm long, 1.5–3.5 mm wide, curved; seeds 0.7–1.0 mm in diameter, tuberculate; chromosome number $2n = 34$ (Beaman et al., 1962) or $2n = 35$–36 (Söllner, 1952, 1954).

DISCUSSION: *Cerastium nutans* is the most widely distributed species of *Cerastium* in Mexico. It has been collected throughout the upland areas (1700–3660 m) except in the northeastern part of the country. Collections have been made in the states of Chiapas, Chihuahua, Distrito Federal, Durango, Guerrero, Hidalgo, Jalisco, México, Michoacan, Morelos, Oaxaca, Puebla, San Luis Potosí, Sonora, and Veracruz. To the south of Mexico, the species is known only from Guatemala (Chimaltenango and San Marcos), and to the north it is found as far as southwestern Quebec and British Columbia (Fernald, 1950) (Figure 1D). The habitat includes such areas as roadsides, woodlands, and rocky hillsides, almost always below timberline.

Not only is *Cerastium nutans* the most widely distributed *Cerastium* in Mexico, it is also the most variable. Some attempt might be made at using this variation to define varietal or even specific boundaries, but in most cases the material available for this study showed too much intergradation between extremes. There was also too little material on which to base sound taxonomic judgement. I will therefore content myself here with describing the variation without assigning any taxonomy to it.

The typical *Cerastium nutans* is a rather large, robust, much branched plant with fairly thin, lanceolate to ovate leaves. It has fairly long pedicels (usually well over 17 mm long) and moderately sized sepals (4.0–5.0 mm long). The petals are usually equal to or slightly longer than the sepals. This form is found from western Guatemala north through the central highland of Mexico and into the United States and Canada. From this typical form, specimens vary in several ways, as described below:

a. In the Sierra Madre Occidental of western Mexico and in the trans-Mexican volcanic belt (Clausen, 1959) there is a tendency for the petals to increase considerably in size, reaching almost twice the length of the sepals. This tendency is also seen in some parts of the United States (Correll and Johnston, 1970).

b. In central and southern Mexico, particularly Michoacan, specimens have been collected which have generally shorter pedicels (13.0–19.0 mm long) and slightly smaller flowers than the typical. These characteristics combine to give the plants to some extent the aspect of *Cerastium brachypodum* with which these specimens have often been confused. However, they are clearly not of that species since, even in these characters, they much more closely approach *C. nutans*.

c. Apparently restricted to the high mountains of Jalisco and Guerrero is a variant which is usually fairly small and has rather small, pale, rhomboidal leaves covered with a distinctively long, glandular-pilose pubescence. Its pedicels are short (12.0–23.0 mm long) and it has fairly large petals (5.2–7.1 mm long).

d. In northern Oaxaca a similar set of specimens has been collected but these have elliptical leaves and lack the distinctive pubescence described above.

e. Also in central Mexico can be found plants with very narrow, attenuate leaves and small flowers.

f. A form found in western Chihuahua and eastern Sonora, is characterized by very few, small flowers (sepals 2.9–4.0 mm long, petals 3.9–4.0 mm long), short, broad capsules (6.0–8.6 mm long, 1.8–2.8 mm wide) and long, linear to lanceolate leaves (the length to width ratio averaging 11.5, as opposed to 4.4 for all other specimens of *C. nutans*).

g. The last variant bears varying amounts of lanate pubescence on the lower parts of the stem and lower leaves. This group is probably referable to the binomial *C. sericeum,* described from the Huachuca and Santa Rita Mountains of Arizona (Watson, 1885). Aside from the lanate pubescence, Watson, and later Robinson (1897), separated it from *C. nutans* because its "seeds are twice larger and more coarsely tuberculate." Kearney and Peebles (1939), however, stated that "intergradation in pubescence [between *C. sericeum* and *C. nutans*] is complete in Arizona specimens" and therefore desribed the specimens as a variety of *C. nutans, C. nutans* var. *obtectum.* This situation is also seen in the Mexican specimens which vary from extremely lanate basally (*Knobloch 5915*) through less lanate (*Ibana G. 416* and *Knobloch 5750*) to only slightly lanate (*Townsend & Barber 160, Phillips 672,* and *Nelson 6122*). Kearney and Peebles also stated that "the two forms are not constantly distinguishable by the seed characters mentioned by Robinson

(1897)." In Mexico, specimens showing lanate pubescence are found in Chihuahua, eastern Sonora, and Durango.

REPRESENTATIVE SPECIMENS: **Guatemala.** CHIMALTENANGO: Sierra Santa Elena, bei Tecpam Guatemala, *Seler 2362* (GH). SAN MARCOS: Volcán Tacaná, east side of mountain at La Haciendita, alt. ca. 3375 m, *Beaman 3188* (GH, MSC). **Mexico.** CHIAPAS: slopes on southeastern side of Zontehuitz near summit, Municipio de Chamula, alt. ca. 9400 ft, *Breedlove 6703* (DS, F); near summit of Chuchil Ton, northeast of Bochil, Municipio de San Andres Larranizar, alt. ca. 2700 m, *Breedlove 26786* (DS, LL, MO). CHIHUAHUA: Mojarachic, *Knobloch 5720* (MSC); Mojarachic, *Knobloch 5915* (MSC); Majalca Cañon, *LeSueur 466* (F, GH, TEX); foothills of the Sierra Madres near Colonia Juárez, *Nelson 6122* (GH, US); Cerro Mohinora, 10 mi south of Guadeloupe y Calvo, alt. 2300–2400 m, *Straw & Forman 1960* (MICH); near Colonia García in the Sierra Madres, alt. ca. 7300 ft, *Townsend & Barber 160* (F, GH, MICH, MO, MSC, NY, TEX, UC, US). DISTRITO FEDERAL: Cañada de Contreras, alrededores del 4° dinamo, alt. ca. 3000 m, *Rzedowski 20411* (ENCB, MSC). DURANGO: ca. 5 mi north of railroad at Coyotes (45 airline mi west of C. Durango), west facing slopes of broad arroyo, tributary to Río del Presidio, alt. ca. 2400–2500 m, *Maysilles 7118* (NY). GUERRERO: near Toro Muerto, Distrito Mina (Galeana), *Hinton 11231* (GH, MICH, NY, US). HIDALGO: Distrito Pachuca, Municipio Mineral del Chico, below Parque Nacional El Chico, *Moore 1554* (GH, UC). JALISCO: Nevado de Colima (Nevado de Zapotlán), a few mi. south of Ciudad Guzman (Zapotlán), alt. ca. 3080 m, *Gregory & Eiten 287* (GH, MICH, MO, MSC, NY). MEXICO: Salto de Agua, *Purpus 1668* (F, GH, NY, UC, US); northwest slopes of Nevado de Toluca, 10 km (by road) southwest of junction of roads to Sultepec and Temascaltepec on Hwy. 130 to Temascaltepec or 27 km (by road) southwest of Toluca, alt. ca. 3000 m, *Roe, Roe & Mori 273* (ENCB, MICH, US, WIS). MICHOACAN: at the southwest side of Cerro San Andres, ca. 12 km (straight line distance) north of Ciudad Hidalgo, alt. ca. 3100 m, *Beaman 4318* (GH, MSC, NY, TEX, UC, US). MORELOS: along Rte. 95, 12 mi north of Cuernavaca toward Mexico City, *Powell & Edmondson 732* (F, MICH, TEX); Lagunas de Zempoala, alt. ca. 2775 m, *Villamar s. n.* (ENCB, MSC). OAXACA: Llano de las Flores, on the Oaxaca-Valle Nacional highway 20 km east of Ixtlán, alt. ca. 2870 m, *Beaman 3711* (GH, MSC, US). PUEBLA: vicinity of San Luis Tutitlanapa, *Purpus 2720a* (F, GH, MO, NY, UC, US). SAN LUIS POTOSI: region of San Luis Potosí, alt. 6000–8000 ft, *Parry & Palmer 47* (GH, NY, US). SONORA: between Las Lierritas and El Tigre, region of the Río de Bavispe, *Phillips 672* (GH, MICH). VERACRUZ: Mt. Orizaba, Sierra Negra, alt. ca. 11,800 ft, *Balls & Gourlay B4436* (MICH, UC).

10. **Cerastium orithales** Schlechtendal, Linnaea 12: 209. 1838. TYPE: MEXICO. state unknown: "in regione subnivale montis Orizaba", September (year not known), *Schiede s. n.* (HOLOTYPE: HAL?) (not seen).

Cerastium arvense var. *orithales* (Schlechtendal) Rohrbach, Linnaea 37: 305. 1873. TYPE: same as above.

Cerastium mutabile var. *arvense* f. *angustatum* Grenier, in part, Monogr. Cerast., p. 68. 1841. Type: "Hab. in America boreali; in Siberia (DC. herb); in Pyrenaeis (Grenier); in alpibus; (ex nonullis bot. hortis etiam habui)" (not seen).

Plant perennial; stems 15–50 cm tall, branched at the base or not, never branching above; branches very slender, usually held up by surrounding grasses, more or less short glandular-pilose; internodes much longer than the adjacent leaves near the inflorescence, gradually becoming shorter basally until the leaves become densely clustered; basal rosette lacking. Leaves more or less similar throughout, sometimes smaller just below the inflorescence, linear to lanceolate, 15.0–25.0 mm long, 2.0–4.0 mm wide, acute, densely short glandular-pilose; cymes 1–6 flowered, bracts not scarious-margined; pedicels various, 7.2–30.0 mm long, densely pubescent with short glandular sub-reflexed hairs; sepals lanceolate to broadly lanceolate or ovate, 6.0–7.5 mm long, 2.0–3.0 mm wide, acute, scarious-margined except at the apex, glandular-pilose; petals large, 12.0–18.5 mm long, bifid about 1/4 of their length, white; filaments 6.1–7.3 mm long, anthers 0.8 mm long; styles 4.0–4.9 mm long; capsules 13.5–17.0 mm long, 2.6–3.2 mm wide, curved; seed 0.9–1.2 mm in diameter, apparently only sparingly tuberculate, dark red-brown; chromosome number $2n = 36$ (Beaman et al., 1962).

Discussion; *Cerastium orithales* is found at elevations between 3600 and 4100 m on Ixtaccihuatl, Pico de Orizaba, Sierra Negra, and Cofre de Perote (all in central Mexico) (Figure 4A). The species is restricted in habitat to grassy floors of open forest (almost invariably *Pinus hartwegii* forests) just below timberline. Specimens were collected by the author on Cofre de Perote in open meadows (*Good 1019*), but these meadows were the result of the recent clear-cutting of the native pine forest.

Specimens examined: **Mexico.** MEXICO: Joya de Alcalicán, extremo sur del Ixtaccihuatl, alt. ca. 3900 m, *Aldanda A. 47* (ENCB); Ixtaccihuatl, northwest side of mountain above San Rafael, alt. ca. 3810 m, *Beaman 2844* (GH, MSC, TEX, UC, US). PUEBLA: Sierra Negra (adjacent to Pico de Orizaba), west side of mountain, alt. ca. 3880 m, *Beaman 2523* (F, GH, MSC, UC); Pico de Orizaba, north of Alberque Piedra Grande, alt. ca. 3950 m, *Beaman 3643* (GH, MSC, UC, US); Pico de Orizaba, north side of mountain, ca. 3 km southeast of Villa Hidalgo, alt. ca. 3780 m, *Beaman 3649* (ENCB, GH, TEX, UC, US); along the road down the east side of the Paso de Cortés, alt. ca. 3660 m, *Good 1018* (MSC); north side of Pico de Orizaba,

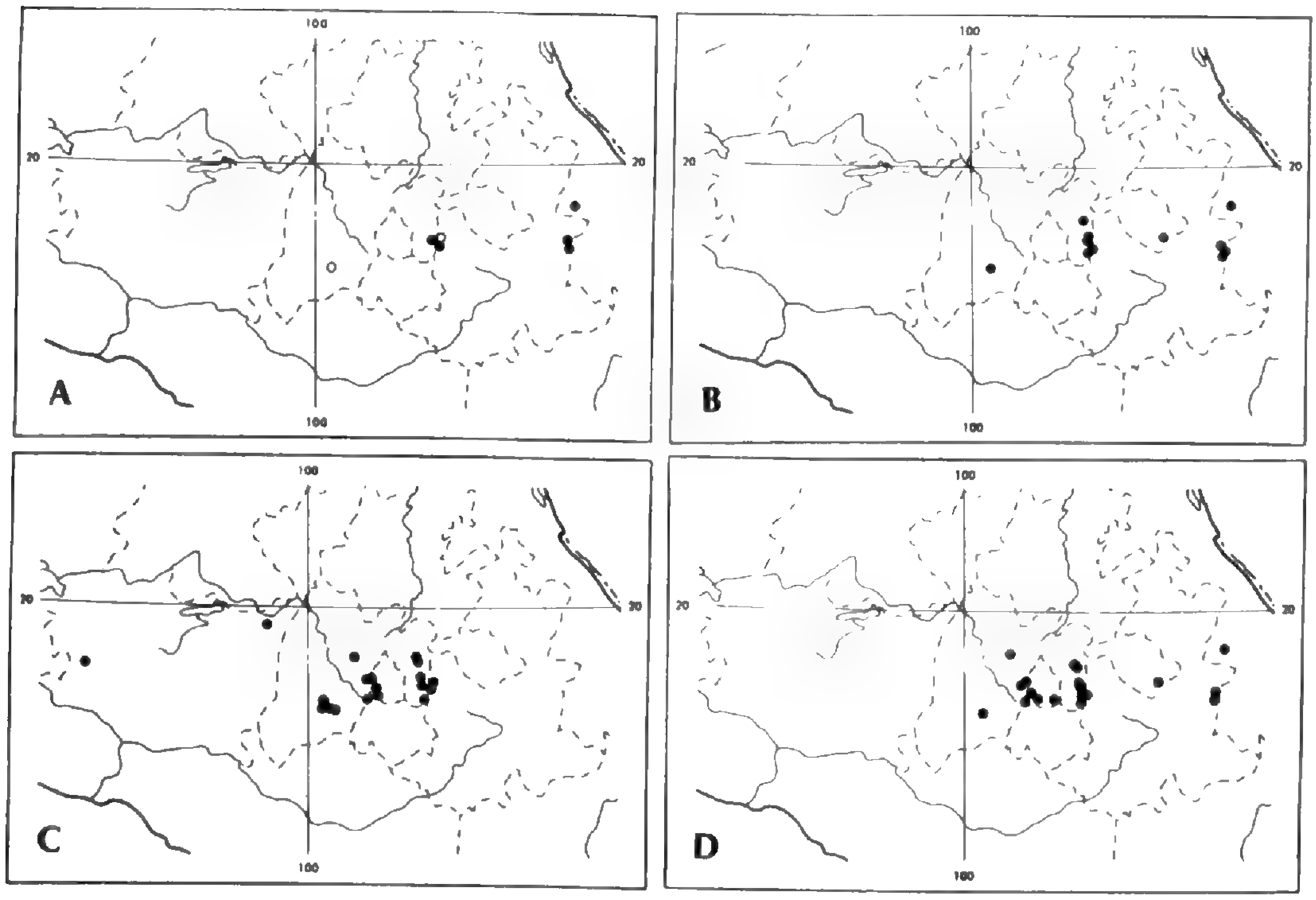

Figure 4. Distribution in central Mexico of *Cerastium*. **A.** *C. orithales* (closed circles) and *C. purpusii* (open circles); **B.** *C. ramigerum;* **C.** *C. tolucense;* and **D.** *C. vulcanicum*. There is also a single specimen of *C. vulcanicum* from Guatemala.

Murry 64 (MSC); Mt. Orizaba, alt. ca. 12,000 ft, *Pringle 8551* (ENCB, F, GH, MICH, MO, MSC, NY, UC, US). VERACRUZ: Cofre de Perote, east side of mountain, alt. ca. 3930 m, *Beaman 2159* (F, MSC, UC); ladera este del Cofre de Perote, alt. ca. 4000 m, *Dorantes L. 331* (CAS, GH); Cofre de Perote, *Nelson 28* (US). STATE UNKNOWN: Mt. Orizaba, alt. 13,000–13,400 ft, *Nelson 283* (US); Ixtaccihuatl, alt. 11,000–12,000 ft, *Purpus 268* (GH, MO, UC, US); Citlaltepetl, *Purpus 2803* (F, GH, MO, NY, UC, US). Mt. Orizaba, *Rose & Hay 5756* (US); Mt. Orizaba, alt. ca. 13,000 ft, *Seaton 236* (F, GH, NY, US).

11. **Cerastium purpusii** Greenman, Zoe 5: 183. 1904. TYPE: MEXICO. state unknown: Mt. Ixtaccihuatl, 1903, *Purpus 472* (HOLOTYPE: GH; ISOTYPES: MO, UC, US).

Cerastium molle Bartling *in* Presl, Rel. Haenk. 2: 17. 1831. (non *C. molle* Villars, Hist. Pl. Dauphine 3: 644. 1789). TYPE: MEXICO. state unknown: *Haenke s. n.* (HOLOTYPE: PR; photograph of holotype in MICH).

Cerastium lanuginosum Sessé & Mociño, Fl. Mex., ed. 2, p. 118. 1894. (non *C. lanuginosum* Willdenow *ex* Reichenbach, Fl. Germ. Excurs., p. 797. 1832.) TYPE: MEXICO. Mexico: "habitat in Vulcano Tolucae" (not seen).

Plant a short-lived perennial, low, dense, caespitose; stems to 20 cm tall, usually less than 10 cm, much branched at the base, not otherwise; branches pilose to lanate; internodes usually, though not always, shorter than the leaves; cauline leaves broadly lanceolate to ovate, 5.0–15.0 mm long, 2.0–6.0 mm wide, often largest just below the inflorescence, usually acute, pilose or lanate; basal rosette often present; basal leaves larger, to 35.0 mm long and 10.0 mm wide, lanate, acute, lanceolate to spatulate; cymes 1–10 flowered, flowers more or less densely crowded at the apex of each branch; bracts not scarious-margined; pedicels less than 10 mm long, pilose; sepals 4.2–7.8 mm long, 1.3–1.8 mm wide, lanceolate, acute, pilose, never glandular, margins narrowly scarious except at the apex; petals 6.0–10.6 mm long, bifid about 1/8 of their length, white; filaments 4.5–6.7 mm long, anthers 0.7 mm long; styles 3.0–3.3 mm long; capsules 7.2–10.3 mm long, 2.5–3.0 mm wide, curved; seeds 0.7–0.9 mm in diameter, densely tuberculate; chromosome number $2n = 34$ (Beaman et al., 1962).

DISCUSSION: *Cerastium purpusii* is one of the species of *Cerastium* living at the highest elevations of any in Mexico, being found only in the high, wet alpine meadows between 3650 and 4610 m on Nevado de Toluca and Ixtaccihuatl, central Mexico (Figure 4A).

The binomial *Cerastium molle* Bartling *in* Presl, commonly used for the species here described as *C. tolucense,* was originally used for this species. However, since Villars used the name *C. molle* in 1789 (42 years before Bartling used it), Bartling's name is not valid.

The name *Cerastium lanuginosum* was published in 1894 by Sessé and Mociño for a plant bearing the description of *C. purpusii*; this binomial antedates *C. purpusii* by ten years. However, the fact that *C. lanuginosum* Willdenow *ex* Reichenbach (probably synonomous with *C. alpinum* Linnaeus) was published in 1832, 62 years before the Sessé and Mociño publication, prohibits its use for the Mexican species.

REPRESENTATIVE SPECIMENS: **Mexico.** MEXICO: Nevado de Toluca, near large lake in the crater, alt. ca. 4140 m, *Beaman 1882* (F, GH, MICH, MSC, NY, TEX, UC, US). PUEBLA: Ixtaccihuatl, alpine region, *Purpus 472* (GH, holotype; MO, UC, US, isotypes).

12. **Cerastium ramigerum** Bartling *in* Presl, Rel. Haenk. 2: 16. 1831. TYPE: MEXICO, state unknown: *Haenke s. n.* (HOLOTYPE: PR; photograph of holotype in MICH).

Cerastium lithophilum Greenman, Zoe 5: 183. 1904. TYPE: MEXICO. state unknown: Mt. Ixtaccihuatl, July 1903, *Purpus 231* (HOLOTYPE: GH; ISOTYPES: MO, UC, US).

Plant perennial; stems 5–25 cm tall, often much branched at the base, sometimes above; sometimes more or less caespitose; branches glandular-pilose; internodes very long just below the inflorescence, very short basally, grading in between; leaves more or less similar throughout, lanceolate to broadly lanceolate, often erect and close to the stem, 10.0–30.0 mm long, 3.0–6.0 mm wide, acute, glandular-pilose; basal rosette lacking; cymes 1–8 flowered, bracts not scarious-margined; pedicels short, 2.2–10.6 mm long, densely pubescent with short glandular subreflexed hairs; flowers nodding; sepals lanceolate, 4.1–5.8 mm long, 1.6–2.2 mm wide, acute, scarious-margined except at the apex; petals 6.4–10.3 mm long, bifid about 1/3 of their length, white; filaments 3.6–4.0 mm long, anthers 0.3 mm long; styles 1.2–1.6 mm long; capsules 7.0–10.8 mm long, 2.0–2.4 mm wide, curved; seeds 0.5–0.7 mm in diameter, light brown, tuberculate; chromosome number $2n = 36$ (Beaman et al., 1962).

DISCUSSION: This is a species of very high elevations (3660 to 4720 m) on Nevado de Toluca, Ixtaccihuatl, Popocatepetl, Tlaloc, Malinche, Pico de Orizaba, and Cofre de Perote in the states of México, Puebla, Tlaxcala, and Veracruz (Figure 4B). It is restricted to the high alpine meadows and barrens on those mountains and is sometimes found approaching the upper limit of vascular plants. One collection from Orizaba (*Swan s. n.*) bears the phrase "in forests only" but this is atypical.

At present this species is referred to (in floras, etc.) as *Cerastium lithophilum*. However, the binomial *C. ramigerum* has precedence.

REPRESENTATIVE SPECIMENS: **Mexico.** MEXICO: Nevado de Toluca, shore of large lake in the crater, alt. ca. 4140 m, *Beaman 1878* (F, GH, MICH, NY, TEX, UC, US); Tlaloc, near summit of mountain, alt. 4100–4140 m, *Beaman 2333* (GH, MSC, NY, TEX, US); Ixtaccihuatl, south side of mountain, alt. ca. 4410 m, *Beaman 2550* (MICH, MSC, NY); Municipio Amecameca, slopes of Popocatepetl between 10,000 and 12,000 ft, *Gilly & Dodds 20* (MICH, MSC). PUEBLA: north side of Popocatepetl, above timberline, *Beaman 1727* (GH, MSC); Ixtaccihuatl, south side of mountain, ca. 7 km north of Paso de Cortes, alt. ca. 4300 m, *Beaman 2875* (MSC). Pico de Orizaba, north side of mountain at Alberque Piedra Grande, alt. ca. 4275 m, *Beaman 3631* (GH, MSC); Ixtaccihuatl, south side of mountain on the south side of Cerro Amacuilecatl, alt. ca. 4300 m, *Beaman 4233* (MSC). TLAXCALA: Malinche, crest of north rim of crater, alt. 4400–4450 m, *Beaman 2241* (MICH, MSC, TEX, UC, US). VERACRUZ: Pico de Orizaba, south side of mountain, north of Cueva del Muerto, *Beaman 1765* (GH, MSC, US); Cofre de Perote, east side of mountain, alt. ca. 3930 m, *Beaman 2158* (GH, MSC, NY, TEX, US).

13. **Cerastium sinaloense** D. A. Good, *sp. nov.* TYPE: MEXICO. Sinaloa: Los Pucheros, Sierra Surotato, alt. 5500–6500 ft, 17–24 March 1945, *Gentry 7224* (HOLOTYPE: GH; ISOTYPES: F, US). (Figure 2).

Planta perennis. Caules usque ad 40 cm alti, basi ramosi. Rami erecti, glanduloso-pilosi. Internodia basi brevissima, inflorescentiam versus longissimascentia. Rosula basalis absens sed folia infima aggregatissima, magna, 30.0–65.0 mm longa, 7.2–18.2 mm lata, spathulata, acuta. Folia superiora pauca (1–3 paria per ramum), parviora, 4.0–28.7 mm longa, 1.2–7.6 mm lata, lanceolata usque ovata, acuta. Omnia folia plus minusve pilosa. Cymae 2–8 floribus, apertae. Pedicelli longi, glanduloso-pilosi, non uncati ubi fructificantes. Sepala lanceolata ad late lanceolate, 4.0–7.2 mm longa, 1.1–2.0 mm lata, praeter apicem scarioso-marginata, glanduloso-pilosa. Petala maxima, 10.0–17.5 mm longa, bifida per circa 1/8 longitudinem, alba. Filamenta 6.4–7.0 mm longa. Antherae 1.1 mm longae. Styli 4.7–5.5 mm longi. Capsulae 11.2–14.2 mm longae, 2.8–3.3 mm latae, rectae, dentibus recurvatis. Semina 0.5–0.6 mm diametro, tuberculata. Chromosomatum numerus non cognitus.

Cerastium sinaloense is characterized by having broad, spatulate leaves crowded at the base of the plant (not in a rosette), very large flowers, and straight, revolute-toothed capsules.

DISCUSSION: *Cerastium sinaloense* has been collected only in the pine-oak forests of the Sierra Surotato in northern Sinaloa, near Rosario in southern Sinaloa, and in the Sierra de Manantlán in Jalisco (Figure 1C). It has been collected only at relatively low elevations, between 1680 and 2250 m.

Three specimens, one from northern Sinaloa (*Gentry 7234*), one from southern Sinaloa (*Norris et al. 20466*), and one from Jalisco (*McVaugh 23172*), while obviously allied with *Cerastium sinaloense*, *C. sordidum* and *C. texanum* by the presence of straight capsules with revolute teeth, are atypical of *C. sinaloense* in that they have far smaller flowers. They do, however, match *C. sinaloense* more closely in general habit and in distribution than they do either *C. sordidum* or *C. texanum*. Whether they merely represent variation within *C. sinaloense* or are in fact specimens of a fourth and as yet undescribed species is not discernible from the limited material at hand.

SPECIMENS EXAMINED: **Mexico**. JALISCO: Sierra de Manantlán (25–30 km southeast of Autlán), along lumber roads 5 km east of the road crossing called "La Cumbre" between El Chante and Cuzalapa, alt. 2000–2250 m, *McVaugh 23172* (ENCB, MICH). SINALOA: east slope of Sierra Madre Occidental, 2.2 mi east of La Palmita, ca. 47 mi east of Concordia on Mexico 40, Municipio de Rosario, alt. ca. 6450 ft, *Breedlove 1710* (DS, MICH); Sierra Surotato, near settlement of Los Ornos along the road to Surotato, 53 mi east of Mocorito, alt. ca. 5800 ft, *Breedlove 15559* (MO, MSC); near settlement of El Triguito along the road from Los Ornos to Surotato, alt. ca. 6200 ft, *Breedlove 16474* (MSC); Sierra Surotato, below Buenas Juntas, 5 mi northwest of Los Ornos along the road to Mocorito, Municipio de Sinaloa y Vela, alt. ca. 5800 ft, *Breedlove 19194* (MSC); Sierra Surotato, 5 mi northeast of La Cienenga along the road to Santa Rita, Municipio de Badiraguato, alt. ca. 7000 ft, *Breedlove 19261* (MO, MSC); Los Pucheros, Sierra Surotato, alt. 5500–6500 ft, *Gentry 7224* (GH, holotype; F, US, isotypes); Los Pucheros, Sierra Surotato, alt. 5500–6500 ft, *Gentry 7234* (GH); along Hwy. 40, ca. 6 mi west of Las Palmitas, alt. ca. 7500 ft, *Norris et al. 20466* (CAS, MO); 4–8 mi west of Palmito on the Durango-Mazatlan Highway, *Oatman & Rowlett s. n.* (TEX).

14. **Cerastium sordidum** Robinson, Bot. Gaz. 30: 58. 1900. TYPE: MEXICO. Chihuahua: Sierra Madre 8 km southeast of Colonia García, alt. ca. 2310 m, 30 May 1899, *Townsend & Barber 40* (HOLOTYPE: GH; ISOTYPES: F, MO, MSC, TEX, UC, US).

Cerastium longepedunculatum var. *sordidum* Briquet, Ann. Conserv. Jard. Bot. Genève 13 & 14: 381. 1911. TYPE: same as above.

Plant perennial; stems to 40 cm tall, usually much less, erect or decumbent, branches primarily at the base but sometimes above; branches erect or decumbent, sparsely glandular-pilose; leaves mostly crowded basally with very short internodes, these becoming longer toward the inflorescence; lower leaves 18.0–35.0 mm long, 6.0–14.0 mm wide, ovate to spatulate, acute, glandular-pilose; upper leaves few, much shorter than the adjacent internodes, 9.0–19.0 mm long, 1.0–2.5 mm wide, linear to lanceolate, acute, glandular-pilose; basal rosette lacking; cymes more or less open, but relatively small, 3–10 flowered; lower pedicels 10.0–20.0 mm long, upper ones 4.0–10.0 mm long, glandular-pilose, not hooked when in fruit; sepals ovate, 3.0–5.7 mm long, 1.2–1.8 mm wide, acute, narrowly scarious-margined; petals 5.5–7.8 mm long, bifid about 1/8 of their length, white; filaments 4.6–6.3 mm long, anthers 1.0 mm long; styles 3.0–3.3 mm long; capsules 8.0–13.4 mm long, 2.2–3.0 mm wide, straight, teeth revolute; seeds red-brown, densely tuberculate, 0.6–0.8 mm in diameter; chromosome number unknown.

DISCUSSION: The only specimen of *Cerastium sordidum* seen during this study bearing any mention of habitat was *Spaulding et al. s. n.* which listed "spruce stand". The species has been collected from Mexico only in Chihuahua (Figure 1C). It is also known from the pine forests of the Chiricahua and Santa Rita Mountains of Arizona (Kearney and Peebles, 1969).

Briquet (1911) stated that *Cerastium sordidum* is not separable from *C. longepedunculatum* (a synonym for *C. nutans*) and therefore coined the name *C. longepedunculatum* var. *sordidum*. He stated that "il existe en effet tous les intermediares a corolle reduite, parfois meme nulle" ("in fact there exist all intermediate forms in regard to reduced corolla, occasionally even none at all"). While I have never seen a specimen with no corolla, the rest of this statement is quite true, as far as it goes. *Cerastium nutans,* in fact, varies considerably in corolla length (see above). If this were the primary distinguishing character between the two species, I would agree with Briquet's diagnosis. However, since other characters such as the straight, revolute-toothed capsule and the shape and distribution of leaves are of greater importance, there is no reason to consider *C. sordidum* and *C. nutans* conspecific.

Briquet (1911) mentioned three specimens from Oaxaca (*Galeotti 4410, Galeotti 4428* and *Jurgensen 15*) as being ascribable to *Cerastium longepedunculatum* var. *sordidum*. Although I have not seen these specimens, no other indication of any plant resembling *C. sordidum* has been found south of Chihuahua. It is therefore likely that Briquet was mistaken about the identity of these three specimens and that they were actually *C. nutans*.

SPECIMENS EXAMINED: **Mexico.** CHIHUAHUA: Mojarachic, *Knobloch 5037* (F, MSC); El Rialito spruce stand, 5 km south-southwest of San Juanito, alt. ca. 2400 m, *Spaulding, Martin & Wiseman s. n.* (ENCB); in the Sierra Madre 8 km southeast of Colonia García, alt. ca. 2310 m, *Townsend & Barber 40* (GH, holotype; F, MO, MSC, TEX, UC, US, isotypes).

15. **Cerastium texanum** Britton, Bull. Torrey Bot. Club 15: 97. 1888. TYPE: "Hills, Blanco", March, April (year not known), *Wright 69* (HOLOTYPE: NY?) (not seen).

Stellaria montana Rose, Contr. U. S. Natl. Herb. 1: 93. 1891. TYPE: MEXICO. Sonora: Alamos Mountains, *Palmer s. n.* (HOLOTYPE: US) (not seen).

Plant perennial; stems very slender, erect or decumbent, much branched basally, not so above, 15–35 cm tall, sparsely glandular-pilose; internodes nowhere long (to 60 mm) but longest toward the inflorescence, almost nonexistent at the base; basal rosette lacking but lower leaves very crowded, large, 8.0–55.0 mm long, 3.0–16.0 mm wide, broadly spatulate, acute or obtuse, sometimes acuminate, very sparsely pilose, often turning pale orange-brown with age; upper leaves few or lacking, small, 4.0–8.0 mm long, 1.0–2.0 mm wide, linear to lanceolate, pilose; cymes very open and loose, 8–25 flowered; pedicels 5.1–18.0 mm long, the lowest ones the longest, very slender, glandular-pilose; sepals lanceolate to ovate, 3.0–5.1 mm long, 1.0–2.0 mm wide, glandular, scarious-margined except at the apex, turning light orange-brown when in fruit; petals 4.1–5.4 mm long, narrow, bifid about 1/8 of their length, white; filaments 4.5 mm long, anthers 0.4 mm long; styles 1.2 mm long; capsules small, only slightly exserted beyond the calyx, 4.2–6.8 mm long, 1.8–2.1 mm wide, straight, teeth revolute; seeds red-brown, 0.4–0.6 mm in diameter, densely tuberculate; chromosome number unknown.

Discussion. *Cerastium texanum* is found near watercourses in canyons (Tidestrom and Kittel, 1941) or in open oak woods (Correll and Johnston, 1970). The only specimens from Mexico seen in this study with habitat data say "igneous rocky canyon slope in pine forest" (*Gentry 7991*) and "talus slope" (*Moran 20425*). *Cerastium texanum* is found at lower elevations than any other native *Cerastium* species in Mexico or Central America, having been collected at between 1275 and 1980 m in Baja California, Chihuahua, and Sonora (Figure 1C). North of Mexico this species is found north to Coconino and Apache counties, Arizona (Kearney and Peebles, 1969) and the Edwards Plateau of Texas (Correll and Johnston, 1970).

Specimens examined: **Mexico.** BAJA CALIFORNIA SUR: San Julio Cañon, *Brandegee s. n.* (UC); lower north slope of Volcán las Tres Virgenes, alt. ca. 1275 m, *Moran 20425* (ENCB, LL, MO). CHIHUAHUA: Arroyo Hondo, Sierra Charuco, alt. 4500–5500 ft, *Gentry 7991* (US); Puerta de San Diego, alt. ca. 6500 ft, *Hartman 593* (CAS, F, GH, NY, UC). SONORA: San Bernardo, Río Mayo, *Gentry 1253* (GH); Sierra de los Alamos, *Palmer 293* (MICH, UC, US). arroyo in Sierra de Alamos, in vicinity of Alamos, *Rose et al. 12975* (NY, US).

16. **Cerastium tolucense** D. A. Good, *sp. nov.* TYPE: MEXICO. Mexico: Nevado de Toluca, north side of mountain, 0.7 mi east of point where road goes above timberline, alt. ca. 3985 m, 28 July 1958, *Beaman 1921* (HOLOTYPE: MSC; ISOTYPES: GH, MICH, TEX, US). (Figure 2).

Planta perennis. Caules usque ad 35 cm alti sed plerumque minus quam 20 cm, erecti vel ascendentes, basi profuse ramosi, non superne. Rami pilosi usque lanati, praesertim basi et ad nodos lanati. Internodia proxima infra inflorescentiam longissima, plerumque (praeter aliquot specimina juvenia) multo longiora quam folia. Folia caulina plerumque parva, 5.0–30.0 mm longa, 1.0–5.5 mm lata, linearia usque lanceolata, acuta, plus minusve lanata. Rosula basalis praesens. Folia basalia majora, usque ad 60.0 mm longa et 10.0 mm lata, lanceolata usque late elliptica, acuta vel obtusa, plerumque praesertim basi dense lanata. Cymae 1–12 floribus. Bracteae non scarioso-marginatae. Pedicelli usque ad 25.0 mm longi, plerumque breviores, pilosi, interdum glanduloso-pilosi. Sepala 3.4–6.5 mm longa, 1.0–2.0 mm lata, elliptica, acuta, praeter apicem scarioso-marginata. Petala 4.5–11.6 mm longa, bifida per circa 1/8 longitudinem, alba. Filamenta 4.0–7.0 mm longa. Antherae 0.7 mm longae. Styli 3.0–4.0 mm longi. Capsulae 6.0–9.0 mm longae, 2.1–2.8 mm latae, curvae. Semina 0.7–0.9 mm diametro, tuberculata. Chromosomatum numerus $2n = 34$ (Beaman et al., 1962).

Cerastium tolucense is characterized by its non-caespitose habit, the presence of a basal rosette, usually extensive lanate pubescence, many cauline leaves, relatively large flowers, and curved capsules.

DISCUSSION: *Cerastium tolucense* is a species of fairly high mountains (3000 to 4000 m) in central Mexico, having been collected in the mountains of Distrito Federal, México, Michoacan, and Puebla (Figure 4C). Its habitat includes both alpine and subalpine meadows and, at slightly lower elevations, open *Pinus* forests.

Although the name *Cerastium molle* Bartling *in* Presl (1831) has, since its publication, been used exclusively for this species, examination of a photograph of the type indicates that the name is instead referable to what is here recognized as *C. purpusii.* Because of this confusion, no description has been published for this species; I therefore describe it here as *C. tolucense.*

Representative specimens: **Mexico.** DISTRITO FEDERAL: top of Cerro Ajusco, alt. ca. 3937 m, *Beaman 2773* (GH, MSC, US); Cerro Coyotes, cerca de Contreras, *Paray 300* (ENCB). Llano Grande, cerca del Desierto de los Leones, alt. ca. 3250 m, *Rzedowski 20496* (ENCB). MEXICO: Nevado de Toluca, north side of mountain, 0.7 mi east of point where road goes above timberline, alt. ca. 3985 m, *Beaman 1921* (MSC, holotype; GH, MICH, TEX, US, isotypes); Telapon (north of Ixtaccihuatl), south side of mountain, alt. 3450–3650 m, *Beaman 2431* (GH, MSC, TEX, UC, US); Ixtaccihuatl, south side of mountain between Altzomoni and La Joya, 0.7 km south of La Joya, alt. ca. 3980 m, *Beaman 3495* (GH, MSC); park area at junction of road to Temascaltepec and road to Nevado de Toluca, alt. ca. 10,500 ft, *Dunn et al. 22518* (MO); vertiente oeste del Ixtaccihuatl, alt. ca. 3800 m, *Espinosa 6* (CAS, ENCB, MSC); Cerro Tlaloc, Municipio de Tecaltitlán, alt. ca. 3000 m, *Garciá S. s. n.* (MSC); Lerma, alt. ca. 3000 m, *Pina C. 79* (ENCB); Nevado de Toluca, alt. 13,000 ft., —Palomas, Municipio de Iturbide (Santiago Tlazala), alt. ca. 3400 m, *Rzedowski 25912* (MSC). *Rzedowski 28562* (ENCB). MICHOACAN: summit of Cerro San Andres, ca. 12 km (straight line distance) north of Ciudad Hidalgo, alt. ca. 3589 m, *Beaman 4278* (GH, MSC, UC, US); Municipio Tancitaro, alt. ca. 12,600 ft, *Leavenworth 278* (F, GH, MO, NY). PUEBLA: Ixtaccihuatl, south side of mountain, ca. 6 km north of Paso de Cortés, alt. ca. 3900 m, *Beaman 2871* (MSC).

17. **Cerastium triviale** Link, Enum. Hort. Berol. 1: 433. 1821. Type: not seen.

Cerastium vulgatum Linnaeus (nom. ambig.), Sp. Pl., ed. 2, p. 627. 1762. Type: "Habitat in Scandiae et Europae australioris pratis, areis" (photograph seen).

Cerastium caespitosum Gilibert (nom. ambig.), Fl. Lithuan. 2: 159. 1781. Type: lithuania: not seen.

Cerastium holosteoides Fries (nom. ambig.), Novit., ed. 2, p. 126. 1823. Type: not seen.

Cerastium fontanum subsp. *triviale* (Link) Jalas, Arch. Soc. Zool.-Bot. Fenn. 'Vanamo' 18: 63. 1963. Type: not seen.

Plant weakly perennial; much branched, mostly basally; often caespitose; braches 10–25 cm long, decumbent, more or less long-pilose; internodes longest just below the inflorescence; leaves more or less similar throughout, ovate to spatulate, 7.0–30.0 mm long, 3.0–10.0 mm wide, acute, sometimes obtuse, pilose; basal rosette lacking; cymes usually quite dense, few to many flowered; bracts with scarious margins; pedicels short, 2.2–8.4 mm long, long-pilose; sepals lanceolate, 4.3–6.2 mm long, 1.0–1.6 mm wide, scarious-margined, acute, pilose; petals slightly shorter to slightly longer than the sepals, bifid about 1/3 of their length, white; filaments 3.7–4.0

mm long, anthers 0.3 mm long; styles 1.8–2.2 mm long; capsules 7.0–11.6 mm long, 2.1–3.0 mm wide, curved; seeds 0.5–0.7 mm in diameter, red-brown, tuberculate; chromosome number $2n$ = 72 (Blackburn and Morton, 1957), 110 (Heitz, 1926), 126 (Hagerup, 1944, Blackburn and Morton, 1957), 136 (Brett, 1950), 137–147 (Brett, 1955), 140 (Taylor and Mulligan, 1968), 144 (Tischler, 1937; Heiser and Whittaker, 1948; Blackburn and Morton, 1957; Favarger, 1969; Löve, 1972), 160 (Favarger and Küpfer, 1968) or 180 (Blackburn and Morton, 1957). No counts have been published for the Mexican or Central American populations.

DISCUSSION: Although native to Europe, *Cerastium triviale* has become established in North America throughout temperate and subarctic Canada and the United States (Hitchcock et al., 1964) and in central Mexico (Distrito Federal, México, and Veracruz), southern Mexico (Chiapas), Guatemala (Alta Verapaz, and Baja Verapaz), Honduras (Morazan), Costa Rica (Alajuela, Cartago, Heredia, and San José), and Panama (Chiriquí). In habitat, it ranges from roadsides and open meadows through brushy and wooded areas to cloud forests at elevations of about 1400 to 3700 m (Figure 3B).

As has already been discussed (see *Cerastium glomeratum*), the oldest name for this species, *C. vulgatum*, is ambiguous and therefore invalid. Two of the other four names listed above have been used interchangeably for *C. triviale* and *C. glomeratum* and have therefore also been considered ambiguous (*C. caespitosum* and *C. holosteoides*). This series of eliminations leaves the names of *C. triviale* and *C. fontanum* subsp. *triviale*. I here use the older and shorter name, *C. triviale*, since in the absence of extensive hybridization studies such a question of taxonomic rank is largely a matter of personal preference.

REPRESENTATIVE SPECIMENS: **Costa Rica.** ALAJUELA: in and around Zaracero, Canton Alfaro Ruiz, Hwy. 15, *Weston et al. 2110* (UC). CARTAGO: cerca de la cima del Volcán Irazú, *Jimenez 140* (F); south slope of Volcán de Turrialba, near Finca del Volcán de Turrialba, alt. 2000–2400 m, *Standley 35276* (US). HEREDIA: Cerro de Zurquí, northeast of San Isidro, alt. 2000–2400 m, *Standley & Valerio 50601* (US). SAN JOSE: Cerro de Piedra Blanca, above Escasú, *Standley 32481* (US). **Guatemala.** ALTA VERAPAZ: mountains east of Tactic, on road to Tamahú, alt. 1500–1650 m, *Standley 71180* (F). BAJA VERAPAZ: region of Patal, alt. ca. 1600 m, *Standley 69597* (F, NY). **Honduras.** MORAZAN: Montaña de la Tigra, al sudoeste de San Juancito, alt. ca. 2000 m, *Molina R. 14490* (F). **Mexico.** CHIAPAS:

northeast slope of Zontehuitz near summit, Municipio de San Cristóbal las Casas, alt. ca. 9300 ft, *Breedlove 14031* (DS, F, LL, MICH, US). DISTRITO FEDERAL: Puerto de las Cruces, alt. ca. 3100 m, *Rzedowski 34297* (ENCB). MEXICO: between kms. 76 and 77 on the Amecameca-Popocatepetl road, alt. ca. 3250 m, *Beaman 2062* (MSC). VERACRUZ: Las Vigas, *Nelson 14* (US). Balsequillo, Municipio de Perote, alt. ca. 2350 m, *Ventura R. 7386* (ENCB). **Panama.** CHIRIQUI: Volcán de Chiriquí, alt. 3500–4000 m, *Woodson & Schery 472* (GH, MO, US).

18. **Cerastium vulcanicum** Schlechtendal, Linnaea 12: 208. 1838. TYPE: MEXICO. state not known: "in regione subnivale montis Orizaba", September (year not known), *Schiede 508* (HOLOTYPE: HAL; MSC photograph no. 3868).

Cerastium micropetalum Greenman, Zoe 5: 183. 1904. TYPE: MEXICO. state not known: Mt. Ixtaccihuatl, 1903, *Purpus 473* (HOLOTYPE: GH; ISOTYPES: MO, UC, US).

Plant annual or short-lived perennial; stems 6–30 cm tall, very much branched, often tangled, sometimes more or less caespitose; branches erect or decumbent, usually leafy, glandular-pilose above, sparsely to densely lanate or villous toward the base; internodes longer than to shorter than the leaves, mostly more or less similar throughout except at the extreme base, where shorter; leaves more or less similar throughout, linear to broadly lanceolate, 10.0–40.0 mm long, 2.0–7.0 mm wide, acute, pilose to lanate, the latter particularly at the leaf bases and on the margins, leaves generally more lanate toward the base of the plant, often lost in very old plants; basal rosette usually lacking; cymes many flowered, plants often mostly inflorescence; bracts not scarious-margined; pedicels 5.2–15.4 mm long, slender, densely glandular-pilose; sepals lanceolate to ovate, 3.5–4.8 mm long, 0.8–1.2 mm wide, acute, scarious-margined, glandular-pilose; petals usually shorter than the sepals, 3.0–4.8 mm long, sometimes longer than the sepals (particularly on Pico de Orizaba), to 5.2 mm long, bifid about 1/4 of their length, white or pale green; filaments 2.6–3.4 mm long, anthers 0.2 mm long; styles 1.3–1.6 mm long; capsules 5.0–9.0 mm long, 1.8 mm wide, curved; seeds brown, 0.5–0.7 mm in diameter, lightly tuberculate; chromosome number $2n = 34$ (Beaman et al., 1962).

DISCUSSION: *Cerastium vulcanicum* is primarily a species of alpine and subalpine meadows and disturbed sites in pine and fir forests at elevations from 2900 to 4210 m in the Distrito Federal and the states of México, Puebla, Tlaxcala, and Veracruz, Mexico (Figure 4D). There is one collection of what appears to be *C. vulcanicum* from northwestern Guatemala (*Skutch 1219*).

REPRESENTATIVE SPECIMENS: **Guatemala.** HUEHUETENANGO: Sierra Cuchumatanes, alt. ca. 10,800 ft, *Skutch 1219* (F, GH). **Mexico.** DISTRITO FEDERAL: Volcán Xitle, *Matuda s. n.* (CAS); Ajusco, *Orcutt 3702* (F, GH, MO, US). MEXICO: Nevado de Toluca, north side of mountain 2.0 mi east of point where road goes above timberline, alt. ca. 4020 m, *Beaman 1937* (F, GH, MICH, MSC, TEX, UC, US); 3 km north of Paso de Cortés on road to Ixtaccihuatl, alt. ca. 3800 m, *Beaman 3610* (GH, MSC, TEX, UC, US); Llano Grande, Municipio de Zequiapán, cerca de Río Frío, alt. ca. 3200 m, *Cruz C. 1261* (ENCB, MICH, MSC). PUEBLA: Pico de Orizaba, west side of Cerro Colorado, alt. ca. 3860 m, *Beaman 2486* (GH, MSC, TEX, UC, US); ca. 1.5 km east of the Paso de Cortés, alt. ca. 3580 m, *Beaman 2897* (MSC). TLAXCALA: Ladera noreste de la Malinche, entre Apizaco y Huamantla, alt. ca. 3750 m, *Ern 95* (ENCB). VERACRUZ: west slope of Barranca de Mala Cara, south-southeast of peak of Orizaba, alt. ca. 4210 m, *Clausen s. n.* (NY); ladera este del Cofre de Perote, alt. ca. 3750 m, *Dorantes L. 346* (CAS, GH).

EXCLUDED SPECIES

Two type specimens seen during this study, those of *Cerastium fasciculatum* Bartling *in* Presl and *C. stellarioides* Mociño *ex* Seringe *in* de Candolle, were labelled as having been collected in Mexico (the type of *C. stellarioides* is a drawing). However, in its type description (de Candolle 1824), *C. stellarioides* is listed as being found "in American bor. circa Nutka" so that either the label on the specimen is in error or it is not the type of this species and is actually an illustration of some Mexican species, probably a large flowered *C. nutans*.

No other specimen even remotely resembling the type of *Cerastium fasciculatum* was seen in this study; it is therefore unlikely that the species occurs in Mexico. Although both the type specimen and the original description (Presl 1831) list "Mexico" as the collection locality, Fenzl, on the type specimen, noted "verosimiliter pl. chilensis non Mexicana!" (probably a Chilean plant, not Mexican).

ACKNOWLEDGMENTS

For advice and aid in preparing this paper, I thank the following people: John H. Beaman, Stephen N. Stephenson, and Richard K. Rabeler, all of the Department of Botany and Plant Pathology, Michigan State University, and Donald L. Beaver and Richard W. Hill of the Department of Zoology, Michigan State University. I thank also the curators and staff of the following herbaria from which specimens were borrowed: CAS, COLO, DS, ENCB, F, GH, LL, MICH, MO, MSC, NY, TEX, UC, US, and WIS. (Abbreviations follow Holmgren and Kueken, 1974.)

Finally, I would like to dedicate this paper to the memory of Dr. William T. Gillis of the Natural History and Botany Departments of Michigan State University. He will be very much missed by all those who knew and, in knowing, loved him.

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A NEW SPECIES OF *ZIZIPHUS* (RHAMNACEAE) FROM FLORIDA[1]

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ABSTRACT

A new endemic, *Ziziphus celata,* is described from the xerophytic scrub and pinelands of the Lake Wales Ridge in peninsular Florida. This distinctive geniculate-thorny shrub shows clear affinity with the arid, southwestern North American "*Condaliopsis* group" of *Ziziphus,* and represents a significant eastward range extension for this group. The native vegetation of the Lake Wales Ridge has been extensively destroyed, and the plant is represented only by a single specimen collected by Ray Garrett in 1948 near Sebring, Highlands County, Florida. The species is very likely now extinct.

Key Words: Endemism, extinction, flora of Florida, Rhamnaceae, *Ziziphus*

Ray Garrett, a local botanist, collected the type (and only) specimen for the species described herein near Sebring, Florida in March 1948. Correspondence at FLAS indicates that Garrett lived in Sebring. He collected extensively in the surrounding scrub and pinelands, and sent numerous specimens to the Herbarium of the University of Florida. Garrett consulted with Erdman West and Lilian Arnold at the U. F. Herbarium; neither could identify the plant but both thought it to be in the Rhamnaceae. The specimen was placed unmounted at the end of the family in an undetermined folder. Over the past thirty-five years no other specimen of this plant has been found, to the authors' knowledge. During this time efforts were made to identify this unusual plant; visiting botanists were shown the specimen, but none was familiar with it. Efforts were also made by several researchers to find the type locality and collect other specimens. On a recent visit to the Field Museum of Natural History (Chicago, Ill.) the senior author noticed the similarity of the undetermined specimen to *Condalia* Cav. and *Ziziphus* Mill. The taxonomic diversity of these genera in the southwestern United States and Mexico further suggested the possibility that they could be reasonable generic determinations, since Florida has a number of disjuncts of western taxa. Examination of material of many genera and species of the family Rhamnaceae has convinced the authors

[1]This paper is Florida Agricultural Experiment Station Journal Series No. 5179.

that the Sebring material is indeed referable to *Ziziphus,* and that it was unnamed. An interesting and prophetic remark was made by Ray Garrett, the collector of this specimen. In a letter written during the summer of 1948, he mused the J. K. Small had found many novelties in the arid scrub habitat, and wondered why he could not also find something rare. The specimen described below gives clear evidence that he did.

The specific epithet "celata" (meaning hidden) reflects the frustrating taxonomic history of the plant.

Ziziphus celata Judd and Hall, *sp. nov.* (Figure 1).

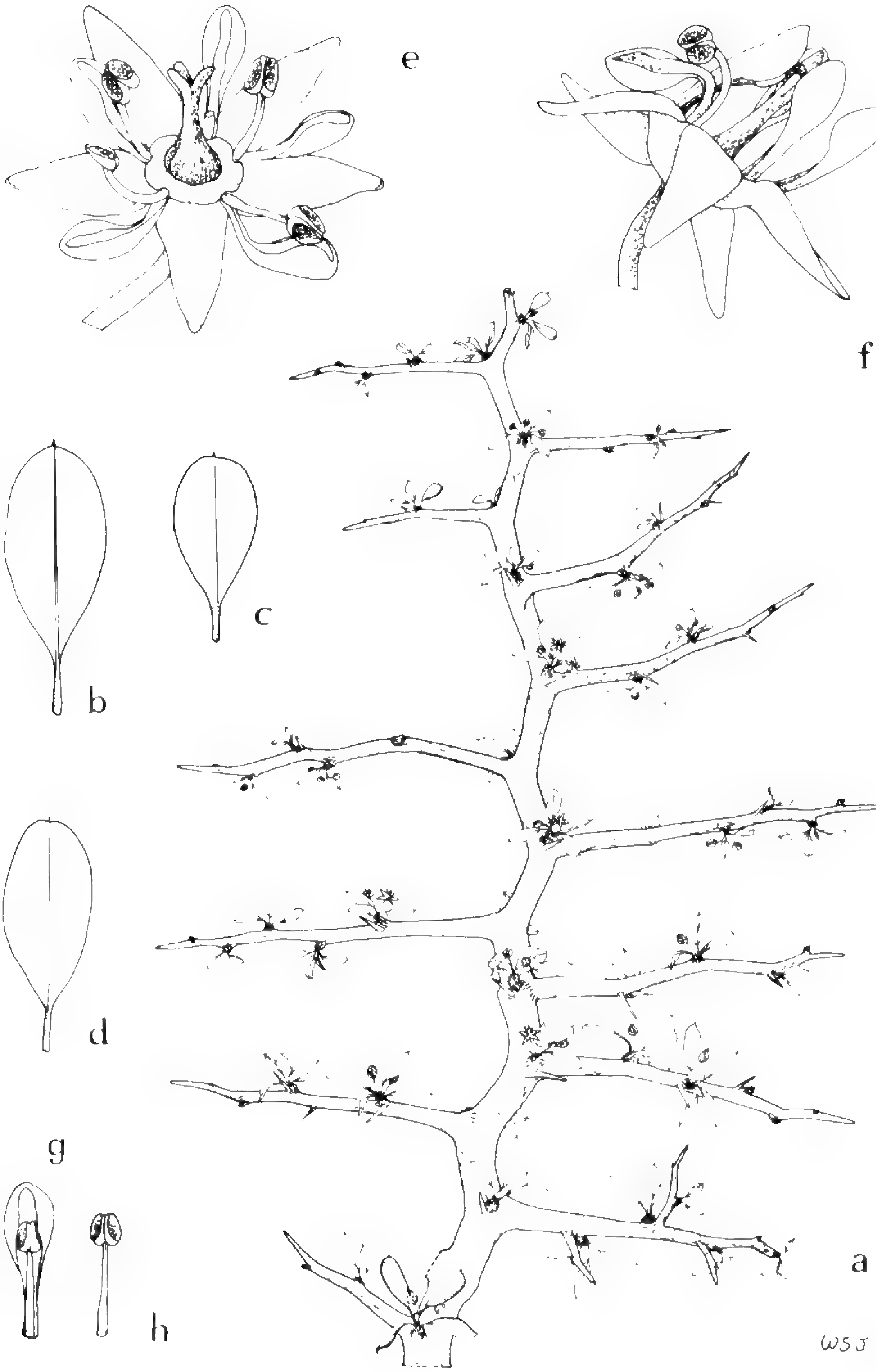
Frutex; rami primarii geniculati et glabri, ferentes brachyblastos et spinas inaequales binatas ad nodos; spinae minores ca. 1–4 mm longae, longiores (0.8) 1.3–3.7 cm longae cum (2)3 vel 4 brachyblastis secundariis et spinis tertiariis parvulis. Cortex grisea; internodia 3–12 mm longa. Folia decidua, alterna (vel fasciculata ad brachyblastos), glabra; lamina ca. 4.5–10 mm longa, 3–5 mm lata, oblonga-elliptica vel leviter ovata, ad apicem rotundata vel leviter emarginata cum mucrone minuto, ad basin cuneata vel attenuata; margo integer; nervatura brochidodroma; petiolus 1.5–3 mm longus; stipulae minutae. Flores axillares (fasciculati ad brachyblastos), vernales; pedicellus 2–3 mm longus. Sepala 5, ovata-triangularia, 1.1–1.6 mm longa, glabra, viridia. Petala 5, spathulata, 1–1.3 mm longa, glabra, alba. Stamina 0.8–1 mm longa. Discus laevis, incrassatus, ovarii basin cingens. Ovarium 2–3 loculare; stylus contractus, bifurcatus vel trifurcatus. Fructus non visus.

Shrubs; primary branches geniculate and arcuate, to 20 cm long, glabrous, without thorn-tips, bearing numerous short shoots from the lowest nodes of which arise one or usually two distinctly unequal thorn-tipped secondary branches [the smaller ca. 1–4 cm long and the larger (0.8)1.3–3.7 cm long] the larger of which in turn bear from (2)3 to 4 short shoots. These secondary short shoots each usually produce a single small [0.3–4(–6.5)mm] tertiary thorn. Bark gray; internodes 3–12 mm long. Leaves deciduous, alternate (fascicled on short shoots); blade oblong-elliptic to slightly ovate, ca. 4.5–10 mm long, 3–5 mm wide (possibly becoming larger with age), glabrous, eglandular, coriaceous; apex rounded to slightly emarginate with a small mucro; base cuneate to slightly attenuate; margin entire; venation brochidodromous with midvein prominent, impressed above and raised beneath, secondary veins inconspicuous; petiole

1.5–3 mm long; stipules narrowly-triangular, minute. Flowers small, perfect, perigynous, solitary and axillary but seemingly fascicled on the short shoots, vernal (appearing with leaves); pedicel 2–3 mm long. Cup ca. 1–1.3 mm in diameter, glabrous. Sepals 5, ovate-triangular, 1.1–1.6 mm long, glabrous, green. Petals 5, spatulate and clasping the stamens, 1–1.3 mm long, glabrous, white. Stamens 5, 0.8–1 mm long; anther opening by 2 longitudinal slits. Disc smooth, thickened and closely surrounding but free from base of ovary. Ovary 2–3 loculed, glabrous, tapering to style; style ca. 0.7–1 mm long, bifid or trifid to ca. one-half its length. Fruit not seen, likely a drupe.

TYPE: UNITED STATES. Florida. Highlands Co., on sand dunes, vicinity of Sebring. 18 March, 1949. *Ray Garrett s.n.* (FLAS).

Ziziphus celata is reminiscent of both *Z. obtusifolia* (Hook.) A. Gray and *Z. parryi* Torr. It consistently differs from the former highly variable species in that it (1) has its flowers solitary in the axils of leaves of the short shoots, (2) lacks unicellular hairs on its twigs, leaves, and flowers, and (3) has branchlets lacking a grayish to whitish wax-like bloom. The taxon is separated from the latter by its (1) usually paired unequal secondary thorns, (2) several-noded secondary thorns (these bearing several short shoots and often small tertiary thorns), and (3) floral cup and sepals greenish (not purplish-green). These three species, along with *Z. lloydii* (Standley) M. C. Johnston, *Z. pedunculata* (Brandg.) Standley and *Z. mexicana* Rose, form a complex intermediate between the widespread tropical genus *Ziziphus* and the xerophytically adapted southwestern U.S.—Mexican—South American genus *Condalia*. This intermediate complex has the floral characters of *Ziziphus, i.e.,* disc thickened around ovary, ovary base broadly attached to receptacle, style tapered and forked, petals present, along with some (to all) of the xeromorphic features of *Condalia*. The latter group includes scrubs of arid habitats with small, ± obovate, entire-margined, pinnate-veined leaves fascicled on short shoots borne on thorn-tipped branches with very short internodes. In addition, stipular spines are lacking (*see* Johnston, 1962). These intermediate species have been treated as *Condalia* subgenus *Condaliopsis* by Weberbauer (1895) or as a distinct genus *Condaliopsis* (Weberb.) Suessenguth (1953). However, Johnston (1962) noted that species of "*Condaliopsis* share characters of ovary, disc and style which set them off from *Condalia*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and at the same time show their similarity to *Ziziphus.*" He added that although these species approach "*Condalia* in several characteristics which can be put under the general heading of 'xeromorphy'", they are "not separable from the large diverse genus *Ziziphus.*" Following Johnston (1962, 1963) we consider the species described above as a *Ziziphus.*

Previously known species of the "*Condaliopsis* group" are limited to arid habitats of the southwestern United States (California to Texas and Oklahoma) and Mexico (Johnston, 1963). *Ziziphus celata,* collected only in the xerophytic sand scrub of Highland Co., Florida, thus represents a significant eastward range extension. However, as mentioned above, other Florida taxa show similar patterns, either occuring as disjuncts in mesic to xerophytic habitats of Florida and the southwestern U.S./Mexico or having closely related species to the west. Some examples include: *Callirhoe papaver* (Cav.) A. Gray, *Ceanothus microphyllus* Michx., *Eriogonum longifolium* Nutt. var. *gnaphalifolium* Gand. (*E. floridanum* Small), *Forestiera pubescens* Nutt., *Krameria lanceolata* Torr., *Lyonia ferruginea* (Walt.) Nutt., *Lyonia fruticosa* (Michx.) G. S. Torrey, and *Rudbeckia nitida* Nutt. var. *nitida.* The ancestors of *Ziziphus celata* may have reached Florida from the west during past periods of increased aridity.

The species has also been compared with various small-leaved Caribbean species of *Ziziphus* (*see* Johnston, 1964). *Ziziphus celata* is clearly distinct from these taxa (compare leaf margin, venation, inflorescence structure), and probably is not closely related. In addition, the Caribbean species are typically plants of limestone or serpentine habitats whereas *Z. celata* is found on acid white sand.

Ziziphus celata is likely a member of the characteristic and highly endemic flora occurring on the sterile white sands of the Central Florida Ridge. The most common plant communities of this region are known as the Sand Pine – Xerophytic Oak Scrub and the High Pinelands/Sandhills. The former is dominated by *Pinus clausa* (Chapm. ex Engelm.) Vasey ex Sarg., *Quercus geminata* Small, *Q.*

Figure 1. *Ziziphus celata:* **a,** habit (drawn from specimen), × 1; **b–d,** leaves (drawn from material re-expanded by boiling), × 2; **e,** flower (drawn from material re-expanded by boiling), × 15; **f,** flower (drawn from dried material), × 15; **g,** petal clasping stamen, × 15; **h,** stamen, × 15.

myrtifolia Willd., and *Q. chapmanii* Sarg., while the latter is dominated by *Pinus palustris* Mill. However, the area is now mainly occupied by citrus groves and urban developments. This area supports numerous other endemics: *Asclepias curtissii* A. Gray, *Bonamia grandiflora* (A. Gray) Heller, *Bumelia lacuum* Small, *Carya floridana* Sarg., *Chapmannia floridana* Torr. & Gray, *Chionanthus pygmaeus* Small, *Clitoria fragrans* Small, *Conradina canescens* (Torr. & Gray) A. Gray, *Dicerandra frutescens* Shinners, *Eryngium cuneifolium* Small, *Garberia fruticosa* (Nutt.) A. Gray, *Hypericum cumulicola* (Small) P. Adams, *H. edisonianum* (Small) Adams & Robson, *Ilex opaca* Ait. var. *arenicola* (Ashe) Ashe, *Lechea cernua* Small, *Liatris ohlingerae* (Blake) Robins., *Lupinus aridorum* McFarlin ex Beckner, *L. cumulicola* Small, *Nolina brittoniana* Nash, *Osmanthus megacarpus* Small, *Paronychia chartacea* Fern., *Persea humilis* Nash, *Polygala lewtonii* Small, *Polygonella ciliata* Meisn. var. *basiramia* (Small) Horton, *P. myriophylla* (Small) Horton, *Prunus geniculata* Harper, *Quercus inopina* Ashe, *Sabal etonia* Swingle ex Nash, *Stylisma abdita* Myint, *Warea amplexifolia* (Nutt.) Small, and *W. carteri* Small (*see also* James, 1961; Harper, 1949; Ward, 1979). Even the striking geniculate-thorny habit of *Ziziphus celata* is present in several other characteristic scrub taxa, such as *Prunus geniculata, Bumelia lacuum, Ximenia americana* L. and a distinctive local variant of *Crataegus flava* Ait.

The authors suggest that systematic studies of the endemic species of the Central Florida Ridge are urgently needed. The natural plant communities of the region are rapidly being destroyed by agricultural and urban development, with the only significant remnants of native flora existing in the Ocala National Forests in the north and Archbold Biological Station in the south. Very likely *Ziziphus celata* is now extinct; most of the natural vegetation near Sebring has been destroyed, and the species has never been collected since, despite repeated searches by D. Burch, D. Ward and the authors. It is feared that many additional taxa of this area (*e.g., Warea amplexifolia, Lupinus aridorum, Stylisma abdita, Nolina brittoniana, N. atopocarpa* Bartl., *Eryngium cunifolium,* and *Hypericum cumulicola*) may soon become extinct thus rendering future studies of their ecology and systematics impossible or very difficult to accomplish.

ACKNOWLEDGMENTS

We thank Dr. Marshall C. Johnston for his several helpful suggestions and comments concerning the manuscript. Thanks are also extended to the curator of the Field Museum (F) for loan of material, and to Drs. Derek G. Burch, Daniel B. Ward, and Erdman West who have puzzled over the plant in the past 30 years.

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THE EFFECT OF POWER UTILITY RIGHT-OF-WAY CONSTRUCTION ON CAT-TAIL (*TYPHA LATIFOLIA* L.) MARSH

F. R. Thibodeau and N. H. Nickerson

ABSTRACT

Vegetation in an eastern Massachusetts freshwater cat-tail marsh was measured over a five-year period, two years before and three years after construction of a 345 kv transmission line; no change in vegetation occurred because of the construction.

Key Words: Inland wetland, power-line construction, vegetative cover

Darnell (1976) suggested that power utility rights-of-way will have a significant long-term effect on the vegetation of a wetland if the natural cover is disturbed. Thibodeau and Nickerson (in preparation) and Nickerson and Thibodeau (1984) questioned this assumption based on field studies of wooded swamp and bog which were subject to both long-term management and new right-of-way construction. Both areas did show evidence of perturbation, but recovery was rapid. We now report that marsh dominated by the cat-tail *Typha latifolia* L. showed no evidence of disturbance even during the first growing season after power line construction.

During the winter of 1977–1978 a 345 kv transmission line was built across an area of marsh covering approximatley 1.5 square miles along the Saugus River in Wakefield, MA. Construction equipment was driven directly across the frozen marsh and no other alterations to the substrate, such as filling, were made. Because the vegetation was uniformly herbaceous, the construction company did not purposefully remove any plants. Any alteration was attributable to incidental effects of the construction equipment itself.

From 1976 to 1980, stem counts of all vegetation were taken during June and July at eight 1 m^2 stations along a transect under the lines and at eight other 1 m^2 stations a parallel distance of 50 m from them. The stations were spaced along the transects using a random digit multiplied by 3 m as the distance from one station to the next. 1976 and 1977 growing season measurements were taken before construction; 1978, 1979, and 1980 measurements were taken after construction. These stem counts were converted to measures of diversity and evenness (Shannon and Weaver, 1949) and richness

Table 1. Plant cover comparisons between right-of-way and undisturbed marsh for years immediately before and after construction.

Year	#Species	#Stems	Diversity	Evenness	Richness
1977	9.56±.83	55.30±7.44	1.21±.01	0.63±.01	1.30±.05
1978	10.63±.72	61.02±8.39	1.20±.01	0.61±.01	1.32±.04

Data shown are grand means for each year ± the deviation between group means under and away from the lines. None of these deviations is significant.

(Margalef, 1957). In addition, analyses were made of the total number of species and of the stem count itself. None of these measures distinguished the two sets of plots in any year-pair using analysis of variance to discriminate between them (SPSS, 1979; $p > .05$ in all cases). The 1977 and 1978 growing seasons, which should mirror the greatest changes, showed no significant differences (Table 1). The vegetative cover ranged from 10% to 80% of each m^2. *Typha* made up 50% to 95% of the total cover per m^2. Table 2 lists the major species comprising the plant cover. Names and authorities are those of Fernald (1950).

It appears that in eastern Massachusetts, at least, frozen substrate protects *Typha* rhizomes and other living plant tissues sufficiently from the compaction and mixing which might be expected to occur when construction equipment is used in such a fresh-water cat-tail marsh. Power transmission line construction carried out in this fashion, with no change in the water regime of the wetland, had no demonstrable effect on the plant association of the marsh.

Table 2. Species comprising plant cover[1]

Typha latifolia L.
Sagittaria latifolia Willd.
Impatiens capensis Meerb.

Cicuta bulbifera L.
Galium palustre L.
Lemna sp.
Dryopteris thelypteris (L.) Gray

Lythrum salicaria L.
Cephalanthus occidentalis L.
Rosa palustris Marsh.

[1]The first three species comprised 80% or more of the cover on any 1 m^2 quadrat; the second four, while often present, never comprised, even together, more than 5% of the cover on any 1 m^2 quadrat; the last three were only sporadically encountered.

ACKNOWLEDGMENTS

We thank the many students who were our conscientious employees over the summers of field work. This investigation was supported by a research grant from the New England Power Company to the second author.

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REDISCOVERY OF *STYLISMA HUMISTRATA* (CONVOLVULACEAE) IN TENNESSEE

VERNON BATES AND PAUL LEWIS

Recent field work has uncovered a native species, *Stylisma humistrata* (Walter) Chapman, that has remained undetected in Tennessee for more than a century. Previously, its presence in Tennessee was known from only one collection ('Lookout Mt., Tenn.', Hamilton County) made by George Vasey in 1878. Our collection is from west Tennessee, approximately 200 miles west of Vasey's original collection site. There has been no attempt as yet to relocate this species in the vicinity of Lookout Mountain.

Vasey's collections of *Stylisma humistrata* were deposited in herbaria outside Tennessee and, until the revision of *Stylisma* (Myint, 1966), had remained unknown to Tennessee botanists. We examined one specimen that was originally deposited in the Princeton University Herbarium and later transferred to the New York Botanical Garden in 1945. According to Myint, a duplicate of the same collection was seen by him at the Philadelphia Academy of Science. However, a search of *Stylisma* material at the Philadelphia Academy of Science did not reveal its presence. It is interesting to note that even though Augustin Gattinger spent about 15 years botanizing in southeastern Tennessee (Oakes, 1932), he apparently did not collect this species nor did he hear of Vasey's collections (Gattinger, 1901). In the most recent state checklist (Sharp et al., 1960), this species continued to be unrecognized as a member of the flora of Tennessee.

Of the eight taxa currently recognized in *Stylisma* (Myint, 1966), *S. humistrata* has the widest distribution. Its range extends from coastal Virginia to northern Florida and west to eastern Texas. It appears that the southern border of Tennessee (35° N lat.) approximates its northernmost limits in the Mississippi River Valley. In fact, our collection site is less than one mile from the Mississippi border. Interestingly, Smith (1978) also gives the northernmost distribution for this species in Arkansas at approximately the same latitude.

The recent collection of *Stylisma humistrata* reported here is from west Tennessee, an area we are currently studying. The collection data are: Tennessee, McNairy Co., deep sand areas along the

Tuscumbia River, at dirt road crossing about 1.0 mi E of its confluence with the Hatchie River, *V. Bates & P. Lewis 5189,* 13 August 1983. Voucher specimens have been deposited at APSC, GH, MEM, TENN, and VDB.

ACKNOWLEDGMENTS

We would like to thank Robert Kral and Eugene Wofford for checking their Tennessee records, and Alfred Schuyler for searching for the Vasey specimen at Philadelphia Academy of Science.

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AN AWARD FOR THE SUPPORT OF BOTANICAL RESEARCH IN NEW ENGLAND, U.S.A.

The New England Botanical Club is offering an award of $1,000 in support of botanical research to be conducted in the New England region during 1985. It is being made to stimulate and encourage botanical research on the New England flora and to make possible visits to the New England region by those who would not otherwise be able to do so. The award will be given to the graduate student submitting the best research proposals dealing with field studies in systematic botany and plant ecology, but proposals for research in other areas of botany will also be considered. This award is not limited to graduate students at New England institutions. The NEBC's support must be acknowledged in any publications resulting from this study. It is encouraged that papers based on this research be submitted to RHODORA, the Club's journal, for possible publication—subject to standard review processes. The New England Botanical Club hopes to be able to make this award on an annual basis.

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Vol. 86, No. 846, including pages 121–238, was issued June 28, 1984.

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JOURNAL OF THE NEW ENGLAND BOTANICAL CLUB

Vol. 86 October 1984 No. 848

The New England Botanical Club, Inc.

Botanical Museum, Oxford Street, Cambridge, Massachusetts 02138

Conducted and published for the Club, by
NORTON H. NICKERSON, Editor-in-Chief

RHODORA.—Published four times a year, in January, April, July, and October. A quarterly journal of botany, devoted primarily to the flora of North America. Price $20.00 per year, net, postpaid, in funds payable at par in the United States currency at Boston. Some back volumes and single copies are available. Information and prices will be furnished upon request. Subscriptions and orders for back issues (making all remittances payable to RHODORA) should be sent to RHODORA, Botanical Museum, Oxford Street, Cambridge, Mass. 02138. In order to receive the next number of RHODORA, changes of address must be received prior to the first day of January, April, July or October.

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Second Class Postage Paid at Boston, Mass.

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THE LEXINGTON PRESS, INC
LEXINGTON, MASSACHUSETTS

Cover illustration

Ledum groenlandicum Oeder, Labrador tea, reaches its southeastern distributional limit in Concord, Mass. It was first collected by Thoreau in 1858, subsequently regarded as extirpated by Richard Eaton in 1974, and rediscovered by Ray Angelo in 1978. Angelo has since found it in two more Concord locations.

Original artwork by Josephine Ewing.

Rhodora

(ISSN 0035 4902)

JOURNAL OF THE

NEW ENGLAND BOTANICAL CLUB

Vol. 86 | October 1984 | No. 848

THE HERB STRATA OF THREE CONNECTICUT RIVER OXBOW SWAMP FORESTS

Marjorie M. Holland[1] and C. John Burk

ABSTRACT

The herb floras of swamp forests in three of four large Connecticut River oxbows in western Massachusetts have been described and compared. The herb stratum at Hatfield includes a lush growth of annual and perennial herbs, lianas, and emergent marsh species, but no seedlings of the dominant canopy tree, *Populus deltoides*. Composition of the herb stratum in Ned's Ditch, Northampton, forest was found to vary markedly during four years of sampling. Seedlings of major canopy species at Ned's Ditch increased steadily through successive years while abundance of floating hydrophytes fluctuated strongly. Ferns and spring-blooming herbs predominated in the herb stratum at Whately which also contained seedlings of all canopy species. Of the herbaceous species sampled, 70% occurred only at one site. An argument is made that floodplain forest, severely limited in New England, should be more stringently protected.

Key Words: Swamp forest, floodplain vegetation, herbaceous flora, wetlands, Connecticut River

INTRODUCTION

Published accounts of floodplain and swamp forest vegetation in New England are chiefly limited to the perceptive comments of Nichols (1915, 1916) on lowlands and stream banks in Connecticut. Floodplain forests elsewhere have been investigated more intensively. However, much of this work has concentrated on overstory

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species with only a few studies examining herbaceous strata in detail (Wistendahl, 1958; Lindsey et al., 1961; Bell, 1974; Keammerer et al., 1975; Barnes, 1978; Hardin and Wistendahl, 1983).

Within an 18 km stretch of the Connecticut River in western Massachusetts, four large oxbow lakes occur. Three are in the active floodplain while the fourth now lies on a higher terrace. We have recently (Holland and Burk, 1982) discussed the relative ages (time since cut-off) of these oxbows. The "youngest" was separated from the main stream in 1840 and remains in large part open water. The others contain varying amounts of open water, marsh, shrub swamp, and forest.

The object of the present study is to describe and compare the floras of the herbaceous strata in the forests of the three older western Massachusetts oxbows. More detailed accounts of the geology, history, and marsh vegetation of these oxbows are found in Robinton and Burk (1971); Burk (1973, 1977), Sackett (1974, unpublished Master's thesis, Smith College, Northampton, Mass.; 1977, unpublished Ph.D. dissertation, U. Mass, Amherst), Burk and Lauermann (1977) and Holland and Burk (1982).

LOCATION AND AGE OF THE STUDY SITES

Figure 1 indicates the location of the study sites. In order of increasing age they are (A) the Hatfield oxbow, which includes two adjacent segments known as Great Pond and Cow Bridge Brook, (B) Ned's Ditch, the northeastern half of a prehistoric oxbow in Northampton, and (C) the Whately oxbow.

The Hatfield oxbow was formed sometime prior to the late 1700's. Depicted as two large ponds on the earliest maps of the area, it was subject to full erosive flow from the Connecticut River during heavy flooding as recently as 1936 (Collins and Schalk, 1937).

Stratigraphy and radiocarbon dating indicate that the prehistoric Northampton oxbow was cut off from the main stem around 710 ($\pm$130) yr. B. P. (Holland and Burk, 1982). The Ned's Ditch section is largely forested. Hulbert's Pond, the lower southeastern portion of this oxbow, contains an extensive marsh complex kept open by the Mill River which flows through it into the 1840 oxbow.

The Hatfield and the prehistoric Northampton oxbows tend to be flooded yearly or more often (Brower, 1971). The Whately oxbow is for the most part above the present floodplain. The lower eastern

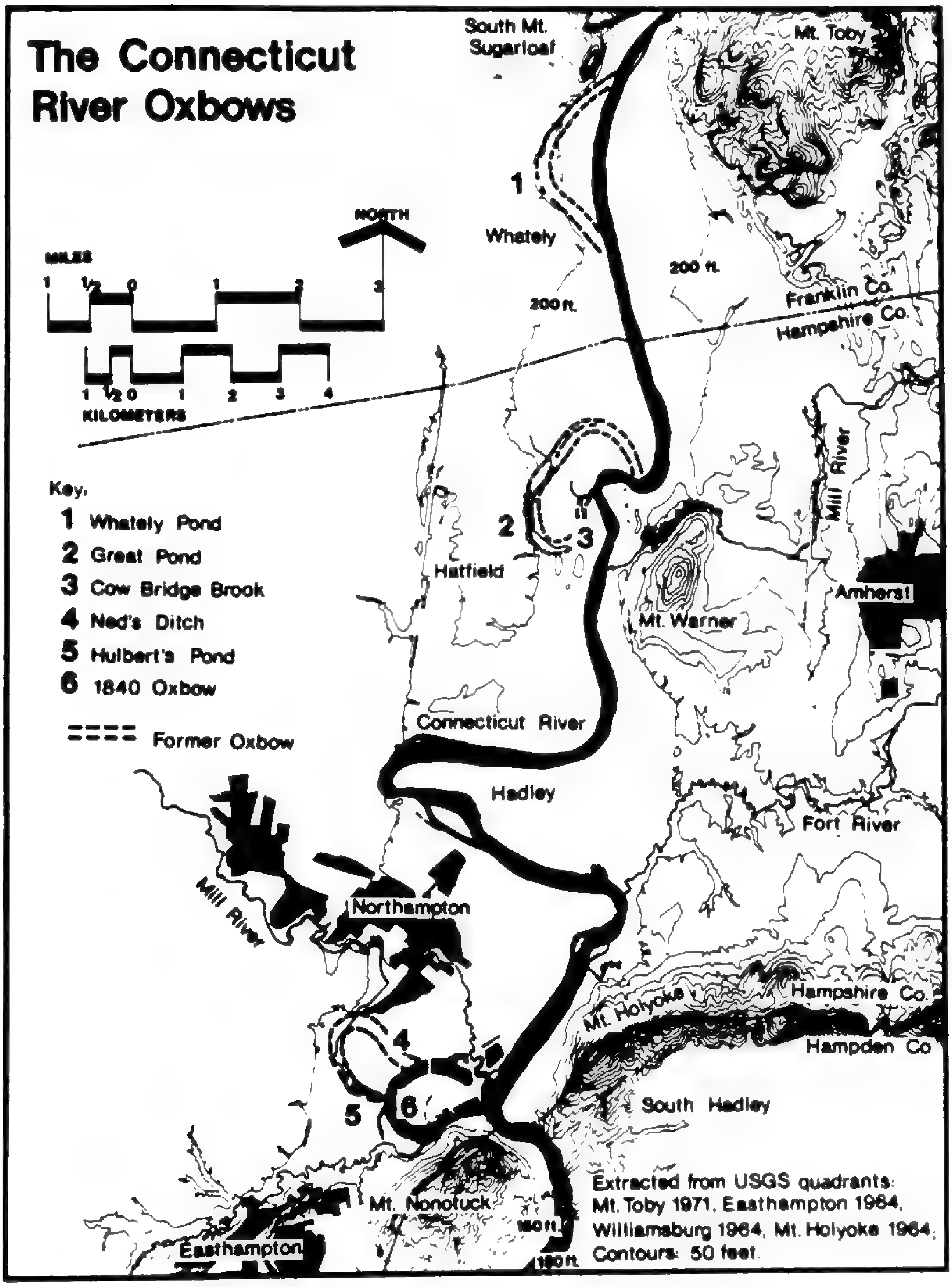

Figure 1. Map of the study area and location of the study sites (from Holland and Burk, 1982. Reprinted with permission from Northeastern Geology, Vol. 4, No.1.)

portions of this oldest site were flooded in 1936, but the western portions have not been flooded at all within historic times (Jahns, 1947).

METHODS

Since each of the oxbows contains a diversity of habitats, sampling techniques were planned to assure that only swamp forest was included. The course of the old river bank can usually be identified. After a general reconnaisance at each site, belt transects approximately 300 m long and 1 m wide were laid out, crossing the former channel at regular intervals.

At Hatfield, 10 belt transects were established at intervals of 575 m. On four of these, swamp forest occurred adjacent to one side of the old river bank in sufficient quantity to lay out a 10 m × 10 m quadrat beginning 3.3 m in from the edge of the forest closest to the bank. Within each 10 m × 10 m quadrat, ten 1 m × 1 m quadrats were laid out, five at regular intervals along the transect and five at regular intervals along a baseline perpendicular to the transect.

Ned's Ditch encompasses approximately half of the total Northampton oxbow. Five transects were laid out at 285 m intervals in Ned's Ditch. Swamp forest occurred adjacent to both sides of the old river bank on all of these. Ten 10 m × 10 m quadrats were established in Ned's Ditch, two on each transect beginning 3.3 m in from the edge of forest at each end of the transect. Within each 10 m × 10 m quadrat, 1 m × 1 m quadrats were laid out as at Hatfield.

Five transects were laid out at 575 m intervals at the Whately site. Sufficient swamp forest was present at Whately to establish five 10 m × 10 m quadrats, one adjacent to the river bank on one transect and two adjacent to the river bank on either end of two other transects. Ten 1 m × 1 m quadrats were laid out within each larger quadrat, as in the other sites.

Presence and coverage as determined by visual estimate were noted for all herbs, vines and woody seedlings under 60 cm height in the 1 m × 1 m quadrats. During 1975, 40 1 m × 1 m quadrats were sampled at Hatfield, 100 at Ned's Ditch, and 50 at Whately. Different numbers of quadrats sampled at each site reflect the different amounts of swamp forest present. The proportion of each oxbow supporting swamp forest was estimated from aerial photographs, USGS topographic maps, and other maps available from local sources. A comparison of ratios of total area sampled to overall swamp forest present indicated that roughly equal proportions of vegetation were sampled at each oxbow.

Within the study area, few floodplain forest herbs break dormancy before early May, and many begin seasonal development in late May or early June. Therefore sampling was conducted during the last two weeks of July and the first three weeks of August, the period when the herbaceous stratum is most fully developed. Because preliminary observations indicated that the herb stratum of Ned's Ditch varied markedly from year to year, Ned's Ditch was sampled in 1973, 1974, 1975, and 1977. At Hatfield and Whately, belt transects and 10 m × 10 m quadrats were situated during 1974, but sampling at these sites that year was limited to five quadrats along the transect in each 10 m × 10 m quadrat. Full sampling at all sites was conducted in 1975. General collecting was conducted each season to determine species present in the swamp forest at any site but not represented in the quadrats.

For purposes of analysis, a table was prepared listing all species sampled in any quadrat during 1973, 1974, and 1975. In a few instances, specimens could be identified only at the generic level and, in the case of some immature grasses, only to family. These identifications are included in the list but omitted in later floristic comparisons. Species occurring at a study site but not within any quadrat in 1975 are indicated (a) if they appeared in any quadrat at the site during any prior year of sampling or (b) if they were collected elsewhere in swamp forest at the site during 1975. Cover and frequency data are included only for 1975. Species collected at a site but never found within a quadrat are not included.

To document changes in the composition of the flora of Ned's Ditch during the four years of sampling, a table was prepared listing cover values and frequencies for all species encountered each year. This list and maps indicating the locations of the belt transects at each site are available from the authors upon request. Precipitation data used in the discussion of vegetational changes were obtained from Philip T. Ives (personal communication through the study period.)

Unless otherwise indicated in Table 1, nomenclature follows Fernald (1950). Voucher specimens of all species collected have been deposited in SCH.

Table 1. Composition of the herb strata. Percent cover (C) and frequency (F) of species sampled, total number of species present, and total vegetative cover of herbaceous strata of three western Massachusetts oxbow forests in 1975. P indicates sampling prior to 1975 but not that year, X indicates presence in swamp forest elsewhere at the site but not in quadrats. Total cover is the sum of actual cover values for each species.

	Hatfield		Ned's Ditch		Whately	
Species	%C	%F	%C	%F	%C	%F
Herbs and vines						
Agrostis alba L.	4	12.5	2	17		
Amphicarpa bracteata (L.) Fern.	<.5	2.5	<.5	2	-	
Apios americana Medic.	--	--	1	6	-	-
Aralia nudicaulis L.	-	--	--	--	1	14
Arisaema triphyllum (L.) Schott	<.5	5	<.5	1	<.5	2
Aster divaricatus L.	-	--	--	--	<.5	2
A. vimineus Lam.	--		P	P		
Aster spp.	<.5	5				
Athyrium filix-femina (L.) Roth	1	2.5	X	X	13	30
Bidens tripartita L.	2	47.5	<.5	8	--	-
B. frondosa L.	--		1	4		
Boehmeria cylindrica (L.) Sw.[1]	7	85	<.5	9		
Botrychium multifidum (Gmel.) Rupr.	--	--	<.5	1		
Callitriche heterophylla Pursh	<.5	7.5	--			
Cardamine pensylvanica Muhl.		-	P	P		
Carex tribuloides Wahlenb.	<.5	10				
Carex spp.	4	22.5	<.5	1	<.5	6
Cicuta maculata L.	<.5	5				
Circaea quadrisulcata (Maxim.) Franch. & Sav.	1	7.5				
Clematis virginiana L.	<.5	2.5				
Clintonia borealis (Ait.) Raf.				-	<.5	2
Commelina communis L.		-	P	P		
Convolvulus sepium L.	<.5	2.5				
Coptis groenlandica (Oeder) Fern.		-	--	--	P	P
Cuscuta gronovii Willd.	<.5	15	X	X		
Cyperus strigosus L.			P	P		
Dennstaedtia punctilobula (Michx.) Moore		--	-	--	11	34
Dryopteris spinulosa (O. F. Muell.) Watt			<.5	5	P	P
D. thelypteris (L.) Gray	1	5	X	X	P	P
Dulichium arundinaceum (L.) Britt.	-		7	16		
Echinocystis lobata (Michx.) T. + G.	<.5	2.5				

[1]May include some immature *Pilea pumila*

Table 1. Continued

Species	Hatfield		Ned's Ditch		Whately	
	%C	%F	%C	%F	%C	%F
Eleocharis acicularis (L.) R. & S.	—	—	2	14	—	—
E. obtusa (Willd.) Schultes	P	P	—		—	—
Equisetum fluviatile L.	2	22.5		—	—	—
Eupatorium rugosum Houtt.	<.5	7.5		—	—	—
Galium aparine L.	1	37.5	<.5	8	—	—
Gaultheria procumbens L.		—	—	—	2	40
Geum canadense Jacq.		—	—	—	P	P
G. virginianum L.	1	15	—	—	—	
Glechoma hederacea L.	<.5	10	—	—		
Gramineae (unidentified)	7	17.5	<.5	2	—	
Hypericum virginicum L.	—		<.5	1		
Impatiens capensis Meerb.	13	80				
Leersia oryzoides (L.) Sw.	4	35	P	P	—	
L. virginica Willd.		—	—	—	<.5	6
Lemna minor L.			34	88		
Ludwigia palustris (L.) Ell.	<.5	30	<.5	16		
L. polycarpa Short & Peter	—	—	<.5	1		
Lycopodium complanatum L.				—	4	28
L. obscurum L.				—	6	30
Lycopus uniflorus Michx.			<.5	1		
L. virginicus L.	P	P	X	X		
Lysimachia ciliata L.	1	17.5	X	X		
L. nummularia L.	7	10	<.5	3		
L. terrestris (L.) BSP.			P	P		
Maianthemum canadense Desf.	<.5	2.5	X	X	3	24
Matteuccia struthiopteris (L.) Tod.	5	10				
Medeola virginiana L.					1	14
Mitchella repens L.			X	X	3	24
Monotropa uniflora L.					P	P
Myosotis scorpioides L.	<.5	10				
Onoclea sensibilis L.	1	7.5	1	3		
Osmunda cinnamomea L.					18	46
O. claytoniana L.					2	6
O. regalis L.	P	P	3	12.5	<.5	2
Oxalis europaea Jord.	<.5	12.5				
Parthenocissus quinquefolia (L.) Planch.	1	12.5	X	X	2	18
Peltandra virginica (L.) Schott & Endl.	2	22.5				
Penthorum sedoides L.			<.5	1		
Pilea pumila (L.) Gray	X	X	X	X		
Polygonatum pubescens (Willd.) Pursh					<.5	2

Table 1. Continued

Species	Hatfield		Ned's Ditch		Whately	
	%C	%F	%C	%F	%C	%F
Polygonum sagittatum L.	<.5	7.5	--	--	--	--
P. scandens L.	<.5	2.5	P	P	--	
Pontederia cordata L.	P	P	--	--	--	--
Potamogeton pectinatus L.	-	--	<.5	1		
Ranunculus abortivus L.	P	P		-		
R. flabellaris Raf.		-	2	22		
Rhus radicans L.	<.5	2.5	X	X	--	.
Sagittaria latifolia Willd.	P	P	--	--	--	--
Scrophularia lanceolata Pursh	3	7.5	--	--	--	--
Scutellaria lateriflora L.	1	20	<.5	1	--	--
Sium suave Walt.	--		<.5	6	--	--
Smilacina racemosa (L.) Desf.			-	--	P	P
Smilax herbacea L.	--	--	<.5	5	--	--
Solanum dulcamara L.		-	<.5	1	--	--
Solidago spp.	<.5	10				
Spirodela polyrhiza (L.) Schleid.	--	-	3	78	-	
Streptopus roseus Michx.	--	--	--	--	1	16
Symplocarpus foetidus (L.) Nutt.	3	10	--	--	--	--
Thalictrum polygamum Muhl.	P	P	X	X	--	
Trientalis borealis Raf.			--	--	1	36
Trillium undulatum Willd.	-	--		-	1	10
Utricularia vulgaris L.	--	--	2	13	--	
Viola conspersa Reichenb.	1	17.5	--	--	P	P
Vitis spp.[2]	<.5	15	<.5	5	<.5	2
Woody seedlings						
Acer negundo L.	1	22.5	--	--	--	--
A. rubrum L.	P	P	-		1	42
A. saccharinum L.	1	37.5	4	35	--	-
Alnus rugosa (DuRoi) Spreng.	1	5	P	P	--	--
Amelanchier laevis Wieg.	--	--	--	--	<.5	2
Betula lutea Michx. f.	--	--	--		<.5	6
Betula spp.	-		<.5	1	--	--
Cephalanthus occidentalis L.	<.5	2.5	4	31	--	--
Cornus alternifolia L. f.	--	--	--	--	<.5	16
C. amomum Mill.	3	25	--	-	--	--
C. stolonifera Michx.	--		2	12	--	--
Fagus grandifolia Ehrh.		--	--	--	<.5	2
Fraxinus pennsylvanica Marsh.		--	1	4	--	-

[2]Not all specimens of *Vitis* could be identified in quadrats. *V. riparia* Michx. was present at all sites, *V. labrusca* L. at Hatfield and Whately, and *V. aestivalis* Michx. at Ned's Ditch.

Table 1. Continued

	Hatfield		Ned's Ditch		Whately	
Species	%C	%F	%C	%F	%C	%F
Hamamelis virginiana L.	--	-	--	-	<.5	16
Ilex laevigata (Pursh) Gray	<.5	2.5	--	--	-	
I. verticillata (L.) Gray	--		1	11	<.5	2
Kalmia latifolia L.	--			--	4	14
Nyssa sylvatica Marsh.	--	--	--	-	P	P
Populus deltoides Marsh.			<.5	1		
Prunus serotina Ehrh.	1	5	--		2	44
Quercus bicolor Willd.	--	--	<.5	1		
Q. palustris Muenchh.	-	--	<.5	3		
Q. velutina Lam.	--		-	--	1	12
Rhododendron viscosum (L.) Torr.	-	--			1	8
Robinia pseudo-acacia L.	--		P	P		
Rubus hispidus L.	P	P				
Rubus spp.					1	14
Salix spp.	--		<.5	2		
Sambucus canadensis L.	<.5	2.5				
Spiraea latifolia (Ait.) Borkh.	<.5	2.5	<.5	1		
Ulmus rubra Muhl.	--	-	<.5	1		
Vaccinium atrococcum (Gray) Heller		--		--	1	6
Viburnum acerifolium L.				-	<.5	4
V. cassinoides L.	-	-	--		1	12
V. recognitum Fern.		--	<.5	1	8	36
Total in 1975	55		47		40	
% Cover	79%		71%		89%	

RESULTS AND DISCUSSION

The Hatfield Oxbow

The forest at the Hatfield oxbow shares aspects of floodplain forests described early this century on the lower Connecticut River (Nichols, 1916). These include "rank and luxuriant" undergrowth, a "wealth of lianas", few shrubs, and a trend toward replacement of *Populus deltoides* by shade-tolerant trees.

An estimated 16 ha of swamp forest occupies approximately 10% of the oxbow. *Populus deltoides* dominates an open canopy in association with *Acer saccharinum* and unusually large specimens of *Alnus rugosa*. *Acer negundo*, *Fraxinus pennsylvanica*, *Ulmus rubra*, and *Rhus typhina* occur as small trees. Shrubs are poorly developed with *Alnus rugosa* and *Cornus amomum* most common.

By late summer, the herb stratum supports lush vegetation. Although fewer quadrats were sampled at Hatfield, more herbaceous species were encountered there than at other sites (Table 1). Perennial herbs contribute most to overall cover. However, annuals are also common, with *Impatiens capensis* ranked first in individual coverage. *Boehmeria cylindrica, Lysimachia nummularia,* and *Matteuccia struthiopteris* are important perennial herbs. Vines, including *Amphicarpa bracteata, Clematis virginiana, Convolvulus sepium, Cuscuta gronovii, Echinocystis lobata, Parthenocissus quinquefolia, Polygonum scandens, Rhus radicans, Vitis labrusca* and *V. riparia* form tangled masses on other growth. Typical emergent marsh species of both the Hatfield and Northampton oxbows, including *Equisetum fluviatile, Leersia oryzoides, Ludwigia palustris, Peltandra virginica,* and *Scutellaria lateriflora,* possess high frequency but low cover.

Few species occur as woody seedlings. *Populus deltoides* is not regenerating, but seedlings of *Acer saccharinum, A. negundo,* and *Cornus amomum* are well distributed.

Ned's Ditch

Swamp-forest is more extensive and better developed in Ned's Ditch, covering 30 ha, an estimated 66% of the upper half of the Northampton oxbow. The forest was intermittently logged prior to 1973 but not since. *Acer saccharinum, Quercus palustris,* and *Fraxinus pennsylvanica* are the most important components of the canopy, with *Ulmus rubra, Betula lenta, B. papyrifera, Acer rubrum,* and large specimens of *Cephalanthus occidentalis. Populus deltoides, Salix nigra, S. fragilis,* and *S. rigida* occur as small trees on one site where coarse sand fill was deposited during highway construction. *Cephalanthus occidentalis, Cornus stolonifera,* and *Ilex verticillata* are important shrubs.

Over the first three years of sampling at Ned's Ditch, species richness (total number of species present) and coverage in the herb stratum increased strikingly. The relative contribution of individual species to cover also varied (Table 2). In 1973, coverage was only 14% with 27 species encountered in 100 quadrats. The depauperate vegetation and sparse flora resulted in large part from an atypical early summer flood which followed a very wet spring (Table 3). The herb stratum was completely inundated for at least 10 days in early July (Sackett, 1974 unpublished Master's thesis, Smith College,

Table 2. Yearly variation in Ned's Ditch. Relative cover (percentage of total vegetative cover) represented by species occurring with a total of 5% or more during any sampling period.

Species	Year 1973	1974	1975	1977
Acer saccharinum L.	7	11	6	12
Cephalanthus occidentalis L.	1	8	6	10
Dulichium arundinaceum (L.) Britt.	29	17	10	<.5
Eleocharis acicularis (L.) R. & S.	1	3	3	8
Lemna minor L.	7	3	48	7
Onoclea sensibilis L.	14	11	1	8
Osmunda regalis L.	14	14	4	7
Ranunculus flabellaris Raf.	1	3	3	11

Table 3. Precipitation measurements. Monthly April–August, total April August, annual 1973 1977, and mean data 1948 1983. Data were recorded in inches at Amherst, MA.

	Month					*Total*	
Year	April	May	June	July	August	April–August	Year
1973	6.40	5.45	4.48	3.33	2.24	21.90	46.65
1974	3.81	4.01	3.46	3.65	3.97	18.90	44.71
1975	2.87	2.10	4.68	10.56	6.13	26.34	59.97
1976	3.40	4.49	2.97	1.58	6.06	18.50	39.63
1977	4.91	3.57	3.83	4.04	5.94	22.29	55.79
Mean Data from 1948–1983							
	4.00	3.57	3.88	3.55	3.86	18.86	44.06

Northampton, Mass.). By August, *Dulichium arundinaceum, Onoclea sensibilis,* and *Osmunda regalis* together accounted for 8% coverage. *Lemna minor* and *Spirodela polyrhiza* contributed little cover but occurred at high frequencies.

Relatively dry conditions during the frost-free period of 1974 allowed successful establishment or re-establishment of numerous species. Cover increased to 36% with 36 species present. *Dulichium arundinaceum, Onoclea sensibilis,* and *Osmunda regalis* were again the most prominent herbs, contributing, with *Dryopteris spinulosa,* 19% coverage. *Lemna minor* and *Spirodela polyrhiza* continued with low cover but high frequency.

The 1975 season was unusually wet and, following heavy rainfall in July (Table 3), shallow standing water was present in most of the quadrats through the sampling period. Cover reached 71% with 47 species encountered. One invader, *Ludwigia polycarpa*, is included in the Massachusetts list of rare and endangered species (Crow et al., 1981). *Lemna minor*, intermixed with *Spirodela polyrhiza*, was most important, contributing 34% cover. Other frequent "errant hydrophytes" (Mueller-Dombois and Ellenberg, 1974) were *Ranunculus flabellaris* and *Utricularia vulgaris*. *Dulichium arundinaceum* increased while ferns as a group declined.

Some woody seedlings present before the August, 1973 sampling may have been destroyed by the July flood. Woody seedlings increased from 5 to 13 species from 1973 to 1975, with coverage by woody seedlings increasing from less than 2% to over 12%. All canopy trees were represented in the herb stratum in 1975.

During 1977, another wet season with precipitation more evenly distributed than in 1975, coverage was 73%, slightly higher than in 1975 with 41 species present. Woody species contributed more than 23% cover (Table 2). *Ranunculus flabellaris* and *Eleocharis acicularis* increased and *Dulichium arundinaceum* declined to very low levels. *Lemna minor* decreased but was still very frequent, as was *Spirodela polyrhiza*. Seedlings of *Fraxinus pennsylvanica* occurred in 51% of the quadrats.

During the four years of sampling at Ned's Ditch, 61 taxa were identified at the specific level within quadrats. Of these, 16 occurred every year. In addition to the species listed in Table 2, these included *Agrostis alba*, *Apios americana*, *Dryopteris spinulosa*, *Ilex verticillata*, *Pilea fontana*, *Quercus palustris*, *Spirodela polyrhiza*, and *Vitis riparia*. Their life forms include six herbaceous perennials, four woody seedlings, two "errant hydrophytes", one annual, and two vines. In addition, immature specimens of *Bidens* spp., probably mostly *B. cernua* and *B. tripartita* were sampled every year. Ferns as a group contributed about 5% of the total coverage during 1973 and 1975 and more than twice that amount in 1974 and 1977. The canopy species, well represented by seedlings, are apparently replacing themselves, and, as long as flooding continues, the forest might be expected to continue in a persistent state of "hydric disclimax" (Daubenmire, 1968) or "pulse stability" (Odum, 1969).

The Whately Oxbow

The lower eastern portions of the Whately oxbow support a poorly drained complex of forest, marsh, and open water. The upper western portions are almost entirely forested; much of this woodland occurs on slopes leading up to a higher river terrace. Only about 25% of the Whately oxbow, an estimated 18 ha, supports swamp forest suitable for sampling.

The forest has been occasionally logged but apparently never clearcut. *Acer rubrum* and *Prunus serotina* are the most important trees in association with *Quercus alba* and *Nyssa sylvatica*. *Amelanchier laevis*, *Castanea dentata*, and *Tsuga canadensis* are present as small trees; some specimens of *Hamamelis virginiana* are also large enough to transgress the canopy. *Viburnum dentatum* and saplings of all overstory species form a dense shrub stratum.

The herb stratum is very well developed with a total coverage of 89%. Perennials and woody seedlings are the most important life forms. Vines are scarce while annuals and "errant hydrophytes" are lacking. Ferns are more abundant at Whately than at any other site, with *Osmunda cinnamomea*, *Athyrium filix-femina* and *Dennstaedtia punctilobula* predominant. These, with *Lycopodium complanatum* and *L. obscurum*, contribute 52% cover. Spring-blooming perennial herbs, generally absent at other sites, are abundant. These include *Aralia nudicaulis*, *Clintonia borealis*, *Coptis groenlandica*, *Medeola virginiana*, *Polygonatum pubescens*, *Smilacina racemosa*, *Streptopus roseus*, *Trientalis borealis*, and *Trillium undulatum*. *Epigaea repens* is also present as is *Monotropa uniflora*. *Maianthemum canadense* occurs at all three sites and *Mitchella repens* at Ned's Ditch and Whately.

Woody seedlings account for more than 20% of the cover with all canopy species represented. *Acer rubrum* and *Prunus serotina* occur with highest frequencies; although the prevalence of these species may reflect disturbance, there is no reason to believe the general composition of the overstory will change under present conditions.

FLORISTIC TRENDS AND COMPARISONS

Overstory strata of floodplain forests are generally characterized by few wide-ranging species with similar life histories (White, 1979). Herb strata of these forests differ markedly, however. In our study, excluding taxa identified only above the species level, 94 species of herbs and vines were sampled. Of these, 70% were found at a single site, with seven species occurring in all three oxbow forests. Most of the 27 species shared by two sites occurred jointly in Hatfield and Ned's Ditch. Similarly, of the 32 species represented by woody seedlings in the oxbow forests, 75% were limited to one site and none occurred at all three sites. Hatfield and Ned's Ditch shared half the woody species occurring at two sites; one of these, *Acer saccharinum*, was a potential overstory tree. More species of woody seedlings were found at Whately than elsewhere and 75% of these occurred only there.

Comparable data from other river systems are few; some of the most interesting come from Wistendahl's (1958) study of the floodplain of the Raritan River in New Jersey. On one stretch of the Raritan, three forest types can be distinguished running more or less parallel to one another along one side of the channel (Buell and Wistendahl, 1955; Wistendahl, 1958). These are (1) outer floodplain forest characterized by a diverse overstory including *Fagus grandifolia, Acer saccharum, Liriodendron tulipifera, Ulmus rubra,* and *Tilia americana,* (2) inner floodplain forest with *Acer rubrum, Ulmus americana,* and other wetland trees, and (3) a forest on a high terrace characterized by *Acer saccharum* in association with tree species more frequent on drier sites.

Wistendahl's methods were generally similar to ours except that he sampled twice during the summer. Excluding taxa identified only to genus level, 56 species of herbs and vines were recorded in the three Raritan forests. Of these, 50% occurred at a single site, while 11 species occurred in all three forests. As in the western Massachusetts oxbows, the greatest number of species shared by two sites occurred in the more frequently flooded sites, and the higher (terrace) site had more species represented as woody seedlings. Herbs and vines were poorly represented in the Raritan terrace, and most of those sampled (83%) were also present in one or both of the other sites. Of the 14 species represented by woody seedlings in the Raritan forests, 57% were limited to one site and 29% occurred at all sites. Possible explanation for the greater similarity of the herb strata within the three Raritan forests is that the sites lie immediately adjacent to one another and that the geological processes which formed them are more gradual than the cut-off of an oxbow, which often takes place in the course of a single major flood event.

A comparison of the various floras of the Massachusetts and New Jersey forests shows that of the 56 species of herbs and vines sampled on the Raritan, 16 were recorded in at least one western Massachusetts site: 12 at Hatfield, 8 at Ned's Ditch, and 4 at Whately. In both cover and shared species, the inner floodplain forest on the Raritan most closely resembles the Hatfield site, while the outer floodplain and terrace forests show little resemblance to any western Massachusetts site.

The herbaceous floras of the western Massachusetts oxbows bear less floristic resemblance to those of bottomland forests along the Missouri River in North Dakota (Keammerer et al., 1975). The North Dakota forests occur near the western limit of "northern floodplain forest" (Vankat, 1979) and have not been flooded since 1954 because of dam and reservoir construction. Of the 216 species, both woody and herbaceous, found in the North Dakota forests, only 20 are represented in the forests of the western Massachusetts oxbows. No species restricted to cottonwood (*Populus deltoides*) forest in North Dakota occurs in the western Massachusetts sites. Twenty species found in North Dakota bottomland forests generally, or restricted to more mesic sites, also occur in one or more western Massachusetts oxbow forests: 15 at Hatfield, 12 at Ned's Ditch, and 1 at Whately.

Only four herbaceous species occur jointly in the Raritan, North Dakota, and western Massachusetts sites: *Amphicarpa bracteata, Circaea quadrisulcata, Ranunculus abortivus*, and *Scutellaria lateriflora.* All four of these occur at Hatfield, two occur in Northampton, and none at Whately.

Ferns are important at all the western Massachusetts sites and several fern species are also included by Nichols (1915, 1916) as characteristic of floodplains and swamp forests in Connecticut. Ferns are scantily represented at sites described elsewhere within the northern floodplain forest from New Jersey (Wistendahl, 1958) through Ohio (Hardin and Wistendahl, 1983), Indiana (Lindsey et al., 1961), Illinois (Bell, 1974), and Wisconsin (Barnes, 1978) west into North Dakota (Keammerer et al., 1975).

An increasing abundance of non-native species in cultivated fields near the three western Massachusetts oxbows was recognized by the mid-Nineteenth Century (Judd, 1863). Non-natives are now of considerable importance in various stages of old field succession there (Walker, 1980, unpublished Master's thesis, Smith College, Northampton, Mass.). The land surrounding the oxbows has been heavily cultivated since the Colonial period or earlier, but non-natives are scarce in the oxbow forests. At the Hatfield oxbow, *Lysimachia nummularia* contributes 7% cover and *Glechoma hederacea, Myosotis scorpioides,* and *Oxalis europaea* occur at low abundance. *Commelina communis, Lysimachia nummularia,* and *Solanum dulcamara* are present though not abundant at Ned's Ditch. No non-natives at all were sampled at Whately.

Non-native species are also relatively unimportant in the herb strata of the floodplain and terrace sites along the Raritan (Wistendahl, 1958). Although these areas are surrounded by agricultural land, only five of the 56 herbs reported are introduced and only two, *Lysimachia nummularia* on the inner floodplain and *Alliaria officinalis* on the outer floodplain, contribute coverage greater than 1%.

In contrast, Keammerer et al. (1975) found that 18.6% of the flora of the Missouri River bottomland forests in North Dakota were non-natives, primarily of European or Eurasian origin. Some of these occurred only on disturbed sites or were persistent after cultivation; others were common or abundant. Johnson et al. (1982) reported recent changes in the composition of the North Dakota forests, including poor reproduction of major overstory species, resulting from altered stream flow and flooding regime. The higher representation of non-natives in the flora may also reflect disruptions of this sort.

CONSERVATION

Floodplain habitats along major streams in New England are severely restricted. They are also increasingly threatened by urban development and by plans to reduce or eliminate flooding (Brower, 1971; Franz and Bazzaz, 1977; Sackett and Nagazina, 1978). The entire Northampton oxbow, which includes Ned's Ditch, is owned by the Massachusetts Audubon Society and is largely preserved. Both the Hatfield and Whately oxbows, however, suffer multiple private ownerships which might allow unrestricted logging at any time. In addition, proposed alterations of flow on the Connecticut

River may result in trends on the floodplain similar to those reported by Johnson et al. (1982), whether logging is restrained or not. The Massachusetts oxbows are of particular interest because they support vegetation which has developed on sites available for colonization during differing lengths of time within a single river system. They support floristic assemblages substantially different from those described elsewhere and therefore deserve more rigorous legal protection than that afforded them at present.

ACKNOWLEDGMENTS

Much of the data on which this paper is based are included as part of a Ph.D. dissertation written at Smith College and submitted by M. Holland to the Five-College Ph.D. program at the University of Massachusetts, Amherst. M. Holland has also published as Marjorie Holland Sackett. We thank Lincoln P. Brower, H. Allen Curran, David Mulcahy, and Marshall Schalk for helpful discussions on several phases of this work, Carolyn Crane and Paul Griffin for help with the map, William Clapham, Wendy Coleman, Florence Holland, Rich Kesselli, Kevin Richardson, Russell Sackett, Karen Stone and Willow Zuchowski for invaluable assistance with the field work, and Robie Hubley, former director of Arcadia Wildlife Sanctuary, for encouragement and logistic support throughout the course of this and previous studies in the area.

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A NEW BASIC CHROMOSOME NUMBER IN THE GENUS *STELLARIA* (CARYOPHYLLACEAE)

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ABSTRACT

Chromosome numbers are reported for two closely related species from the deciduous forest region of eastern North America, *Stellaria pubera* Michx. ($2n = 30$) and *S. corei* Shinners ($2n = 60$). These counts represent a new basic chromosome number of 15 for the genus *Stellaria*.

Key Words: *Stellaria*, basic chromosome number, North America

INTRODUCTION

Stellaria is a large, very variable and cosmopolitan genus of the Caryophyllaceae with about 120 species. Its main centers of diversity are in the temperate and sub-temperate regions of Europe, Asia and North America, but representative species occur in the montane floras of the tropics. Basic chromosome numbers of $x = 10$, 11, 12 and 13 have been reported for the genus, but almost all the native North American species that have been examined have a base number of 13 (Federov, 1969; Moore, 1973; Goldblatt, 1981). As part of a survey of chromosome numbers in the North American Caryophyllaceae, *Stellaria pubera* and *S. corei* were examined. Their respective chromosome numbers of $2n = 30$ and 60 are here reported for the first time and provide a new basic chromosome number of 15 in the genus *Stellaria*.

MATERIALS AND METHODS

Rooted material was transplanted into the greenhouse and grown in clay pots in a sterile potting-soil mixture. Root-tips were removed from actively growing plants, pre-treated for about two hours in a saturated aqueous solution of paradichlorobenzene, fixed in 1:3 acetic acid:ethanol, hydrolyzed for 15 mins. at 60° C. in N-hydrochloric acid, rinsed in water and squashed in aceto-carmine. A few drops of ferric chloride solution were added to the rinse water before squashing, to intensify staining. Also, flower-buds were fixed in the field in Carnoy's solution and the pollen mother cells subsequently squashed in aceto-carmine. The plant

Table 1. Source of materials of *Stellaria*

		n	$2n$
S. pubera			
Morton NA4435	Asheville, N.C.	–	30
Morton NA4460	Cheoah Reservoir, Fontana, N.C.	–	30
Morton NA5710	Cherokee, N.C.	15	–
Morton & Venn NA15014	Whitley to Honeybee, McCreary Co., Ky.	–	30
S. corei			
Morton NA4444	Gatlinburg, TN	–	60
Morton NA5705	Cherokee, N.C.	–	60
Morton & Venn NA14969	Linville, Avery Co., N.C.	–	60

materials used in this study are listed in Table 1. Voucher specimens have been deposited in the following herbaria: WAT and JKM, with incomplete sets in CAN and MICH.

RESULTS

Four populations of *Stellaria pubera* were examined, three using root-tips and one using flower-buds. They had chromosome numbers of $2n = 30$ and $n = 15$ respectively. Pollen mother cells showed a regular configuration of 15 bivalent chromosomes at diakinesis. Three populations of the much rarer *S. corei* each had $2n = 60$ chromosomes in root-tip preparations.

DISCUSSION

Stellaria pubera and *S. corei* are part of the endemic flora of the Carolinian region in the deciduous forest zone of eastern North America. This is an ancient flora and characterizes the mixed deciduous mesophytic forests which have had a continuous existence in this part of North America since the mid-Tertiary era (Graham 1972). These two species are closely related and morphologically very similar. *S. corei* appears to be a polyploid derivative of the diploid *S. pubera*. Classification within the genus usually follows that proposed by Fenzl in Endlicher (1840). Under this system *S. pubera* and *S. corei* belong to Section *Eu-Stellaria*, along with most of the familiar North American and European species. The division of this section into subsections is based on leaf characters and appears to be unsatisfactory. Neither of the species under consideration fits clearly into any of the five subsections.

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A FIRST REPORT OF THE FERN GENUS *VITTARIA* IN NEW YORK

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ABSTRACT

The first New York State records for gametophytes of the fern genus *Vittaria* are reported from Cattaraugus and Chautauqua Counties. The Chautauqua Co. station is only the third in a glaciated area and is the northernmost location known. The stations cited also provide the first county records in western New York for *Trichomanes* gametophytes.

Key Words: *Vittaria*, gametophytes, state record, *Trichomanes*

The morphology, ecology, and biogeography of sporophyteless gametophytes of the fern genera *Vittaria* and *Trichomanes* have been described by Farrar (1967, 1978) and McAlpin and Farrar (1978). Farrar et al. (1983) established state records for these genera in Pennsylvania and expanded considerably the known range of *Trichomanes* in New England. Noting that all sites reported for *Vittaria* were south of the Wisconsinan terminal moraines, these workers suggested that its pre-Pleistocene distribution may have been truncated by glaciation. Cusick (1983) subsequently reported *Vittaria* gametophytes from 80 km north of the Wisconsinan terminal moraine in Geauga County, Ohio.

The first reports of *Vittaria* for New York State are recorded herein as follows:

1. Cattaraugus Co. August 3, 1983. Rock City Park, Rt. 646. Scattered in large NW-facing rock houses of Pottsville sandstone conglomerate, in woods. *Parks 4295*.
2. Cattaraugus Co. August 3, 1983. Three miles W of Rt. 646 on Nichols Run Road. Very rare in shaded crevice of SW-facing outcrop of Pottsville sandstone conglomerate, in woods. *Parks 4296*.
3. Chautauqua Co. August 3, 1983. Panama Rocks Park. Scattered populations of gemmiferous plants in massive 10 m high, SE-facing rock houses of Pottsville sandstone conglomerate, in woods. Area glaciated. *Parks 4298*.

Trichomanes gametophytes were also located at sites one and three above (*Parks 4294* and *4297* respectively) and at Bear Cave

Rocks in Allegany Park, Cattaraugus Co., on August 2, 1983, *Parks 4293*. Vouchers of Parks' cited collections are on deposit at MVSC.

The Chautauqua County station at Panama Rocks lies in a glaciated region (Muller, 1963) and was itself ice covered (Muller, personal correspondence, 1983). The Wisconsinan–Kent terminal moraine lies about 19 km to the southeast and the Illinoian–Mapledale terminal moraine lies an additional 6.2 km further away (Berg, 1980). Panama Rocks is the northernmost station reported for *Vittaria* and is quite different from the surrounding area of Chautauqua County. It is part of an outlying ridge of Pennsylvanian sandstone conglomerate (Pottsville formation or equivalent). Though the Cattaraugus County site to the southeast is in an unglaciated portion of New York known as the Salamanca reentrant, it is strikingly similar geologically and ecologically to Panan Rocks. Further, judging from Cusick's (1983) description of *Vittaria* habitat in glaciated Ohio, that site is also similar to the Panama Rocks station. These observations support Cusick's argument that the occurrence of *Vittaria* gametophytes probably is closely related to appropriate physical and geological factors.

Post-Pleistocene reestablishment in glaciated areas of these sporophyteless fern gametophytes has been discussed by Farrar et al. (1983). The report of *Vittaria* from glaciated western New York is consistent with this discussion. Dispersal mechanisms and other factors which might influence the differential distribution of *Vittaria* and *Trichomanes* in the glaciated NE United States and adjacent Canada remain enigmatic. Workers are encouraged to examine carefully other appropriate sites north of the terminal moraines for *Vittaria* gametophytes. Though less likely to be encountered there than the gametophytes of *Trichomanes*, those of *Vittaria* clearly may be found.

ACKNOWLEDGMENT

Grateful acknowledgment is expressed to Dr. Eugene Williams, Professor of Biology, Edinboro University of Pennsylvania, who provided invaluable field assistance and kind hospitality to the senior author.

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LOMATOGONIUM ROTATUM (GENTIANACEAE) AND *PRIMULA LAURENTIANA* (PRIMULACEAE) IN MAINE: NEW LOCALITIES AND GENERAL DISTRIBUTIONS

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ABSTRACT

Two herbaceous plant species, *Lomatogonium rotatum* and *Primula laurentiana*, are known to occur in the United States only on the offshore islands of eastern Maine. Both species grow in full sun and in thin, circumneutral soil just above the upper splash zone of the ocean. We report new localities and discuss the overall geographic distribution for these two species.

Key Words: *Lomatogonium rotatum*, *Primula laurentiana*, Maine, range limit, offshore islands

Several plant species reach the southern limit of their range along the coastal headlands and islands of the west coast of the Bay of Fundy (Fernald and Wiegand, 1910; Hodgdon and Pike, 1964; Olday et al., 1982). A maritime climate of cool summer temperatures, extensive rainfall and fog, and low evapotranspiration rates account, in part, for this phytogeographic pattern. In this region, two boreal species, *Lomatogonium rotatum* (L.) Fries, the star gentian or marsh felwort, and *Primula laurentiana* Fern., the bird's-eye-primrose, are now known from only one location each in New Brunswick and a total of 16 offshore islands in eastern Maine. We report discovery of eight of these stations during our field work on a more detailed study of the reproductive biology of *P. laurentiana*. We also characterize the local habitat and overall distribution of these two taxa.

Stebbins (1929) first discovered *Lomatogonium rotatum* in Maine at Schoodic Point. This population has not been seen recently, but this species has since been found on nine islands in eastern Maine (Table 1; Figure 1). In 1982 and 1983 we discovered five of them and verified those previously reported. In all of these localities, *L. rotatum* grows in full sun and in thin, granitically derived, mineral soil and organic duff in a narrow belt between the forest edge and the upper splash zone above the intertidal zone. It also occurs in areas of high soil moisture near brackish pools and in rock crevaces serving as drainage tracks from the upland. This plant

Table 1. Historic, current and new localities of *Lomatogonium rotatum*[1] and *Primula laurentiana* in eastern Maine. (Numbers correspond to map locations indicated in Figure 1.)

Island	*L. rotatum*	Estimated number of individuals of *P. laurentiana*
1. Sand Island (outer)	extant, new	
2. Seal Rock		0
3. Curlew Rock	extant, new	15, new
4. Crumple Island	extant	100's
5. Great Wass Island	extant	100,000
6. Unnamed Island North of Water Island	extant, new	400, new
7. Water Island (inner)	extant, new	400, new
8. Water Island (outer)	extant, new	
9. Mistake Island	extant	1,000
10. Knight's Island		unknown[5]
11. Head Harbor Island		unknown[2]
12. North Scabby Island		100,000[3]
13. Little Scabby Island		no estimate[2]
14. Ram Island		0[3]
15. South Libby Island		10,000[4]
16. North Libby Island		0[4]

[1]Also extant, but not shown on Figure 1, on Little Moose Island (Olday, Gawler & Vickery, 1982); also known historically from Schoodic Point (Stebbins, 1929).
[2]Odlay, et al., 1982.
[3]Lewis (1983).
[4]Lewis (pers. comm.)
[5]Norton (pers. comm.)

has probably been overlooked because it is small and rather inconspicuous, occupies a specialized habitats, and flowers after the peak of summer field work by botanists. Undoubtedly it grows on other islands east of Frenchman's Bay. Species associated with *L. rotatum* include: *Agrostis stolonifera* L., *Aster novi-belgii* L., *A. nemoralis* Ait., *Campanula rotundifolia* L., *Carex canescens* L., *C. viridula* Michx., *Deschamsia flexuosa* (L.) Trin., *Empetrum nigrum* L., *Euphrasia canadensis* Townsend, *E. randii* Robins., *Festuca rubra* L., *Iris hookeri* Penny, *Juncus filiformis* L. (vel aff.), *Plantago juncoides* Lam. var. *decipiens* (Barnéoud) Fern., *Prenanthes trifoliata* (Cass.) Fern., *Primula laurentiana, Sagina nodosa* (L.) Fenzl. ssp.

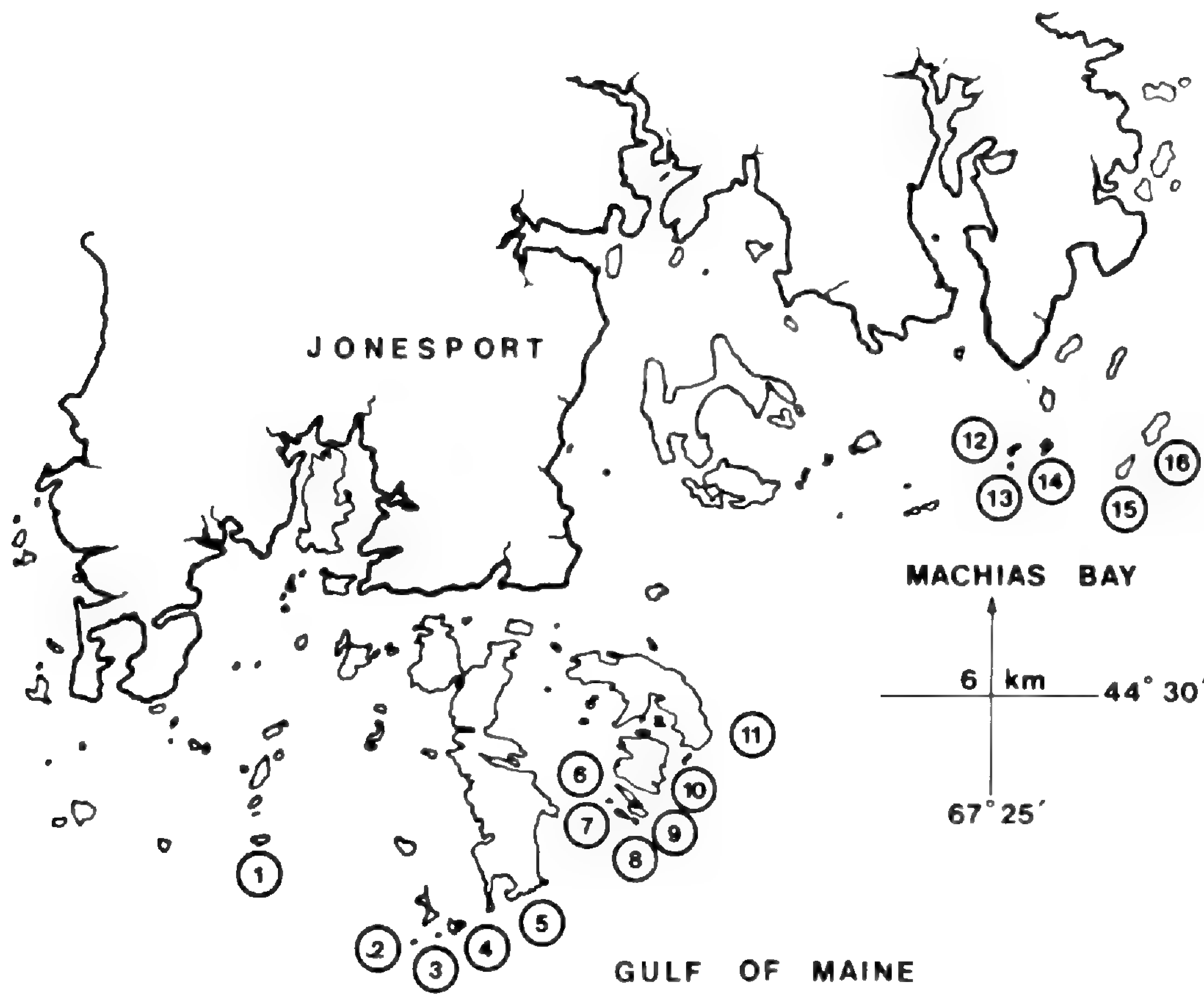

Figure 1. Map of Islands off Jonesport and in Machias Bay, Maine. See Table 1 for reference to numbered locations.

borealis Crow, *Solidago bicolor* L., *Triglochin maritima* L., and *Viola septentrionalis* Greene. Authorities are those of Fernald (1950).

At the two inland localities discovered in the nineteenth century, *Primula laurentiana* has not been seen in this century (Critical Areas Program, 1981). Cushman (1907) was the first to find coastal populations of the bird's-eye-primrose, and Norton (1913), Pike (1963) and Lewis (1983) added to our knowledge of its ecology and local distribution. We located three new island sites (Table 1; Figure 1), uncovered one historical record (Knight's Island) and determined that this species no longer grows on Seal Rock. The plant is therefore now known to occur on nine islands and to be absent from three historic sites; Its status for two additional localities is unknown (Table 1). The bird's-eye-primrose is more likely to have attracted people's attention because of its striking, early summer flowers and light-green leaves than is the star gentian.

Primula laurentiana occupies the same habitats as *Lomatogonium rotatum*, although the primrose appears to prefer better soil drainage. The soils are derived from granitic bedrock, but soil tests from five *Primula* localities indicate circumneutral pH (from 5.9 to 7.5, mean = 6.6) and oftentimes an excessive level of calcium. Proximity to salt spray and shell clasts may account for this relatively high pH. These tests verify the generally held view that this species is a calciphile (Fernald, 1928; Lewis, 1983; Pike, 1963; Scoggin, 1979).

In the eastern United States, these two species are limited to eastern Maine and are threatened or endangered in New England (Crow *et al.*, 1981). In New Brunswick, the star gentian is known only from South Wolf Island (Hodgdon and Pike, 1963) and the bird's-eye-primrose only from one recently located population of about 150 individuals in the coastal town of Alma (H. R. Hinds, pers. comm.). *Primula laurentiana* is also rare in Nova Scotia (Maher *et al.*, 1978). Globally, *Lomatogonium* is a circumpolar halophyte while *Primula* occupies meadows, ledges and cliffs chiefly near the ocean over much of northeastern North America (Scoggin, 1979).

ACKNOWLEDGMENTS

This work was supported by grants from the Maine Chapter of The Nature Conservancy and the Critical Areas Program of the Maine State Planning Office. We thank the Maine Soil Testing Laboratory for the soil tests.

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POPULATION STRUCTURE AND ENVIRONMENTAL COROLLARIES OF *PANAX QUINQUEFOLIUM* (ARALIACEAE) IN DELAWARE COUNTY, NEW YORK

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ABSTRACT

A large population of *Panax quinquefolium* from New York is characterized by age structure, morphology, and flowering. Population dynamics are correlated with local climate, the most interesting association being the dramatic increase in population size during 1982 when monthly precipitations between January and June compared favorably with 20-year averages at a time when the need for protective snow cover for seeds and optimum conditions for seed germination would apparently be paramount.

Key Words: *Panax quinquefolium*, American ginseng, population, environment, New York

INTRODUCTION

Panax quinquefolium L. (American ginseng) is a rare or extirpated species in northeastern United States and adjacent Canada where it once thrived. To locate a large population of some age that is expanding in a natural ecosystem is uncommon. Thus, the discovery by Arthur W. Rashap and Edmund Millar of such a population near Roxbury, Delaware County, in the Catskill Mountains of eastern New York, where the species at one time must have been frequent, was important. It prompted me to initiate a study of population dynamics similar to one underway in Missouri (Lewis and Zenger, 1982), which could serve not only as a comparison with this geographically different site, but could apply to programs for re-establishing the species in New York. The first of these goals is partially fulfilled by this report, insofar as population structure is concerned, but the second proved impossible. Within weeks of recording the data on June 30, 1982, the population was eradicated by root diggers.

MATERIALS AND METHODS

The population was found in a well-drained, sloping, deciduous woods with deep humus accumulated from leaf litter. Plants were described, labeled, numbered, and located on a map for future reference. Several were photographed for permanent record and prints are deposited at MO (*Lewis 9778*). Rhizomes were carefully exposed to count bud scars in order to determine ages and then re-covered.

U.S. climatological data for New York include only four stations with precipitation and two having temperature records in Delaware County during a 20-year period from 1963–82. These reports are summarized monthly for a 6-year period, 1977–82, together with 20-year means and standard deviations. The station near Roxbury, which is situated very close to the population, is not included, for recording of data terminated in 1972. Nevertheless, the other county stations are sufficiently near and similar in their situation to present approximate environmental conditions for the population site.

RESULTS AND DISCUSSION

Age structure and morphology

For a population of 211 individuals, ages in 1982 ranged from 1 to 21 years (Table 1), plus an exceptional plant 48 years old. This plant not only was 27 years older than the next oldest plant in the population, but the aerial stem was strongly flattened and the leaflets were very coarse and thick; it does not figure further in this analysis. A second exceptional plant had two aerial stems, one having three prongs (15 leaflets) and an inflorescence with nine flowers, and the other with two prongs (10 leaflets) and seven flowers. For analytical purposes, these stems are considered representative of two plants. The most predominant age class, representing 56.9% of the whole population, was of seedlings that had germinated during the spring of 1982. Plants of two and three years of age were next most common, but each represented only about 10% of the population. Those between 4 and 11 years of age varied from 1.8 to 3.8%, whereas all plants established between 1963 and 1971 were represented by a total frequency of only 3.8%. Thus, annual recruitment represented by surviving plants was gradual for 18 years, followed by modest expansions during 1980 and 1981, and culminated by an explosive increase during 1982. There is, of course, no certain way of knowing whether these frequencies represent nearly equivalent numbers of plants established annually or not, but based on the high annual survival rate of 97% for a large Missouri population (Lewis and Zenger, 1982), it is a reasonable assumption. The interesting ecolog-

Table 1. Population structure of 211 plants of *Panax quinquefolium* from Roxbury, NY.

Age	Frequency (%)	Prongs/plant (average)	Leaflets/plant (average)	Flowering plants (%)	Flowers flowering plants (average)
1	56.9	1.0	3.2	0	0
2	10.4	1.5	6.2	13.6	2.7
3	9.5	2.2	10.1	60.0	7.3
4	3.8	2.4	11.4	87.5	8.4
5	1.8	2.8	12.8	75.0	12.7
6	1.8	1.8	12.8	100	14.0
7	3.3	2.6	12.7	100	8.2*
8	2.8	3.0	15.0	100	16.7
9	1.4	2.3	12.0	100	22.5*
10	1.8	3.0	15.0	100	22.0*
11	2.4	3.0	14.8	100	15.4
12–21	3.8	3.0	15.0	87.5	20.7*

*One inflorescence broken or chewed and flower number could not be determined.

ical observations of Hu et al. (1980) involving a quadrat of 24 plants in Connecticut showed a death rate of 58.3% over an interval of seven years, but this high mortality may be biased because of small sample size.

Morphologically the population consisted of four classes based on prong and leaflet numbers (a prong consists of 3–6 palmately compound leaflets and a petiole without an axillary bud at the juncture of the aerial stem typical of leaves; most flowering plants have 2–4 prongs and an inflorescence in a whorl). One-pronged plants had 3–5 leaflets, predominantly with 3 leaflets and only infrequently 4 (0.8%) or 5 (3.3%), two-pronged plants had 6–10 leaflets, three-pronged plants had 14–16 leaflets, and the one four-pronged plant had 19 leaflets. Five leaflets per prong were most common, those with 3 or 4 occasional, and those with 6 rare among plants with two or more prongs.

Most one-pronged plants were one year old, although a few were two (9.0%) or 3 years (0.8%) of age. Two-pronged plants varied in age from 2 to 9 years, with an exceptional one being 19 years old, for an average of 3.9 years. The majority were two (26.0%), three (40.5%), or four (13.5%) years old. Three-pronged plants also varied markedly in age from 3 to 21 years. They averaged 8.6 years, but their numbers were rather constant between years 3 and 11 (minimum of 3 plants or 7.5% and maximum of 6 plants or 15.0%), and consistently very few (0 or 1) between ages 12 and 21. The single 4-pronged plant was 17 years old. There was a strong correlation between age and morphological class as measured by both prong number (r = 0.798, $P<0.001$) and leaflet number (r = 0.799, $P<0.001$), and thus the population illustrated an orderly increase in size and leaf area with age, as found in Missouri (Lewis and Zenger, 1982).

Flowering

All one-pronged plants were juveniles (nonflowering), 45.9% of two-pronged plants were also juveniles, but all three-pronged and the one four-pronged plants formed inflorescences. Of the two-pronged flowering plants, those two years old averaged 2.7 flowers (or floral buds) per plant, while older ones averaged 4 to 5 flowers depending on age. They ranged from 1–12 per plant with an overall average of 4.4 flowers. Interestingly, the 19 year old two-pronged plant had no discernable inflorescence. Flowers of three-pronged plants ranged from 5–32 with an average of 16.2 flowers per plant. The four-pronged plant had 31 flowers. There were highly significant correlations between flower numbers and morphological class (prong number r = 0.817, $P<0.001$, leaflet number r = 0.822, $P<0.001$) and also age (r = 0.724, $P<0.001$), as reported for populations in Missouri (Lewis and Zenger, 1982) and Wisconsin (Carpenter and Cottam, 1982). However, two-pronged plants rarely flowered in Wisconsin in contrast to those in Missouri and New York where flowering reached 55.8% and 54.1%, respectively.

Environmental Corollaries

Based on survivorship in 1982, only 15.6% of the population was established in the 15-year period from 1962 to 1976. During the subsequent five years the number of plants increased by 25.6%, a modest rise perhaps reflecting additional propagules in an aging and slowly increasing population. Not until 1982 was there a large increase in plants when 56.9% of the population was established in a single year. To explain this dramatic rise solely by small population increases and propagule accumulations seems unlikely based on the modest reproductive performance in the immediate past.

As growth and development patterns were altered markedly in a Missouri population of *P. quinquefolium* during adverse environmental conditions (Lewis and Zenger, 1982), it is of interest to compare the New York population structure during the past few years with local climatic conditions during the same period. The latter are summarized for monthly precipitation and temperature measurements in Table 2, as well as for 20-year averages. For the 5-year period prior to 1982, one striking aspect of the precipitation data

Table 2. Precipitation and temperature records for Delaware Co., NY.

	1982	1981	1980	1979	1978	1977	20-yr Mean ± S.D.
Precipitation (inches)[1]							
January	3.32	0.64	1.05	6.69	5.72	1.25	2.77 ± 1.63
February	2.21	5.78	0.95	1.56	1.20	2.65	2.41 ± 1.20
March	2.47	0.74	5.59	3.42	2.42	6.55	3.22 ± 1.31
April	2.22	3.28	3.96	3.70	1.70	3.38	3.08 ± 0.86
May	3.84	4.22	1.05	5.56	3.48	4.03	3.88 ± 1.45
June	3.89	3.53	4.74	1.27	3.59	3.02	3.94 ± 1.75
July		3.47	2.95	3.77	3.63	2.55	3.83 ± 1.39
August		3.16	4.21	2.50	5.14	5.49	3.82 ± 1.20
September		5.54	3.44	5.03	3.36	10.21	3.74 ± 2.07
October		4.30	3.17	5.22	3.95	7.32	3.28 ± 1.91
November		3.96	3.28	2.62	1.45	4.98	3.54 ± 1.37
December		1.55	1.59	2.38	3.25	4.80	3.35 ± 1.61
Total		40.15	35.97	43.69	38.88	56.22	40.87 ± 6.34
Temperature (°F)[2]							
January	14.95	14.65	24.35	22.80	20.15	13.10	20.3 ± 4.8
February	24.75	31.60	20.15	13.55	15.60	23.50	21.8 ± 4.5
March	31.25	34.60	31.90	37.35	29.55	36.70	32.8 ± 3.2
April	42.35	47.85	46.30	44.50	42.75	46.40	43.9 ± 3.5
May	57.45	56.20	57.05	57.25	55.80	57.95	55.2 ± 3.1
June	59.75	64.30	60.50	62.65	62.45	61.15	63.8 ± 2.1
July		68.40	68.60	68.75	66.70	67.95	68.4 ± 1.4
August		63.60	70.25	66.70	69.20	66.85	66.5 ± 2.3
September		59.15	61.25	58.50	58.10	60.90	59.7 ± 2.0
October		48.80	46.05	45.60	47.45	47.30	48.7 ± 3.4
November		42.90	34.80	39.05	38.75	42.00	39.0 ± 3.4
December		31.10	21.05	25.80	27.65	25.00	27.1 ± 3.3

[1]Arkville (42°08′, 74°39′, 1310 ft), Deposit (42°04′, 75°26′, 1000 ft), Downsville Dam (42°05′, 74°58′, 1300 ft), and Kortright (42°25′, 74°48′, 1720 ft).

[2]Deposit and Downsville Dam.

was the irregular monthly averages during the first part of each year. Thus, very low precipitation occurred either in January or February each year from 1977 to 1981 when much moisture would be in the form of snow. If adequate, snow would serve as an important insulation for seeds during the coldest months of the year (averages 13.1–20.2° F), but when markedly reduced, as from 1977 to 1981, this lack of cover might prove deleterious to seed viability. Also, during these years, precipitation was sometimes much lower than average in April or May when seed germination and seedling establishment would have been paramount; reduced moisture at this time would clearly hinder maximal recruitment. In 1981, for example, January precipitation totaled only 0.6 in. (20–year average 2.8 in.) during one of the coldest months in Delaware County (average 14.7° F). In 1980, the situation was even more extreme, for not only was there below average precipitation (0.95 in. versus 20–year average 2.41 in.) during the coldest month of the year (February, average 20.2° F), but May proved low in precipitation (1.05 in. versus 20-year average 3.88 in.) during an important month for germination and seedling development. For the first six months of 1982, however, monthly precipitation averages compared favorably with the 20-year averages. This presumed norm had not prevailed in Delaware County since 1974–76. That no appreciable population increase occurred during this period is perhaps explained by the fact that only 20 to 33 plants existed in the population, many being juveniles, and thus few propagules and little recruitment would have been possible even under ideal conditions.

These corollary data suggest that local environmental factors are very significant for the recruitment and survival of American ginseng populations. It is unfortunate, but because of the destruction of this important population, such a relationship cannot be tested further.

ACKNOWLEDGMENTS

I appreciate the assistance of Arthur W. Rashap, Ginseng Research Institute, and Edmund Millar, Cold Mountain Farm, both of Delaware Co., New York for locating the population and helping in the field, and the O'Connor Foundation and its Executive Secretary, Donald Bishop, Hobart, New York, for a grant-in-aid to study American ginseng in Delaware County. Special thanks go to Dr. Vincent E. Zenger, Washington University School of Medicine.

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A 24-YEAR COMPARISON OF THE VEGETATION OF AN ADIRONDACK MOUNTAIN SUMMIT

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ABSTRACT

A permanent 300-foot triangular transect was installed by H. E. Woodin in 1957 immediately above timberline on the isolated west slope of the summit cone of Mount Marcy, elevation 5334 feet, highest peak in the Adirondack Mountains of northern New York State. Re-measurement of the transect in 1981 revealed only slight change in either the floristic composition of the transect or in the percentage of arctic species present. Minor differences in data appear to be caused by different personnel performing the measurements or by sampling error inherent in the line-intercept procedures.

Key Words: Adirondack Mountains, permanent transect, arctic species

The value of permanent vegetation sampling sites for long-term ecological studies is increasingly evident; their importance is particularly great in evaluating the impact of recreation upon the natural environment. Fragile ecosystems such as alpine meadows are often subject to intense trampling by hikers visiting scenic summits. More recently, vegetational stability of alpine peaks in the northeast is of concern because of increasing evidence of vegetational damage due to acid deposition, especially in the high-elevation spruce-fir forests of New York and New England. In the Adirondack Mountains, the only permanent study site designed for alpine investigations was established by H. E. Woodin (Woodin, 1959) on Mount Marcy, el. 5334 ft., highest peak in the region. Woodin selected an isolated section of the 15-acre open summit zone extending above timberline on the unfrequented western slope of the peak, far from the public hiking trail and thus free from trampling by summit visitors. The transect, an equilateral triangle 100 feet on a side and spanning the elevations of 4,958 ft. to 4,984 ft., was intended to allow "future investigators to determine whether timberlines in the eastern United States are ascending or descending". The transect now serves equally well as a baseline for studies of vegetational stability in general. In 1981, we remeasured the transect to ascertain any floristic changes or vegetational shifts that may have occurred over the past twenty-four years.

Comparison of the data from 1957 with those of 1981 (Table 1) showed little change in either flora or vegetation along the transect during the 24-year period. Minor differences are attributable to sampling error inherent in use of a line-intercept procedure in a floristically diverse community which contained approximately ninety-three species of vascular plants. Similarly, some variation can be expected whenever different personnel remeasure the same population. The most striking result was the apparent absence of significant change in the virgin alpine meadow when contrasted with the severe deterioration observed along the public hiking trail several hundred feet upslope and out of sight of the study area.

FLORISTIC CHANGES

We note two additions to the list of species. *Trientalis borealis* was a single plant. The species is frequent in the krummholz transition into the spruce-fir zone downslope but is rarely successful on the wind-swept open summit. The occurrence of *Vaccinium boreale* is not unexpected either. Its presence in the alpine zone of the Adirondacks was first pointed out to us over fifteen years ago by the late Stanley Jay Smith, Senior Curator, New York State Herbarium, Albany, who identified the 1957 plants for Dr. Woodin. Currently we have records for the species from seven alpine summits and from five exposed stations at lesser elevations in New York State. We report also that *Vaccinium myrtilloides* and *V. angustifolium* occur sporadically near the timberline in the Adirondack high country.

We are uncertain of the significance of absence of the Mountain Alder and Cordate Birch from the 1981 data. The alder covered eleven inches in 1957 and was likely a single plant. The birch, however, which covered forty-one inches, may have been two or more plants. Both species are still present in the transect area but neither had branches intercepting a vertical projection through the intercept line. Plants nearby seemed otherwise healthy and vigorous at the time of measurement.

VEGETATIONAL SHIFTS

The living plant cover decreased 1.43% during the 24-year period, from 77.67% in 1957 to 76.24% in 1981. This minor shift may be

Table 1. Comparison of 1957 and 1981 permanent transect line-intercept data on Mt. Marcy.

Species Recorded	1957 (data of Woodin, 1959) Inches	Cover	1981 Inches	Cover
SPHAGNACEAE				
Sphagnum pylaesii Brid.*	25	0.69%	110	3.05%
Sphagnum spp.	80	2.22	95	2.64
ANDREAEACEAE				
Andreaea rupestris Hedw.	42	1.16	75	2.08
GRIMMIACEAE				
Racomitrium spp.	55	1.53	2	0.06
Other Bryophytes & Lichens**	113	3.14	95	2.63
LYCOPODIACEAE				
Lycopodium annotinum L. var. *pungens* Desv.***	5	0.14	1	0.03
Lycopodium selago L.	7	0.19	10	0.28
PINACEAE				
Abies balsamea (L.) Mill.	210	5.83	257	7.14
Picea mariana (Mill.) BSP.	280	7.77	374	10.39
CYPERACEAE				
Carex bigelowii Torr.	8	0.25	16	0.44
Scirpus caespitosus L.	290	8.05	268	7.44
BETULACEAE				
Alnus viridis (Ait.) Pursh ssp. *crispa* (Ait.) Turrill	11	0.31	0	0.00
Betula cordifolia Regel	41	1.14	0	0.00
CARYOPHYLLACEAE				
Minuartia groenlandica (Retz.) Ostenf.	7	0.19	4	0.11
ROSACEAE				
Potentilla tridentata Solander ex. Ait.	67	1.86	7	0.19
EMPETRACEAE				
Empetrum nigrum L.	85	2.36	63	1.75
CORNACEAE				
Cornus canadensis L.	6	0.17	10	0.27

Table I. Continued

Species Recorded	1957 (data of Woodin, 1959) Inches	Cover	1981 Inches	Cover
ERICACEAE				
Chamaedaphne calyculata (L.) Moench	18	0.50	66	1.84
Kalmia polifolia Wang.	16	0.44	15	0.42
Ledum groenlandicum Oeder	110	3.06	43	1.19
Vaccinium boreale Hall & Aalders	0	0.00	6	0.17
Vaccinium oxycoccus L.	5	0.14	13	0.36
Vaccinium uliginosum L.	1241	34.47	1107	30.75
DIAPENSIACEAE				
Diapensia lapponica L.	78	2.16	107	2.97
PRIMULACEAE				
Trientalis borealis Raf.	0	0.00	1	0.03
DEAD LEAF LITTER	--	---	125	3.47
BARE SOIL	93	2.58	81	2.25
BARE ROCK	706	19.61	649	18.02
Totals	3600	99.96%	3600	99.98%

*Nomenclature of bryophytes follows Ketchledge, 1980.

**Includes 113 inches of lichens missing by printers' error from Woodin, 1959, but subsequently supplied to us (personal correspondence, Woodin, 1982).

***Nomenclature of vascular plants follows Kartesz, John T. and Rosemarie Kartesz, 1980.

attributed either to sampling error or to our recognition of a new cover category, Dead Leaf Litter, which was visible through discontinuities in the living plant canopy. Whatever the cause, the shift is too slight to indicate major vegetational change.

On the other hand, the 2.36% increase in *Sphagnum pylaesii* and 1.59% decrease in Bare Rock is in our opinion, a notable shift. Our observations of the ecology of summit bryophytes, begun in 1949, repeatedly demonstrate the pioneering nature of *Sphagnum pylaesii* spreading over the wet bedrock wherever water seeps out from the vegetational mat. Lateral expansion of the vascular plant community on the open Adirondack summits is mediated by the *Sphagnum* mat which engulfs other bryophytes and in time provides a substrate permitting the establishment of herbaceous and woody plants.

The lateral spread of branches of the two nano-phanaerophytes, *Picea mariana*, up 2.6%, and *Abies balsamea*, up 1.31%, seemed to be at the expense of their chief canopy competitor, *Vaccinium uliginosum*, down 3.72%. These three species characteristically occur in intermixtures where the upward growth of spruce and fir is truncated every two or three years by winter-killing above the protecting snow field. The basal branches of spruce, less so fir, may slowly grow outward many feet, whereas the central trunks are ecologically restricted to a height of one or two feet; some of these dwarfed trees, we find, are over 200 years old.

ARCTIC VS. NON-ARCTIC SPECIES

Woodin considered only four species found along the transect to be "non-arctic": *Cornus canadensis, Abies balsamea, Betula cordifolia* and *Carex bigelowii.* He suggested future investigators should note any change in arctic vs. non-arctic percentages and should evaluate the invasion or loss of species on the transect. Using his criteria, non-arctic species totalled 7.66% cover in 1957 and 7.85% in 1981. We do not agree, however, with Dr. Woodin's inclusion in the "arctic" category of a number of species which reach their greatest abundance and vigor in non-arctic environments at lower elevations but which also survive in lesser numbers in alpine situations. We place the following additional summit species in that non-arctic category: *Picea mariana, Alnus viridis* ssp. *crispa, Chamaedaphne calyculata, Kalmia polifolia, Ledum groenlandicum, Vaccinium oxycoccus* and *Trientalis borealis.* On this revised basis, the non-arctic plants totalled 19.88% in 1957 and 22.08% in 1981, an increase of 3.20% during a quarter century.

The apparent stability over time of the virgin, alpine community on Mount Marcy stands in sharp contrast to the severe damage occurring along public hiking trails elsewhere on this peak.

ACKNOWLEDGMENTS

We gratefully acknowledge the assistance of Dixie Sipher in data analysis and Debbie Berrier and Jean Ketchledge in preparation of the manuscript. We particularly thank Dr. Woodin for supplying us with the lichen data inadvertently omitted from his 1959 report.

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A REAPPRAISAL OF THE ORCHID GENERA *BROUGHTONIA* R. BR., *CATTLEYOPSIS* LEM. AND *LAELIOPSIS* LINDL.

Ruben P. Sauleda and Ralph M. Adams

ABSTRACT

The orchid genera *Broughtonia* R. Br., *Cattleyopsis* Lem. and *Laeliopsis* Lindl. are re-established on the basis of observations of natural populations or living material from them. The six species that comprise these genera were previously placed in the genus *Broughtonia*. A new combination, *Cattleyopsis cubensis* (Lindl.) Sauleda and Adams and a new natural hybrid, *Broughtonia* ×*jamaicensis*, are reported.

Key Words: Orchids, *Broughtonia*, *Cattleyopsis*, *Laeliopsis*, monograph

The taxonomic status of the orchid genera *Broughtonia* R. Br., *Cattleyopsis* Lem. and *Laeliopsis* Lindl. has been the subject of much controversy. There appears to have been three major, but often overlapping, taxonomic approaches to these three genera. One approach retains the three genera as distinct entities (Correll, 1941; Leon, 1946). Another approach incorporates *Laeliopsis* into *Broughtonia*, ultimately recognizing the existence of only two genera, *Broughtonia* and *Cattleyopsis* (Rolfe, 1889; Cogniaux, 1910; Schlechter, 1915; Acuña, 1939; Fowlie, 1961a and 1961b). The third approach incorporates the genera *Laeliopsis* and *Cattleyopsis* into the genus *Broughtonia*, lumping all species into a single genus (Dressler, 1966; Liogier, 1969; Adams, 1970 and 1971).

Much of this taxonomic confusion was caused initially by the floral similarities of some of these species which resulted in gross misidentifications. Once these problems were resolved and the six species that comprise the group were established, their differentiation into genera was impeded because of: 1) a failure to examine natural populations of all species in the group as well as their distributional patterns; 2) a startling misunderstanding of the morphology of the nectary; and 3) a disagreement on the number and significance of pollinia in certain species in the group.

All the botanists who have made taxonomic decisions concerning this group of orchids neither saw natural populations of each of the six species nor possessed living material of them. Most decisions were based on scanty collections of dried herbarium specimens. Adams (1970) recognized this failure when he stated that taxonomically, "almost every error as we now see it can be attributed to the extreme difficulty of obtaining reliable factual information from a small number of inadequate herbarium specimens...".

The terms "spur", "nectary-spur", "sepaline tube" and "external adnate spur" have all been used as a principal character in the separation of the genus *Broughtonia* from *Cattleyopsis* and *Laeliopsis*. The use of this character in this group requires that its precise morphological identity be determined and its presence or absence in each of the species in the alliance be ascertained. In no case has the morphology of the nectary been carefully studied, presumably owing to the lack of fresh material available for dissection.

The number and symmetry of the pollinia in species of this alliance also has been a source of confusion. As Adams (1970) pointed out, even in good dried herbarium specimens, "the pollinia are often missing altogether, either having been removed naturally or stuck to the drying sheets".

We have examined natural populations or living specimens collected from natural populations of all six species in the alliance as well as extant herbarium specimens and types. Their distinctive distributional patterns strongly suggest evolutionary divergence as a function of isolation. The three species comprising the genus *Cattleyopsis* are restricted to Cuba, with the exception of *C. lindenii* which extends northward into the Bahama Archipelago. The two species of *Broughtonia* are endemic to Jamaica, while the monotypic genus *Laeliopsis* occurs on Hispaniola and Mona Island. The floral similarities among certain members of this alliance are attributable in part to what we perceive as secondary adaptations to ornithophily or to melittophily. The vegetative similarities of the four species that comprise the genera *Cattleyopsis* and *Laeliopsis* are attributable in part to secondary adaptations to the more xeric habitats in which they occur. In addition, we have noticed that *Laeliopsis* appears to make vegetative phenotypic adjustments to environmental conditions more readily than does either *Cattleyopsis* or *Broughtonia*. For example, vegetatively, *Laeliopsis* resembles *Broughtonia* in mesic habitats and *Cattleyopsis* in xeric habitats.

The confusion concerning the terms "spur", "nectary-spur", "sepaline tube" and "external adnate spur" was easily resolved when we made cross-sectional dissections of living flowers of each species. Unequivocally, none of these structures occurs. Instead, each species has a well-defined nectary embedded within the ovary. In all six species of the alliance the nectary lumen is wide at its distal opening, gradually narrowing proximally, except in the two species of *Broughtonia,* in which the proximal end of the nectary lumen swells to form a nectar-filled chamber. The externally visible proximal swelling has been confused with a spur or sepaline tube.

Arditti (1969) and Arditti and Fisch (1977) were the only researchers to recognize the true nature of the nectary in this group although they failed to note the prominent proximal nectary chamber present only in *Broughtonia.* This understanding of the nature of the nectary, when coupled with their results of pigment analyses, led Arditti and Fisch (1977) to question the lumping of all six species into the genus *Broughtonia* by Dressler (1966).

We agree with Dressler (1966) that the number of pollinia is not an inviolable generic character. However, differences in distributional patterns, and in vegetative and floral morphology, combined with differences in the number and symmetry of pollinia, are compelling reasons to maintain separation of the three genera *Broughtonia, Cattleyopsis* and *Laeliopsis* (Table 1).

KEY TO THE GENERA

1. Leaves coriaceous, margin entire; column short relative to pedicel, wings short and thick; nectary lumen swollen proximally .... **1.** *Broughtonia*
1. Leaves fleshy-rigid, margin erose; column elongate, relative to pedicel, narrowly-winged; nectary lumen not swollen proximally 2
    2. Pollinia 8, unequal; column with basal appendages .....**2.** *Cattleyopsis*
    2. Pollinia 4, equal; column without basal appendages ......**3.** *Laeliopsis*

1. Broughtonia Robert Brown in Aiton, Hort. Kew, ed. 2, 5: 217. 1813.

Epiphytic plants; rhizomatous; roots velamentous; stems modified into ellipsoid to ovoid pseudobulbs; leaves coriaceous, margin entire; inflorescence terminal; ovary pedicellate, with a proximally swollen nectary; labellum entire, obovate or obovate to orbicular; column short, blunt, wings near apex short and thick; anther terminal, incumbent, operculate; pollinia 4, equal, with a caudicle; capsule smooth, ellipsoid.

TYPE: **Epidendrum sanguineum** Sw.

This genus contains two species, endemic to Jamaica.

Table I. Major characteristics which differentiate the genera *Broughtonia*, *Cattleyopsis* and *Laeliopsis*.

GENUS	LEAVES		POLLINIA		COLUMN				DISTRIBUTION
	Margin	Rigidity	Number	Symmetry	Length relative to pedicel	Apical wings	Basal appendages	Nectary lumen	
Cattleyopsis	erose	fleshy-rigid	8	unequal	elongate	narrow	present	distally swollen, gradually narrowing proximally	Bahama Islands, Cuba
Laeliopsis	erose	fleshy-rigid	4	equal	elongate	narrow	absent	distally swollen, gradually narrowing proximally	Hispaniola and Mona Island
Broughtonia	entire	coriaceous	4	equal	short	short and thick	absent	distally swollen, mesally narrowing, proximally swollen	Jamaica

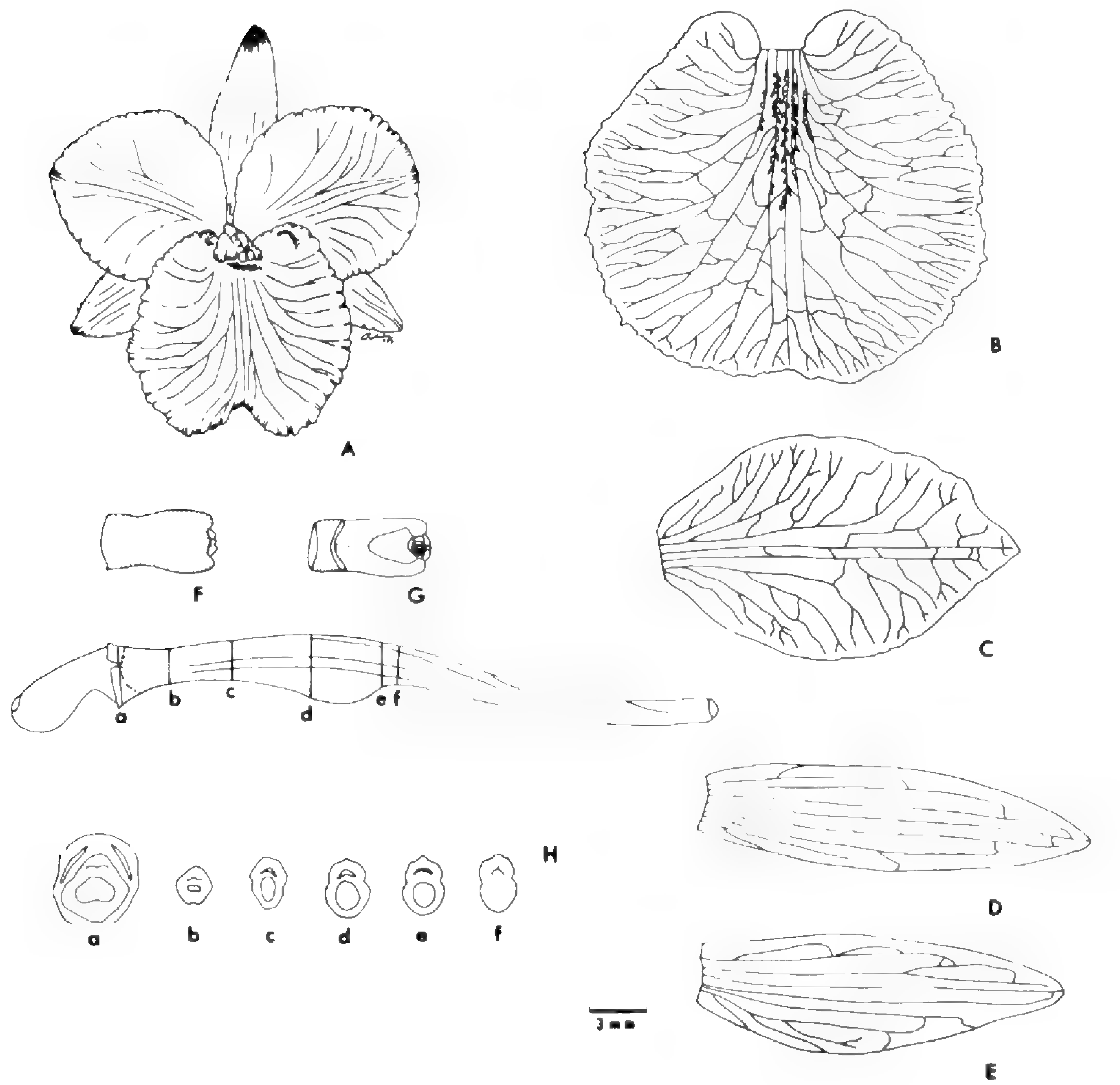

Figure 1. ***Broughtonia sanguinea*** (Sw.) R. Br. **A.** Flower, frontal view. **B.** Labellum, frontal view. **C.** Petal. **D.** Dorsal sepal. **E.** Lateral sepal. **F.** Column, dorsal view. **G.** Column, ventral view. **H.** Column and ovary, lateral view and serial cross sections (a–f) showing nectary lumen.

KEY TO THE SPECIES

1. Basal margins of labellum not involute, not enclosing column, not forming a tube; center of labellum glabrous .... 1. *B. sanguinea*
1. Basal margins of labellum involute, enclosing column, forming a tube; center of labellum with yellow villous lamellae .... 2. *B. negrilensis*

1. **Broughtonia sanguinea** (Sw.) R. Br. in Aiton, Hort. Kew ed. 2, 5: 217. 1813. (Figure 1)

Epidendum sanguineum Sw., Prodr. Veg. Ind. Occ. 124. 1788.
Dendrobium sanguineum (Sw.) Sw., Nov. Act. Ups. 6: 82. 1799. Type: No holotype indicated. A search of the major herbaria known to contain collections of

Swartz failed to uncover any specimens that can be ascertained to have been collected or examined by Swartz. In the absence of a holotype, a lectotype is here chosen from material cited by Swartz in the protologue. LECTOTYPE designated here: Plate 121, figure 2, in H. Sloane, A Voyage to the Islands Madera, Barbados, Nieves, S. Christophers and Jamaica, Vol. I, 1707.

Broughtonia coccinea Hook., Bot. Mag. 63, t. 3536. 1836. Based on *Broughtonia sanguinea* (Sw.) R. Br.

Plant epiphytic, rhizomatous, to 72 cm tall; roots numerous, thick, velamentous; rhizome short, stout, creeping or ascending, enclosed by imbricating scarious sheaths; stem modified into pseudobulb, erect or ascending, clustered, ellipsoid to ovoid, flattened, to 5 cm long, 4 cm wide, 3 cm thick, basally enclosed by scarious sheaths, to 4-leaved at apex; leaves coriaceous, elliptic to oblong or ligulate, subacute, margin entire, to 18 cm long, 3 cm wide; inflorescence to 67 cm tall, peduncle slender, erect, distantly several-sheathed, simple or paniculate raceme, to 18 flowers; floral bracts ovate, acute, to 0.4 cm long, 0.2 cm wide; ovary slender, to 4 cm long; sepals and petals pink, white, yellow or usually reddish-lavender to red; sepals elliptic to lanceolate, acute, to 2.7 cm long, 0.8 cm wide; petals oblong to orbicular, abruptly acute, to 2.4 cm long, 1.6 cm wide; labellum pink, white, yellow or usually reddish-lavender to red, with a central basal yellow spot and 8–12 radiating red veins, to 3 cm long, 2.7 cm wide, broadly obovate to orbicular, center of labellum glabrous, basal margins not involute, not completely enclosing column, margin erose, shallowly emarginate; column white, occasionally tinged with red, to 0.8 cm long, 0.5 cm wide, anther white; capsule pendent, to 2.4 cm long, 0.8 cm thick.

REPRESENTATIVE SPECIMENS: Jamaica: Parish of St. Elizabeth, Pepper, 13 Mar 1931, *Miller 1349* (US); coastal region E of Montego Bay, 28 Mar 1920, *Maxon & Killip 1626* (AMES, NY); Great Goat Island, 19 Apr 1906, *Harris 9209* (NY); Lover's Leap, Santa Cruz Mts., 4 Sep 1907, *Britton 1148* (NY).

FLOWERING PERIOD: Flowers sporadically throughout the year, mainly from March to June.

Vegetatively, this species may be confused with *Broughtonia negrilensis* Fowlie. Florally they differ significantly in color and in the position of the basal margins of the labellum. *Broughtonia sanguinea* is usually reddish-lavender to red, while *B. negrilensis* is pink to lavender. In *B. negrilensis* the basal margins of the labellum are involute, enclosing the column to form a tube and the center of the labellum has yellow villous lamellae, while in *B. sanguinea* the basal margins are not involute, do not enclose the column and the center of the labellum is glabrous.

A rare autogamous dwarf form occurs with flowers that remain partially closed. Hooker illustrated this dwarf form as *Broughtonia sanguinea* (Bot. Mag. 58, t. 3076, 1831) and later, after seeing the more common fully-opened form, mistakenly named it *B. coccinea* Hook. (Bot. Mag. 63, t. 3536, 1836). Inexplicably, Hooker based *B. coccinea* on *B. sanguinea* (Sw.) R. Br. making *B. coccinea* a superfluous name at the time of publication.

Although this species is endemic to Jamaica, the name has been misapplied to *Cattleyopsis ortgiesiana* (Reichb. f.) Cogn. (Grisebach, 1866; Cogniaux, 1910; Acuña, 1939), a species endemic to Cuba.

In southwestern Jamaica, on Negril Ridge, where *Broughtonia sanguinea* and *B. negrilensis* are sympatric, a natural hybrid occurs which is intermediate between the two parental species. Introgressive hybridization appears to occur between this natural hybrid and *B. sanguinea*, accounting for the high degree of variability in shape and color of the floral parts of *B. sanguinea* in the areas of sympatry. A series of experimental crosses verified the introgression.

2. **Broughtonia negrilensis** Fowlie, Orch. Digest 25: 417–418. 1961. (Figure 2) TYPE: JAMAICA, Negril Ridge, 2 mi SW of Old Hope, elev. 250 ft., epiphytic on *Ceiba*, collected Nov. 1959, flowered in cultivation at the Los Angeles State and County Arboretum at Arcadia, California, *Fowlie s.n.* (HOLOTYPE: LASCA).

Broughtonia domingensis auct. non (Lindl.) Rolfe: Fawcett & Rendle, Fl. Jam. I: 24, 1910; Cogn. in Urban, Symb. Antill. 6: 543, 1910.

Laeliopsis domingensis auct. non (Lindl.) Lindl.: Grisebach, Fl. B. W. I., 621, 1864.

Plant epiphytic, rhizomatous, to 75 cm tall; roots numerous, velamentous; rhizome short, stout, creeping or ascending, enclosed by imbricating scarious sheaths; stem modified into pseudobulb, erect or ascending, clustered, ellipsoid to ovoid, flattened, to 6.0 cm long, 2.8 cm wide, 1.8 cm thick, basally enclosed by scarious sheaths, to 3-leaved at apex; leaves coriaceous, elliptic to oblong, subacute, margin entire, to 12 cm long, 2.4 cm wide; inflorescence to 69 cm

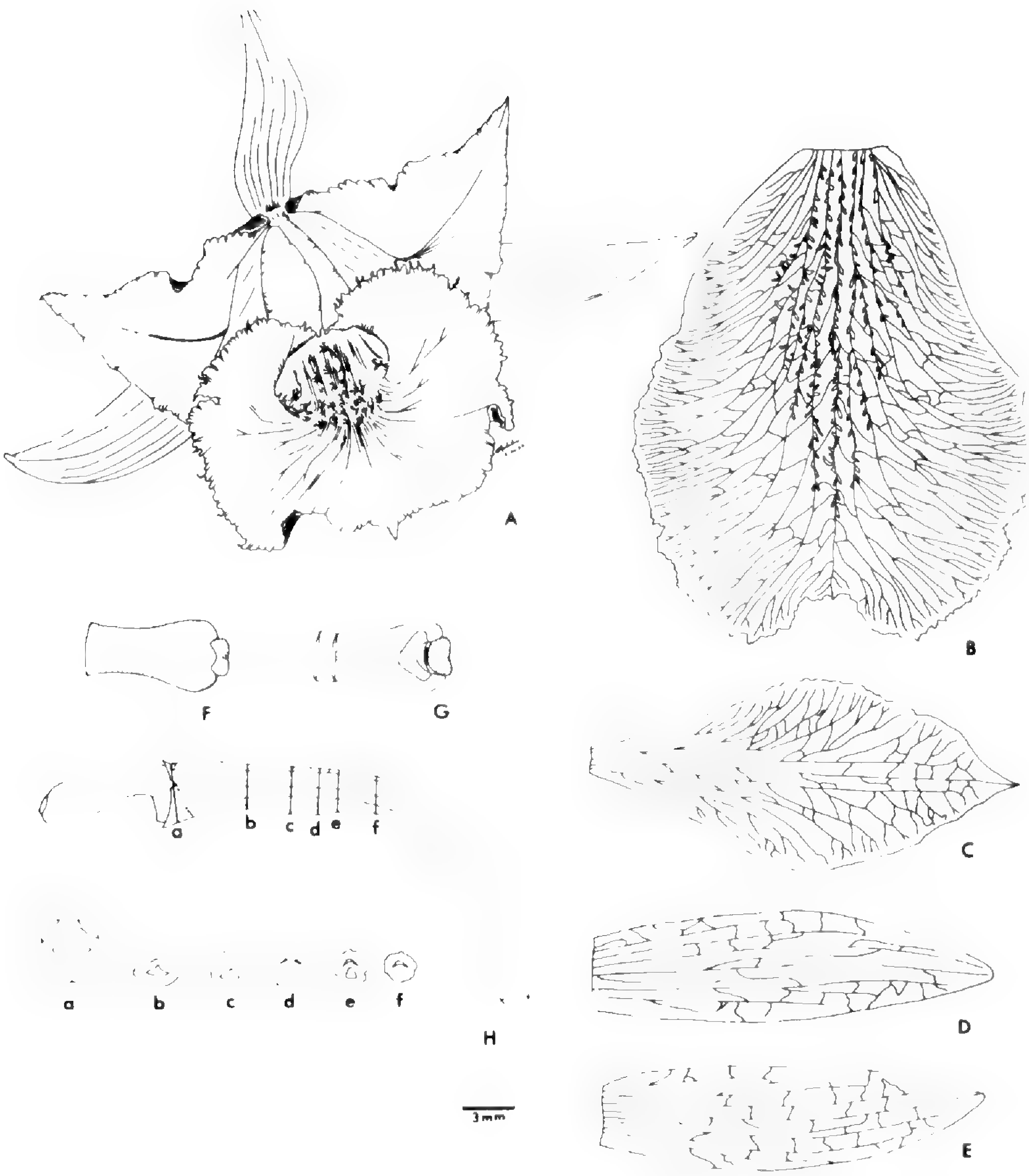

Figure 2. *Broughtonia negrilensis* Fowlie. **A.** Flower, frontal view. **B.** Labellum, frontal view. **C.** Petal. **D.** Dorsal sepal. **E.** Lateral sepal. **F.** Column, dorsal view. **G.** Column, ventral view. **H.** Column and ovary, lateral view and serial cross sections (a–f) showing nectary lumen.

tall, peduncle slender, erect, distantly several-sheathed, simple or rarely paniculate raceme, to 12 flowers; floral bracts ovate, acute, to 0.6 cm long, 0.3 cm wide; ovary slender, to 3.0 cm long; sepals pink to lavender, linear-oblong, subacute, to 2.8 cm long, 0.8 cm wide; petals pink to lavender, broadly-oblanceolate to obovate, acute, to 3.0 cm long, 1.3 cm wide; labellum basally yellow, pink to lavender towards apex, with purple lines from center radiating to near margin, to 3.6 cm long, 2.9 cm wide, obovate, basal margins involute, enclosing column, forming a tube, center of labellum with yellow villous lamellae, margin crenate-dentate, undulate, emarginate; column white, occasionally tinged with pink, to 0.9 cm long, 0.5 cm wide, anther white; capsule pendent, to 2.8 cm long, 1.0 cm thick.

SPECIMEN EXAMINED: JAMAICA: Negril Ridge, Jun 1967, *Gauntlett s.n.*, flowered in cultivation (USF).

FLOWERING PERIOD: Flowers sporadically throughout the year, mainly from October to December.

Broughtonia negrilensis is similar vegetatively to *B. sanguinea* R. Br. but florally can be easily distinguished by floral color and by shape and ornamentation of the labellum.

This species was incorrectly referred to *Laeliopsis domingensis* (Lindl.) Lindl. by Grisebach (1864) and to *Broughtonia domingensis* (Lindl.) Rolfe by Fawcett & Rendle (1910) and Cogniaux (1910). *Laeliopsis domingensis* is a different species endemic to Hispaniola while *Broughtonia domingensis* is a synonym of it.

NATURAL HYBRID

Broughtonia ×jamaicensis Sauleda & Adams, *hybr. nov.* (Figure 3)
Broughtonia sanguinea (Sw.) R. Br. × *Broughtonia negrilensis* Fowlie

Hybrida floraliter intermedia. Plantae epiphyticae, rhizomatosae; pseudobulbi ellipsoidei usque ovoidei; folia coriacea, elliptica usque oblonga; inflorescentia erecta, simplex vel paniculata; flores rosei usque rubeo-lavenduli.

Plants epiphytic, rhizomatous, to 68 cm tall; roots numerous, velamentous; rhizome short, stout, creeping or ascending, enclosed by imbricating scarious sheaths; stem modified into pseudobulb, erect or ascending, clustered, ellipsoid to ovoid, flattened, to 4.8 cm long, 2.7 cm wide, 1.9 cm thick, basally enclosed by scarious sheaths, 2-leaved at apex; leaves coriaceous, elliptic to oblong, subacute, margin entire, to 9.6 cm long, 2.3 cm wide; inflorescence to 63 cm tall, peduncle slender, erect, simple or paniculate raceme, to 8 flowers; floral bracts ovate, acute, to 0.5 cm long, 0.3 cm wide; ovary slender, with proximally swollen nectary, to 3.2 cm long; sepals and petals pink to reddish-lavender, elliptic, acute, to 2.8 cm

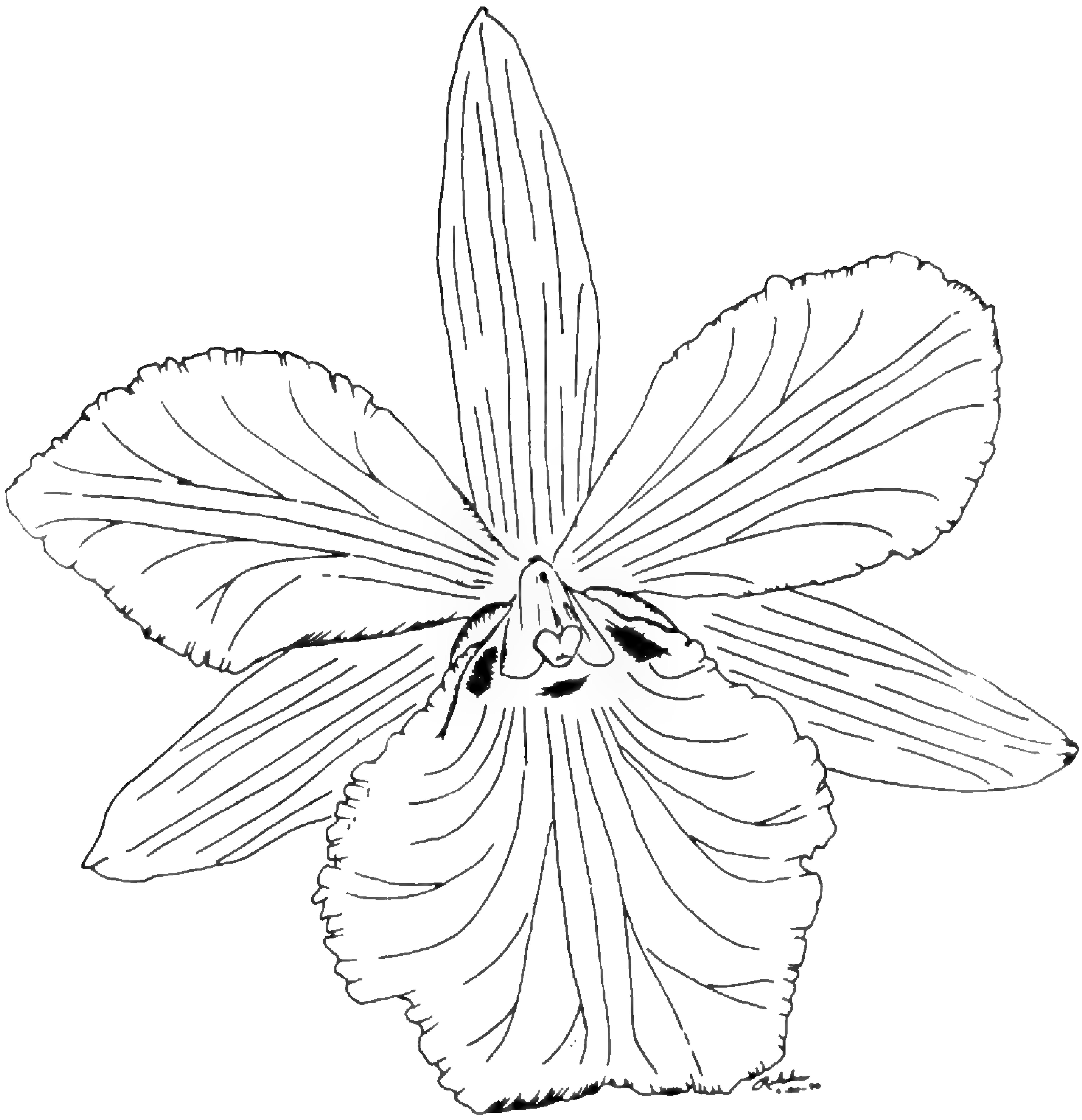

Figure 3. *Broughtonia* ×*jamaicensis* Sauleda & Adams. Flower, frontal view, × 2.

long, 0.6 cm wide; petals obovate to oblong, acute, to 2.8 cm long, 1.3 cm wide; labellum pink to reddish-lavender, basally usually yellow, with purple lines from center radiating to near margin, to 3.4 cm long, 2.7 cm wide, obovate, basal margins slightly involute but not completely enclosing column, center of labellum occasionally with a few yellow villous lamellae, margin crenate-dentate, undulate, emarginate; column white, to 0.9 cm long, 0.5 cm wide, anther white.

TYPE: JAMAICA: Negril Hill, Jun 1967, *Gauntlett s.n.* (HOLOTYPE: NY). Flowered in cultivation September 1968.

FLOWERING PERIOD: Flowers sporadically throughout the year, mainly from August to October.

This natural hybrid has been referred to in the literature (Adams, 1970 and 1971; Fowlie, 1961a and 1961b) on several occasions but has not been named.

Florally, the hybrid is intermediate between the parental species and occurs commonly where they are sympatric. The labellum has the characteristic yellow villous lamellae of *Broughtonia negrilensis* while the basal margin of the labellum is slightly involute but does not enclose the column, a characteristic of *B. sanguinea.* This hybrid is named for the type location.

2. Cattleyopsis Lemaire, Jard. Fleur. 4, Misc. p. 59. 1853.

Epiphytic plants; rhizomatous; roots velamentous; stems modified into cylindric, ovoid or pyriform pseudobulbs; leaves fleshy-rigid, margin erose; inflorescence terminal; ovary pedicellate; labellum entire, oblong or obovate to orbicular; column elongate, slender, with two auricle-like appendages near the base, narrowly winged towards apex; anther terminal, incumbent, operculate; pollinia 8, unequal, with a caudicle; capsule smooth, ellipsoid.

TYPE: **Cattleyopsis delicatula** Lemaire

This genus contains three species endemic to xeric regions of Cuba and the Bahama Archipelago.

KEY TO THE SPECIES

1. Basal margin of labellum enclosing column, forming a tube; center of labellum with yellow villous lamellae; margin of labellum incised to crenate-dentate or crenate 2
1. Basal margin of labellum not enclosing column; center of labellum glabrous; margin of labellum entire .... 3. *C. ortgiesiana*
    2. Labellum oblong; leaves obtuse.......................... 1. *C. cubensis*
    2. Labellum broadly-obovate to orbicular; leaves acute .... 2. *C. lindenii*

1. Cattleyopsis cubensis (Lindl.) Sauleda & Adams, *comb. nov.* (Figure 4)

Epidendrum cubense Lindl., Bot. Reg. 29, Misc. p. 17. 1843.

Laeliopsis cubense (Lindl.) Lindl. ex Cogn. in Urban, Symb. Antill. 6: 543. 1910, pro syn.

Broughtonia cubensis (Lindl.) Cogn. in Urban, Symb. Antill. 6: 542. 1910. Type: Cuba, imported to England by Messrs. Loddiges (Holotype: K-L, photograph seen).

Plant epiphytic, rhizomatous, to 33 cm tall; roots few, thick, velamentous; rhizome short, stout, creeping or ascending, enclosed by imbricating scarious sheaths; stem modified into pseudobulb, erect or ascending, clustered, ovoid to pyriform, to 3 cm long, 1 cm wide, enclosed by scarious sheaths, to 2-leaved at apex; leaves

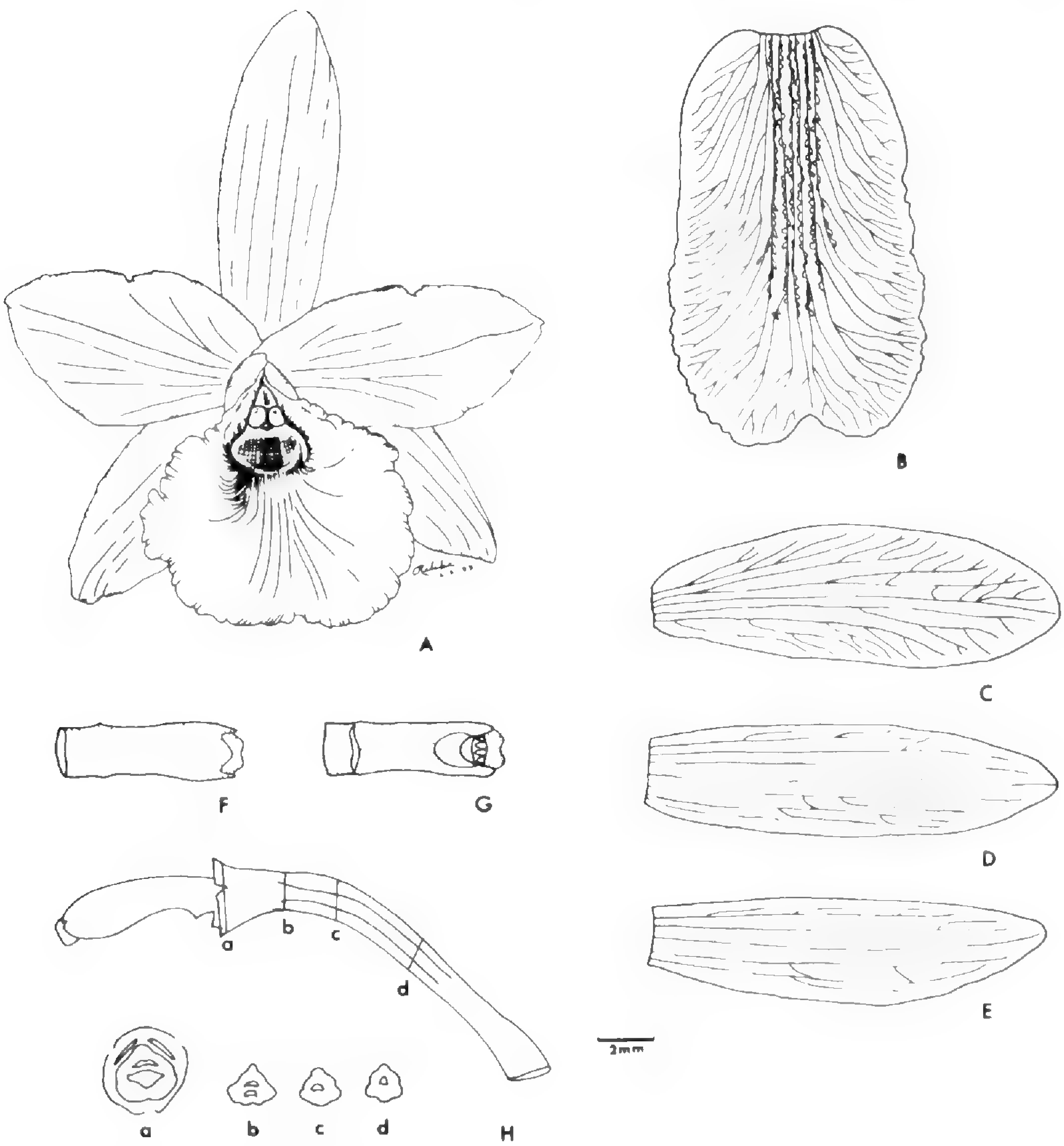

Figure 4. *Cattleyopsis cubensis* (Lindl.) Sauleda & Adams. **A.** Flower, frontal view. **B.** Labellum, frontal view. **C.** Petal. **D.** Dorsal sepal. **E.** Lateral sepal. **F.** Column, dorsal view. **G.** Column, ventral view. **H.** Column and ovary, lateral view and serial cross sections (a–d) showing nectary lumen.

fleshy-rigid, oblong, obtuse, margin minutely erose, to 8 cm long, 1 cm wide; inflorescence to 30 cm tall, peduncle slender, erect, distantly several-sheathed, simple raceme, to 8 flowers; floral bract ovate, acute, to 0.2 cm long, 0.1 cm wide; ovary slender, to 1.5 cm long; sepals pink to yellowish-pink, linear oblong to ligulate, obtuse, to 1.8 cm long, 0.5 cm wide; petals pink to yellowish-pink, oblong, obtuse, to 1.8 cm long, 0.7 cm wide; labellum pink to yellowish-pink with reddish-pink radiating lines near base extending to margin, to 2.0 cm long, 1.1 cm wide, oblong, basal margins involute enclosing column, forming a tube, center of labellum with yellow villous lamellae, margin crenate, shallowly emarginate; column pink, to 0.7 cm long, 0.3 cm wide, anther pink to reddish-pink; capsule pendent, to 2.5 cm long, 1.2 cm thick.

SPECIMEN EXAMINED: CUBA: Prov. de Pinar del Rio, Peninsula de Guanahacabibes, 2–3 mi E of Caleta Piojo, near Sawmill La Posa de Juan Claro, Jul 1959, *Osment s.n.* (USF).

FLOWERING PERIOD: Flowers sporadically throughout the year, mainly from December to March.

Cattleyopsis cubensis was first described by Lindley (1843) as *Epidendrum cubense* Lindl. and later (Lindley, 1853) referred it to the genus *Laeliopsis* Lindl. without formal transfer. Although Lindley examined living material, he failed to recognize that the anthers contained eight unequal pollinia. Cogniaux (1910) also failed to note the number of pollinia and transferred this species to the genus *Broughtonia* R. Brown. Correll (1941 and pers. comm.), after examining a photograph of the type, concluded that the exact taxonomic status of this species was not clear and in the absence of living material suggested that it should be retained in the genus *Laeliopsis,* to which Lindley (1853) had originally referred it. Dressler (1966) examined the type and considered it to be conspecific with *Epidendrum chinense* Lindl. and placed it under synonymy with *Barkeria chinensis* (Lindl.) Thien ex Dressler.

We have examined three living plants of this species which were collected by William Osment in Prov. de Pinar del Rio, Cuba, July 1959. Additionally, we have examined the progeny of selfing crosses from the original material. In every case, the specimens have eight unequal pollinia, elongate and narrowly-winged columns with basal appendages, no proximally swollen nectaries and erose leaf margins. Taken together, these characters unequivocally place these specimens in the genus *Cattleyopsis* Lemaire.

Furthermore, an examination of a photograph of the holotype of *Barkeria chinensis* convinces us that *Cattleyopsis cubensis* is not conspecific with it.

2. **Cattleyopsis lindenii** (Lindl.) Cogn. in Urban, Symb. Antill. 6: 544. 1910. (Figure 5)

Laelia lindenii Lindl., Orch. Lind. 10. 1846.

Bletia lindenii (Lindl.) Reichb. f., Walp. Ann. Bot. 6: 431. 1862.

Laeliopsis lindenii (Lindl.) Lindl. ex Cogn. in Urban, Symb. Antill. 6: 545. 1910, pro syn.

Broughtonia lindenii (Lindl.) Dressler, Taxon 15: 241. 1966. TYPE: CUBA, *Linden 1805* (HOLOTYPE: K-L, photograph seen).

Cattleyopsis delicatula Lem., Jard. Fleur. 4, Misc. p. 59. 1853. TYPE: No holotype indicated and a search of the major herbaria of Europe failed to uncover any specimens that can be ascertained to have been collected or examined by Lemaire. LECTOTYPE designated here: Figures 1–3 in Lemaire's Jard. Fleur. 4, p. 60, 1853.

Cattleyopsis northropiorum Cogn. in Urban, Symb. Antill. 6: 545. 1910. TYPE: No holotype indicated. LECTOTYPE here designated from syntypes: Bahama Islands, Andros, *Northrop & Northrop 437* (AMES).

Cattleyopsis guanensis Acuna, Cat. Descr. Orquid. Cub., Estac. Exper. Agron. Bol. Tec. 60: 109–110, 1939, *nom illeg.*, lacking Latin diagnosis. TYPE: CUBA, Pinar del Rio, Guane, *Fors 4837* (HOLOTYPE: Present location of specimen in Cuba not known, photograph seen at AMES).

Cattleya domingensis auct. non Lindl.: Britton & Millspaugh, Bahama Fl. 95, 1920; Richard, in Sagra's Hist. Fisica, Polit. Nat. Isl. Cuba, pt. 2, 11: 243, 1850.

Laeliopsis domingensis auct. non (Lindl.) Lindl.: Britton & Millspaugh, Bahama Fl. 95, 1920; Northrop, Mem. Torr. Bot. Cl. 12: 30, 1902.

Broughtonia domingensis auct. non (Lindl.) Rolfe: Cogn. in Urban. Symb. Antill. 6: 543, 1910; Britton & Millspaugh, Bahama Fl. 95, 1920.

Broughtonia lilacina auct. non Henfr.: Northrop, Mem. Torr. Bot. Cl. 12: 30, 1902.

Plant epiphytic, rhizomatous, to 68 cm tall; roots numerous, thick, velamentous; rhizome short, stout, creeping or ascending, enclosed by imbricating scarious sheaths; stem modified into pseudobulb, erect or ascending, clustered, cylindric to narrowly ovoid, to 8 cm long, 2 cm wide, enclosed by scarious sheaths, to 3-leaved at apex; leaves fleshy-rigid, oblong to linear-oblong, acute to apiculate, subcanaliculate, margin erose, to 11 cm long, 2.5 cm wide; inflorescence to 60 cm tall, peduncle slender, erect, distantly

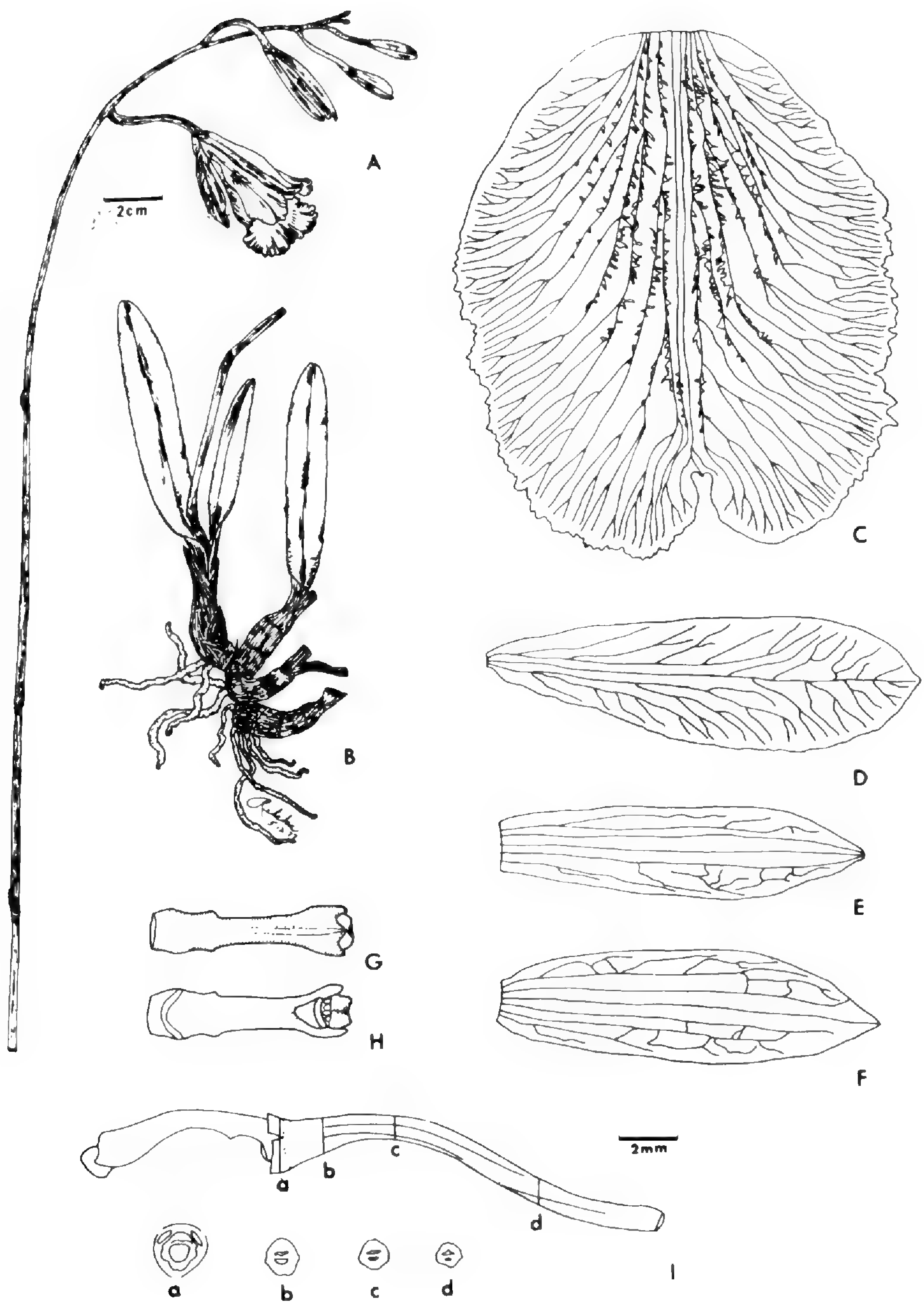

Figure 5. *Cattleyopsis lindenii* (Lindl.) Cogn. **A.** Inflorescence. **B.** Plant. **C.** Labellum, frontal view. **D.** Petal. **E.** Dorsal sepal. **F.** Lateral sepal. **G.** Column, dorsal view. **H.** Column, ventral view. **I.** Column and ovary, lateral view and serial cross sections (a d) showing nectary lumen.

several-sheathed, simple or paniculate raceme, to 12 flowers; floral bracts ovate, acute, to 0.5 cm long, 0.3 cm wide; ovary slender, to 2.5 cm long; sepals pink to lavender, linear-oblanceolate, acute, to 2.8 cm long, 0.8 cm wide; petals pink to lavender, narrowly obovate to oblanceolate, subobtuse to acute, to 2.4 cm long, 1.0 cm wide; labellum pink to lavender with purple lines radiating from center to near margin, to 3.5 cm long, 3 cm wide, broadly-obovate to orbicular, basal margins involute enclosing column, forming a tube, center of labellum with yellow villous lamellae, margin incised to crenate-dentate, undulate, deeply emarginate; column white, to 1.2 cm long, 0.3 cm wide, arcuate, anther greenish-white; capsule pendent, to 3.0 cm long, 1.5 cm thick.

REPRESENTATIVE SPECIMENS: **Bahama Islands:** GREAT ABACO, near North Harbour, 20 Jul 1904, *Barbour 773* (AMES); Cherokee Sound, 29 Dec 1904, *Brace 1942* (F, NY); Abaco Heights road, 11 Apr 1979, *Sauleda & Correll 2262* (FAU); Guiana Schooner Bay, 12 Apr 1979, *Sauleda & Correll 2304* (FAU); Hole-in-the-Wall, 28 Jun 1980, *Sauleda & Sauleda 3667* (FAU). LITTLE ABACO, near Fox Cay settlement, 4 Aug 1979, *Sauleda, Adams & Adams 2864* (FAU). ANDROS ISLAND, mangrove swamp, SE edge of Lake Forsythe, 6 Nov 1976, *Sauleda 1530* (FAU); 8 mi S of Fresh Creek, 5 Feb 1977, *Sauleda 1834* (FAU); Deep Creek, 2 May 1979, *Sauleda & Correll 2465* (USF). BIMINI GROUP, South Bimini, 15 Apr 1904, *Millspaugh 2397* (F, NY). ELEUTHERA, N. of James Cistern, 17 May 1975, *Correll & Hill 45248* (FTG). GREAT EXUMA, 6 mi N of George Town, 22 Jan 1979, *Sauleda, Correll & Correll 2200* (FAU). GRAND BAHAMA, Garden Cay, West End, 16 Apr 8 May 1905, *Brace 3660* (F, NY). LONG ISLAND, Gordons, trail to lighthouse, 7 Jul 1974, *Hill 2426* (FTG). MAYAGUANA, *Dykes s.n.* (AMES). **Cuba:** Prov. de Oriente, southern Baracoa region, 17 Jul 4 Aug 1924, *Leon 11761* (NY); Prov. de Oriente, Guantanamo Bay, 17–30 Mar 1909, *Britton 2230* (NY); Prov. de Pinar del Rio, Pan de Azucar, 5 Feb 1956, *Morton 9834* (US); Isle of Pines, top of Sierra de los Caballos, 12 May 1910, *Jennings 230* (NY).

FLOWERING PERIOD: Flowers sporadically throughout the year, mainly from May to September.

Cattleyopsis lindenii is a highly variable species distributed only in the Bahama Islands and Cuba. The Cuban populations are characteristically larger florally and vegetatively, and the flowers open more fully than those in the Bahamas. While these characteristics appear to predominate in the two areas, occasional variants can be found.

Cattleyopsis lindenii was first described by Lindley (1846) as *Laelia lindenii*, based on a Cuban specimen. *Cattleyopsis northropiorum* was first described by Cogniaux (1910) based mainly on collections from the Bahama Islands. A comparison of the types cited by these authors convinced us that *C. northropiorum* represents the smaller-flowered and more closed form of *C. lindenii* and should be considered a synonym of it.

Cattleyopsis guanensis was first described by Acuña (1939) based on a specimen collected in Cuba. We compared a photograph of the type of *C. lindenii* with a photograph of the type of *C. guanensis.* Additionally, we examined a color photograph of the type plant of *C. guanensis* in flower, taken by Acuña. We are convinced that *C. guanensis* is in reality the small-flowered *C. lindenii,* but a peculiarly dark lavender form, and should therefore be considered a synonym of it.

Cattleyopsis delicatula was first described by Lemaire (1853) as the type of the genus. An examination of an illustration published with the protologue (lectotype) leads us to the conclusion that it is the Cuban form of *C. lindenii* and should be considered a synonym of it.

The floral similarities between *Cattleyopsis lindenii* and *Laeliopsis domingensis* (Lindl.) Lindl. has lead to a great deal of confusion in the literature. These two species can be easily distinguished by an examination of the column. *C. lindenii* has eight unequal pollinia and two basal appendages on the column, while in *L. domingensis,* the column bears four equal pollina and lacks basal appendages.

Specimens of *Cattleyopsis lindenii* were incorrectly referred to *Laeliopsis domingensis* by Britton & Millspaugh (1920) and to *Broughtonia domingensis* (Lindl.) Rolfe by Cogniaux (1910). *Laeliopsis domingensis* is a different species endemic to Hispaniola while *B. domingensis* is a synonym of it. In addition, Northrop (1902) referred specimens of *C. lindenii* to *B. lilacina* Henfr. which is also a synonym of *L. domingensis.*

3. **Cattleyopsis ortgiesiana** (Reichb. f.) Cogn. in Urban, Symb. Antill. 6: 546. 1910. (Figure 6)

Bletia ortgiesiana Reichb. f., Hamb. Gartenz. 420. 1860.

Broughtonia ortgiesiana (Reichb. f.) Dressler, Taxon 15: 241. 1966. TYPE: Locality not known. Cultivated in Botanical Garden in Zurich, by Mr. E. Ortiges. (HOLOTYPE: W).

Broughtonia sanguinea auct. non (Sw.) R. Br.: Cogn. in Urban, Symb. Antill. 6: 542. 1910; Griseb., Cat. Pl. Cub. 263. 1866.

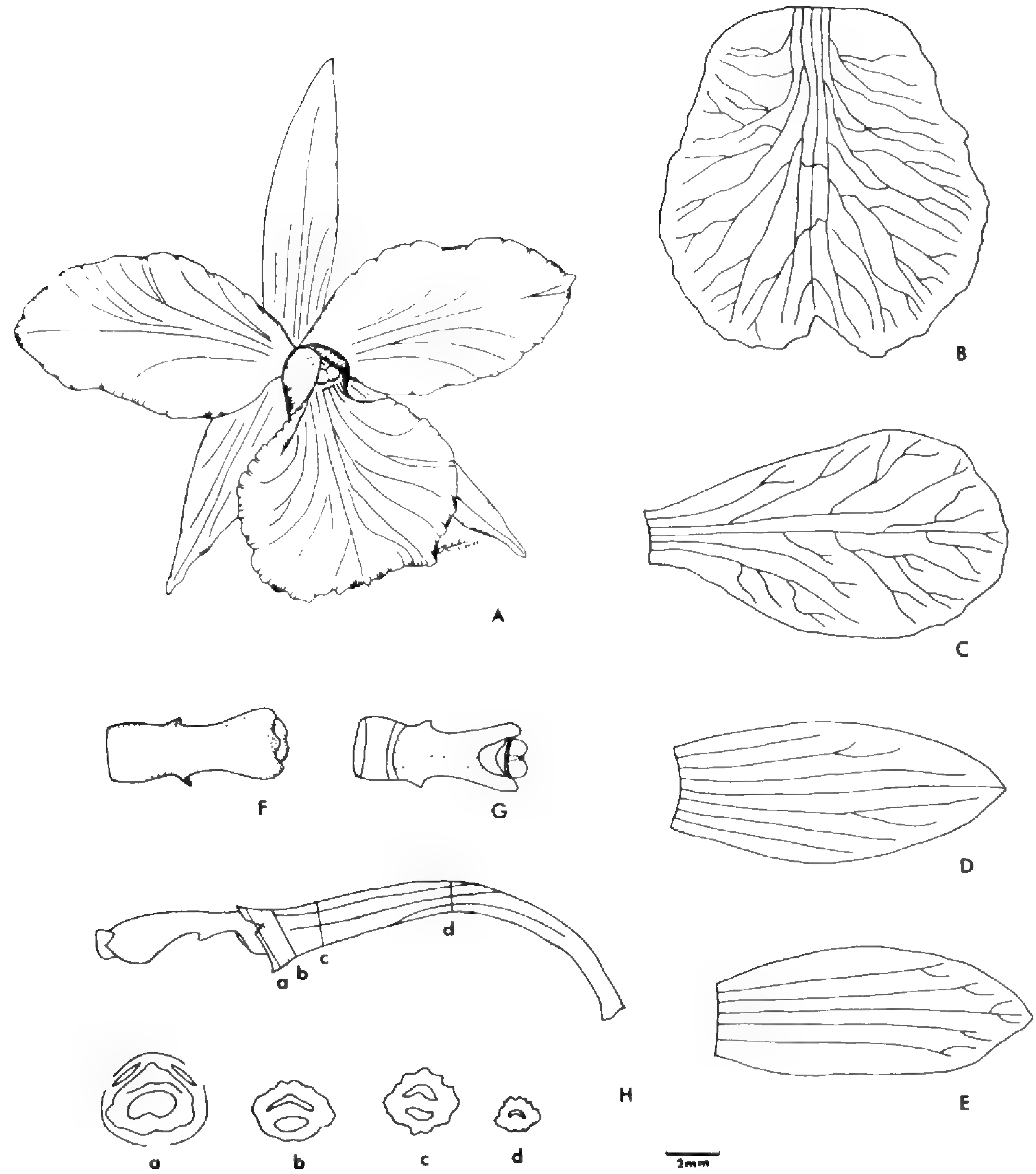

Figure 6. *Cattleyopsis ortgiesiana* (Reichb. f.) Cogn. **A.** Flower, frontal view. **B.** Labellum, frontal view. **C.** Petal. **D.** Dorsal sepal. **E.** Lateral sepal. **F.** Column, dorsal view. **G.** Column, ventral view. **H.** Column and ovary, lateral view and serial cross sections (a–d) showing nectary lumen.

Plant epiphytic, rhizomatous, to 58 cm tall; roots thick, velamentous; rhizome short, stout, creeping or ascending, enclosed by imbricating scarious sheaths; stem modified into pseudobulbs, erect or ascending, clustered, cylindric to narrowly pyriform, to 5 cm long, 1.4 cm wide, enclosed by scarious sheaths, to 2-leaved at apex; leaves fleshy-rigid, oblong to linear-oblong, obtuse, margin erose, to 18 cm long, 2.4 cm wide; inflorescence to 53 cm tall, peduncle slender, erect, distantly several-sheathed, simple or paniculate raceme, to 20 flowers; floral bracts narrowly ovate, acute, to 0.4 cm long, 0.2 cm wide; ovary slender, to 2 cm long; sepals reddish-purple to pink, oblong, acute, to 1.7 cm long, 0.7 cm wide; petals reddish-purple to pink, obovate, obtuse, to 1.8 cm long, 0.9 cm wide; labellum reddish-purple, with a central basal white spot and with 8–12 radiating red veins, to 1.8 cm long, 1.8 cm wide, obovate to orbicular, basal margins involute, but not completely enclosing column, margin entire, undulate, emarginate; column reddish-purple to pink, to 0.7 cm long, 0.3 cm wide, anther reddish-purple to pink; capsule pendent, to 2.2 cm long, 1.1 cm thick.

REPRESENTATIVE SPECIMENS: CUBA: Prov. de Oriente, Playa de Punto Padre, 24 Jul 1959, *Lopez 10* (US); Prov. de Camaguey, near Camaguey, 2 7 Apr 1912, *Britton, Britton & Cowell 13143* (AMES, NY, US); Prov. de Pinar del Rio, vicinity of Coloma, 2 Mar 1911, *Britton & Cowell 9692* (NY); Prov. de Camaguey, 3 km E of Florida, 31 Mar 1950, *Cutler 12204* (AMES); Isle of Pines, Loma la Daguilla, 3 Mar 1916, *Britton, Britton & Wilson 15165* (AMES, NY, US).

FLOWERING PERIOD: Flowers sporadically throughout the year, mainly from December to March.

This species has been referred to *Broughtonia sanguinea* (SW.) R. Br. by Cogniaux (1910), Grisebach (1866) and Acuña (1939). These misidentifications account for the incorrect reports of *B. sanguinea* occurring in Cuba. *Broughtonia sanguinea* is a different species endemic to Jamaica.

Florally, *Broughtonia sanguinea* is similar to *Cattleyopsis ortgiesiana* but is distinctive in column morphology. The column of *C. ortgiesiana* bears eight unequal pollinia and has two basal appendages, while the column of *B. sanguinea* bears four equal pollinia and lacks basal appendages.

3. **Laeliopsis** Lindley in Paxton, Flow. Gard. 3: 155. 1853.

Epiphytic plants; rhizomatous; roots velamentous; stems modified into ovoid pseudobulbs; leaves fleshy-rigid, margin erose; inflorescence terminal; ovary pedicellate; labellum entire, narrowly obovate; column elongate, clavate, narrowly winged towards apex; anther terminal, incumbent, operculate; pollinia 4, equal, with a caudicle; capsule smooth, ellipsoid.

TYPE: **Cattleya domingensis** Lindl.

This is a monotypic genus occurring on Hispaniola and Mona Island.

1. **Laeliopsis domingensis** (Lindl.) Lindl., Paxt. Flow. Gard. III: 156, t. 105. 1853. (Figure 7)

Cattleya domingensis Lindl., Gen. & Sp. Orch. 118. 1831.
Bletia domingensis (Lindl.) Reichb.f., Walp. Ann. VI: 432. 1862.
Broughtonia domingensis (Lindl.) Rolfe, Gard. Chron. Ser. 3, V: 491. 1889. TYPE: SANTO DOMINGO, *MacKenzie s.n.* (HOLOTYPE: K-L, photograph seen).
Broughtonia lilacina Henfr. in Moore & Ayres, Gard. Mag. Bot. 3: 201. 1851. TYPE: No holotype designated. LECTOTYPE designated here: Plate in Moore & Ayres, Gard. Mag. Bot. 3, 1851, drawn from a plant collected on Hispaniola.
Broughtonia violacea Henfr. in Moore & Ayres, Gard. Mag. Bot. 3: 201. 1851. Published in synonomy.

Plant epiphytic, rhizomatous, to 110 cm tall; roots numerous, velamentous; rhizome short, stout, creeping or ascending, enclosed by imbricating scarious sheaths; stem modified into pseudobulb, erect or ascending, clustered, ovoid, to 6 cm long, 5 cm wide, enclosed by scarious sheaths, to 3-leaved at apex; leaves fleshy-rigid, oblong, obtuse to subacute, subcanaliculate, margin erose, to 18 cm long, 3 cm wide; inflorescence to 104 cm tall, peduncle slender, erect, distantly several-sheathed, simple or paniculate raceme, to 15 flowers; floral bracts ovate, acute, to 0.3 cm long, 0.3 cm wide; ovary slender, to 2.5 cm long; sepals pink to lavender, linear-oblong, acute, to 3.3 cm long, 0.6 cm wide; petals pink to lavender, broadly-oblanceolate to obovate, acute, to 3 cm long, 1.2 cm wide; labellum pink to lavender, to 4 cm long, 2.7 cm wide, narrowly obovate, basal margins involute, enclosing column, forming a tube, center of labellum with yellow villous lamellae terminating near apex, frontal margin with purple veins terminating near apex, margin minutely incised to crenate-dentate, undulate, shallowly emarginate; column pink, to 1.6 cm long, 0.5 cm wide, slender, anther pink to reddish-purple; capsule pendent, to 5.2 cm long, 2.4 cm thick.

REPRESENTATIVE SPECIMENS: **Hispaniola:** DOMINICAN REPUBLIC, Prov. La Romana, NE of La Romana, 19 Aug 1982, *Sauleda, Sauleda, Ragan & Dod 7450* (USF); Prov. Peravia, Bani, 19 Feb 1966, *Lavastre 2070* (NY); Prov. Altagarcia, SE of Playa El Macao, 13 May 1980, *Mejia & Zanoni 6263* (SDM); Prov. Monte Cristi, NW of Villa Sinda, 21 May 1980, *Mejia & Zanoni 6398* (SDM). HAITI, Ile de la Tortue,

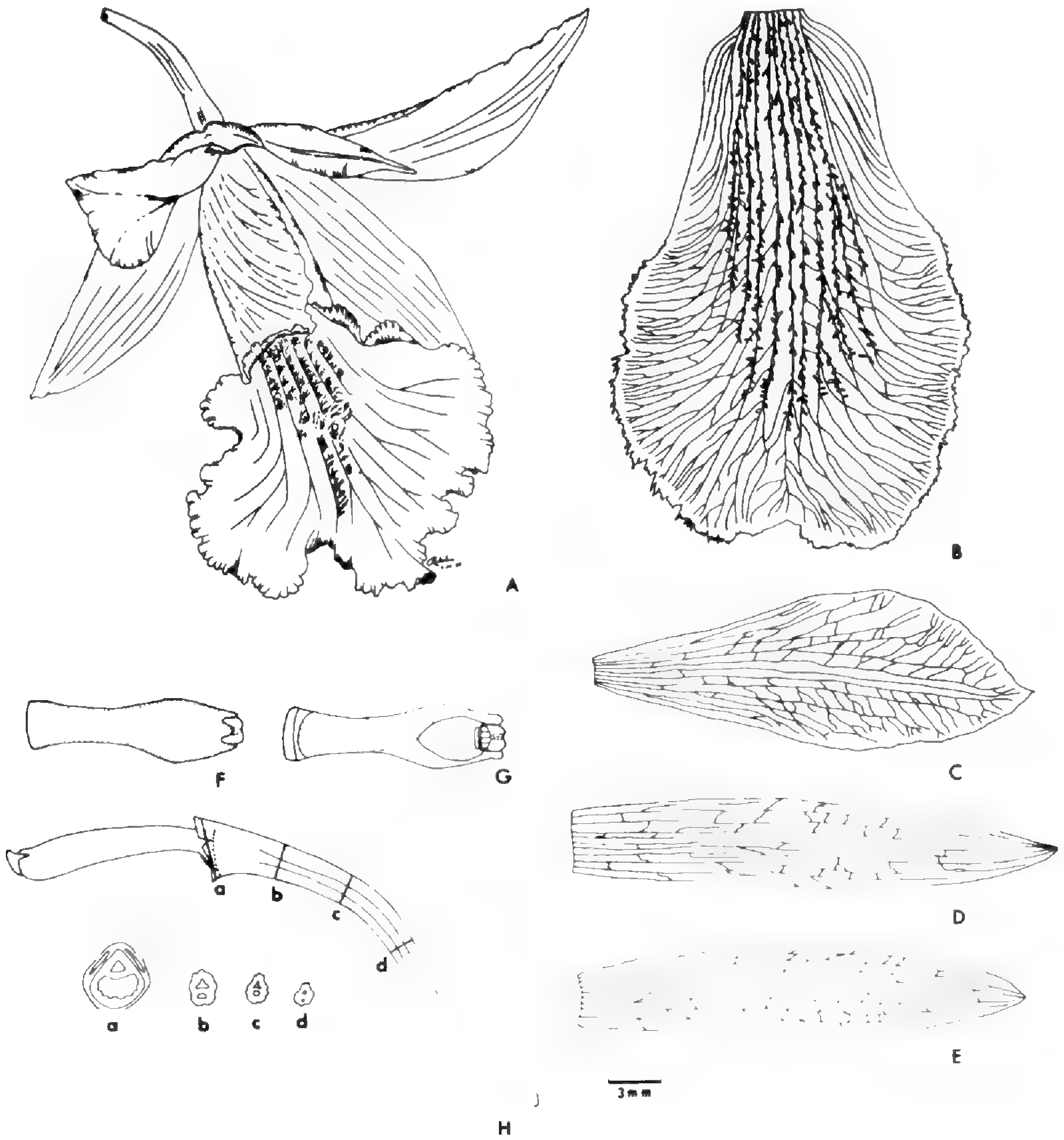

Figure 7. *Laeliopsis domingensis* (Lindl.) Lindl. **A.** Flower, frontal view. **B.** Labellum, frontal view. **C.** Petal. **D.** Dorsal sepal. **E.** Lateral sepal. **F.** Column, dorsal view. **G.** Column, ventral view. **H.** Column and ovary, lateral view and serial cross sections (a–d) showing nectary lumen.

vicinity of La Vallee, 3–10 May 1929, *Leonard & Leonard 15612* (NY, US); Dept. Du Nord, NW of Pedro Santana (D. R.), 27 Aug 1982, *Sauleda, Sauleda, Ragan & Dod 7617A* (USF).

Flowering period: Flowers sporadically throughout the year, mainly from April to June.

This species has been reported to occur in the Bahama Islands and Cuba based on misidentifications of *Cattleyopsis lindenii*

(Lindl.) Cogn., by Richard (1850), Britton & Millspaugh (1920) and Cogniaux (1910). Additionally, this species has been reported from Jamaica, based on misidentifications of *Broughtonia negrilensis* Fowlie, by Fawcett & Rendle (1910), Cogniaux (1910) and Grisebach (1864).

Laeliopsis domingensis is florally similar to *Cattleyopsis lindenii* and *Broughtonia negrilensis.* These three species can be distinguished easily by examining column morphology. *Cattleyopsis lindenii* has eight unequal pollinia and two basal appendages on the column, while *B. negrilensis* and *L. domingensis* both have four equal pollina and lack basal appendages. *Broughtonia negrilensis* is distinguished from *L. domingensis* by having a short column relative to the pedicel, thick wings on the column and a nectary which is swollen proximally. *Laeliopsis domingensis* has an elongate column relative to the pedicel, narrow column wings and a nectary not swollen proximally.

ACKNOWLEDGMENTS

We thank the Directors, Curators and staff members of the herbaria cited throughout the text for their cooperation and help. Special thanks are extended to Drs. Peter Taylor (K) and Robert Read (US). We acknowledge the generous field assistance given by Donald and Tudy Dod of the Dominican Republic, Gladys and Kenneth Fehling of the Bahama Islands and Marv Ragan of Orange Park, Florida. Our thanks are also extended to William Osment of Hollywood, Florida for his donations of plant material, to Dr. Helen B. Correll for preparing the Latin description, and to Rebeka Sauleda for some of the illustrations. This research was supported in part by donations from the Tropical Orchid Society of Palm Beach, Florida.

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A RE-EVALUATION OF *SPIRANTHES* ×*STEIGERI* CORRELL

PAUL M. CATLING

ABSTRACT

The hybrid *Spiranthes* ×*steigeri* Correll has been re-examined and found to be referable to *S. ochroleuca* (Rydb.) Rydb., a recently re-established species. Synonymy of the hybrid with *S. ochroleuca* is proposed.

Key Words: *Spiranthes*, putative species hybrid, extant synonymy

Spiranthes ×*steigeri* Correll was proposed as a hybrid of *S. cernua* (L.) L. C. M. Rich. and *S. romanzoffiana* Cham. parentage in 1941, based on material collected on 22 September 1940 by Theodore L. Steiger in a "dense grassy marshland" near Warner, Merrimack County, New Hampshire (Correll, 1941). It has become the most frequently recognized and widely accepted hybrid in northeastern *Spiranthes*, having been reported over a broad geographical area and included in various manuals (*e. g.* Correll, 1950; Case, 1964; Voss, 1972; Luer, 1975).

Correll (1941) made reference to several plants, four of which he referred to *Spiranthes cernua* and three which he considered to represent the new hybrid, *S.* ×*steigeri*. The largest plant of the three was recognized as a monstrosity, the flowers having multiple aborted lips with adnate anther tissue. This plant was referred to the hybrid since its abnormality suggested a hybrid origin and it was found growing with the hybrid. The smallest of the three plants had rather small calli at the base of the lip suggesting *S. romanzoffiana*. However, it was apparently the plant of intermediate size (of these three) upon which Correll (1941) based his description, *i. e.* "the plant with intermediate characters that typifies the hybrid . . .". The flowers of this plant were described as having the characteristic ascending appearance of the flowers of *S. romanzoffiana*, and the basal calli of the lips "approached most closely those of *S. cernua*". Lips from the flowers of this plant were reported to be highly variable, ranging from distally pandurate to pandurate on one side to not at all pandurate (Correll, 1941, Figures 3, 4, and 5).

The type sheet (AMES 59049) contains three plants. These are definitely the same three plants on which Correll based his taxon since the largest (left hand) plant has abnormal flowers with multiple pollinia and viscidia and anther tissue developed in some perianth parts, as described and illustrated (Correll, 1941).

All three plants have glandular pubescence, ascending flowers, leafy stems, and rather long inflorescences accounting for 22–30% of the plant height. These features and the general appearance suggest the recently re-established *Spiranthes ochroleuca* (Rydb.) Rydb. (Luer, 1975; Sheviak and Catling, 1980). The ascending flowers noted by Correll (*loc. cit.*) as a feature of *S. romanzoffiana* are also characteristic of *S. ochroleuca*.

With the permission of L. A. Garay, curator of AMES, a flower was removed from each of the three plants on the type sheet, softened in warm strong saline and drawn with the aid of camera lucida (Figure 1, a–o). The left-hand plant (the largest) has flowers that are characteristic of *Spiranthes ochroleuca* with respect to the relatively well developed basal calli, relatively long claw, cuneate base, median constriction and fleshy centre (Figure 1, a). The column (Figure 1, f) is abnormal, having two viscidia, and anther tissue is apparent in the lateral petals (Figure 1, c, d).

The middle plant (the smallest) on the type sheet has flowers approaching *Spiranthes ochroleuca* with respect to the separation of dorsal and lateral sepals (Figure 1, g), the basal curvature of the lip stalk (Figure 1, h), and the central fleshiness of the lip (not shown). The basal calli and claw are also relatively well developed (Figure 1, i). However, the truncate base of the lip and relatively wide perianth parts (Figure 1, j, k, l; Correll, 1941, Figure 6) are unusual in *S. ochroleuca*.

A flower from the plant of intermediate size (*i. e.* the right-hand plant and the one Correll apparently considered most typical of the hybrid) has a lip with well-developed basal calli, a cuneate base, a slight central constriction and a conspicuously fleshy centre (Figure 1, o). It is therefore clearly referable to *Spiranthes ochroleuca*. While it may be that some flowers on this plant have a median constriction in the lip, they are not pandurate as in *S. romanzoffiana*.

All three plants are lacking in intermediacy in certain characters that would allow confidence in the hybrid concept. For example, lateral sepals are not basally connate and distally confluent with the dorsal sepal, the pubescence is not shorter and sparser, there is not strong venation in the lateral sepals, the pattern of lip venation is not

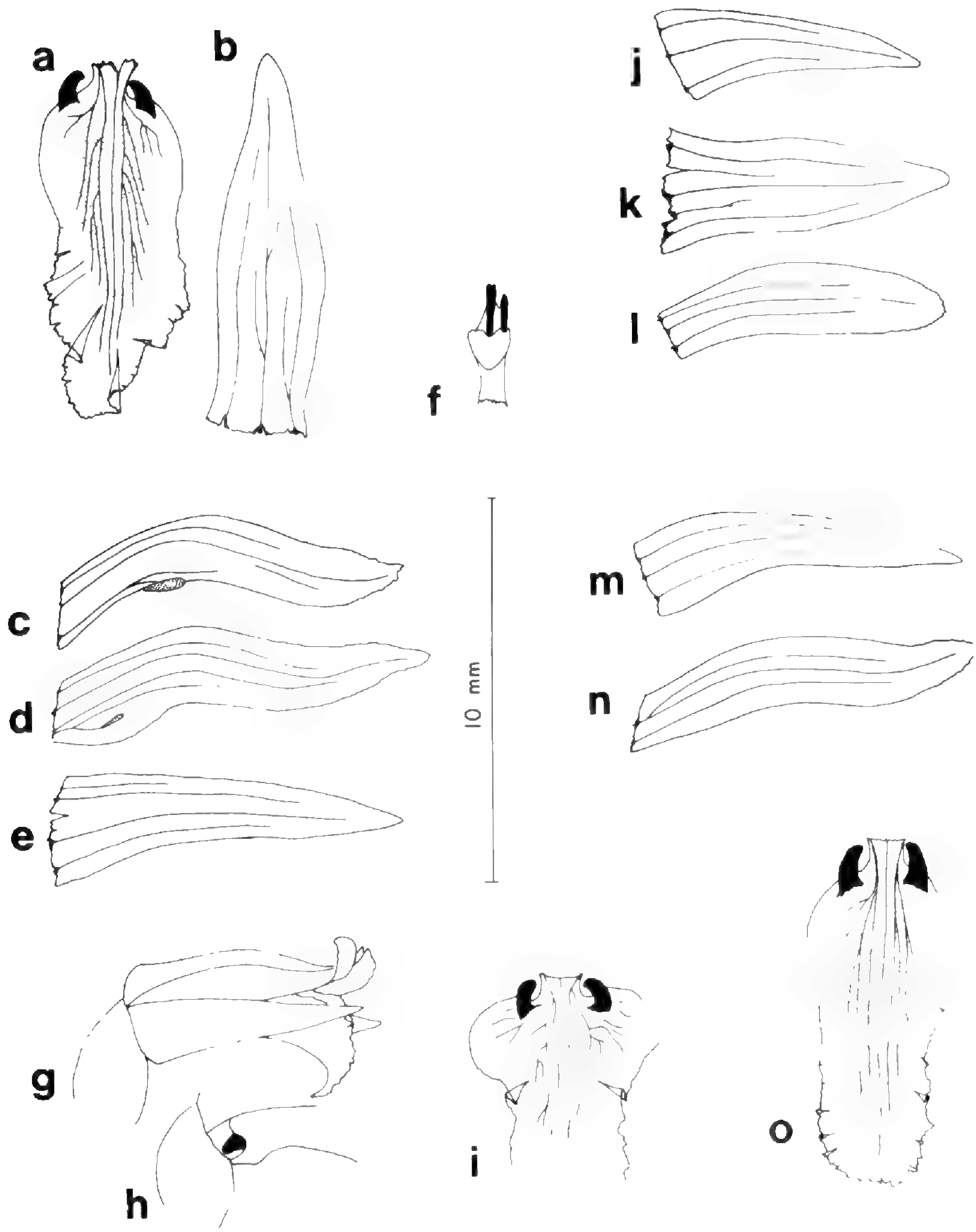

Figure 1. Camera lucida drawings of flowers from the type sheet of *Spiranthes* ×*steigeri* Correll (AMES 59049). **a–f,** left-hand plant: **a,** lip; **b,** dorsal sepal; **c, d,** lateral petals; **e,** lateral sepal; **f,** column from below. **g–l,** middle plant; **g,** flower in lateral view; **h,** basal portion of flower with lateral sepal removed; **i,** lip; **j,** lateral sepal; **k,** dorsal sepal; **l,** lateral petal; **m–o,** right-hand plant: **m,** lateral sepal; **n,** lateral petal; **o,** lip.

intermediate, nor are the lengths of the basal calli. Pollen from each of the three flowers examined was normal, *i. e.*, there was no indication of disturbed meiosis through the presence of dyads or monads, as one might expect from a hybrid involving plants as different as *Spiranthes romanzoffiana* and either *S. cernua* or *S. ochroleuca* (*c.f.* Simpson & Catling, 1978).

Although a first generation hybrid may show only the dominant expression of a particular trait, most hybrids are more or less intermediate and demonstrate features of both parents. This intermediacy is not the case with the putative *Spiranthes* ×*steigeri*. The only characters in the type material which could be regarded as atypical of *S. ochroleuca* are the disorganized floral structure in the left hand plant, and the relatively wide perianth parts and truncate lip base (the latter a feature of *S. cernua* instead of *S. romanzoffiana)* in the middle plant. These few abnormalities do not seem to be sufficient to assume a hybrid.

The four plants assigned to *Spiranthes cernua* which were collected with *S.* ×*steigeri* on the same date (AMES 59203) are also referable to *S. ochroleuca*. Correll's misidentification of Steiger's collections as *S. cernua* and as a *S. cernua* × *S. romanzoffiana* hybrid is understandable given the lack of information on various diagnostic characters at the time. Furthermore, *S. ochroleuca* was poorly understood then and considered trivial until quite recently (*cf.* Correll, 1950; Luer, 1975; Sheviak and Catling, 1980).

As for the reports of *Spiranthes* ×*steigeri* from Yarmouth County, Nova Scotia (Correll, 1950), Chippewa County, Michigan (Case, 1964) and Caledonia County in northern Vermont (Luer, 1975), it appears that there are no documenting specimens (for list of herbaria checked, see Sheviak and Catling, 1980). Luer's (1975) photograph of *S.* ×*steigeri* from Vermont appears to represent only an abnormal specimen of *S. romanzoffiana*. A plant labelled *S.* ×*steigeri* collected from the shoreline of Deep Lake in Barry County, Michigan by F. W. Case on 4 September 1967 (MICH), a site with both putative parents present (MICH), has a weakly pandurate lip. This characteristic and its unusually late flowering may suggest a hybrid, but otherwise the plant resembles *S. romanzoffiana*, which does occasionally bloom late. The pollen of this plant is normal. Both of the Michigan reports of *S.* ×*steigeri* have recently been rejected (Case and Catling, 1983). In view of the points discussed above, I formally propose that *Spiranthes* ×*steigeri* Correll be considered a synonym of *S. ochroleuca* (Rydb.) Rydb.

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TAXONOMY OF THE *VICIA LUDOVICIANA* COMPLEX (LEGUMINOSAE)[1]

J. STUART LASSETTER

ABSTRACT

The annual vetches *Vicia ludoviciana* Nutt. ex T. & G., *V. leavenworthii* T. & G., *V. exigua* Nutt. ex T. & G., and their varieties compose the native North American *V. ludoviciana* complex. The center of diversity is Texas; distribution is from Alabama to California, and from northern Mexico into the Rocky Mountains of Colorado. Karyotypes, artificial hybridizations, characteristics of the breeding system, and various morphological data are used with previously reported edaphic relationships and seed morphology to establish relationships reported herein. This taxonomic treatment reduces the taxa of the complex to 1 wide-ranging and variable species, consisting of 1 subspecies containing 5 geographical races, and a second subspecies containing 2 races.

Key Words: *Vicia*, North America, taxonomy, chromosomes, breeding system

INTRODUCTION

The *Vicia ludoviciana* complex (Leguminosae) is a group of annual vetches native to North America. The complex includes *Vicia ludoviciana* Nutt. ex T. & G., *V. leavenworthii* T. & G., *V. exigua* Nutt. ex T. & G., and varieties of each. Lassetter (1975) has shown that *Vicia hassei* Wats. (*V. exigua* var. *hassei*) is not part of this complex. Taxa of the complex are found from Alabama to California and from northern Mexico into the Rocky Mountains of Colorado. The center of diversity is Texas where the greatest number of taxa occur and where intergradation between taxa is greatest.

The taxonomic relationships within the complex have been problematic, and conclusions of different authors have not agreed. Previous workers relied almost solely on field and herbarium data.

Shinners (1948) recognized *Vicia ludoviciana* (varieties *typica, texana, laxiflora*) and *V. leavenworthii* (varieties *typica, occidentalis*) in Texas. Species were separated by peduncle length, and varieties by overall size as well as flower characters. According to Shinners, the distribution of taxa is at least partly associated with soil texture. He stated that overlaps and intergradation between

[1]Journal Paper No. J-9717 of the Iowa Agriculture and Home Economics Experiment Station, Ames, Iowa. Project No. 1983.

taxa exist. Shinners did not consider the western *V. exigua* as occurring in Texas.

Turner (1959) also recognized two species in Texas, but distinguished them on the basis of flower number. Varieties were separated by leaflet characters and by length of flowering axes. Like Shinners, Turner believed that distribution was related in part to soils, and stated that intergradation exists between varieties of each species, and between the species. Turner considered *Vicia ludoviciana* var. *texana* to be *V. leavenworthii* var. *occidentalis*.

In addition to *Vicia ludoviciana* and *V. leavenworthii,* Hermann (1960) also believed *V. exigua* extended into Texas and was in fact *V. leavenworthii* var. *occidentalis* sensu Shinners and Turner. These three species were separated by Hermann on the basis of number of flowers per peduncle, peduncle length, and flower character.

Isely (personal communication) believed that only two species exist although this scheme was not formally proposed. He viewed *Vicia exigua* (as did Hermann, 1960) to encompass *V. leavenworthii* var. *occidentalis* sensu Shinners. Isely believed all the other taxa were best recognized as one of two varieties of *V. ludoviciana.*

Because the total range of the complex is widespread, the constituent taxa have been included in several state and local floras. Correll and Johnston (1970) is the only treatment that covers a geographical area from which all three species have been reported. The treatment of *Vicia* by these authors is largely adapted from Hermann (1960), and their view of the *V. ludoviciana* complex differs only in minor details of ranges and descriptions.

The traditional taxon names of Shinners are predominately used throughout this paper so that the reader can better relate to the taxa being discussed. Name changes and shifts in taxon concepts are largely reserved for the taxonomic treatment.

MATERIALS AND METHODS

Chromosome study included meiotic counts determined from anther squashes and karyotype analyses from mitotic root material. Field-collected buds were fixed in Newcomer's (1953) fixative. Buds and root tips from greenhouse plants were fixed in acetic-alcohol (absolute ethanol: glacial acetic acid – 3:1). Anther material was stained with propiocarmine. Root tips were pretreated for 4 hours at 13–14° C in 0.002 M 8-hydroxyquinoline and were stained with Schiff's reagent according to the Feulgen method. Slides were made permanent by the method of Bowen (1956). Meiotic figures and karyotypes were drawn with a Zeiss camera lucida and a Leitz drawing apparatus, respectively. Voucher specimens are deposited in the Iowa State University Herbarium (ISC).

Reciprocal artificial hybridizations were attempted between the three traditional species. It was necessary to emasculate the self-fertile flowers because pollen is often released in the bud stage. A total of 216 crosses was made. An additional 15 emasculations with no pollen transfers were performed as a check for apomixis. Observations were made on the breeding system.

One hundred six mass collections of about 1,200 total specimens were made. Fifty-five morphological characters were observed and recorded. The characters observed included those used by previous workers that I also believed useful, as well as some additional ones. For brevity, the entire list and explanation is omitted here, but is available from Lassetter (1972).

Herbarium studies were conducted by utilizing material from the following herbaria: ARIZ, ASC, BRY, CAS, COLO*, DS, F*, FSU, GH, ISC, LA, LAF, LSU, MEXU*, MICH*, MIN, MISS, MISSA, MO, NLU, NMC, NO, NY, OKL, OKLA, ORE, PH*, POM*, RSA, SBBG, SMB, SD, SMS, SMU, TENN, TEX, TTC, UARK, UC, UM, UNM, US, VDB, and University of Southern Mississippi (herbarium designations follow Holmgren and Keuken (1974); asterisks indicate selected material only).

Lassetter (1978a) discussed the taxonomic significance of the following seed characters: diameter, relative hilum length (hilum length ÷ seed circumference × 100), hilum length, hilum width at wide end, hilum width at narrow (lens) end, base color of testa, and color of mottling. Identification of taxa by seed characters alone was shown to be unreliable due to overlapping variation.

Lassetter (1978b) reported on edaphic relationships and demonstrated that some taxa are rather plastic and regularly occur in soils of various texture. Other taxa were only found on sandy or sandy loam soils.

RESULTS AND DISCUSSION

Cytological data

The genus *Vicia* has chromosome base numbers of $x = 5$, $x = 6$, and $x = 7$ (Senn, 1938; Darlington and Wylie, 1955; Fedorov, 1969). Workers presume that the lower numbers are derived from an ancestral $n = 7$ (Stebbins, 1958; Rousi, 1961).

During the present study, more than 40 meiotic counts were made, several for each taxon from various locations throughout the range of the complex. All counts for all taxa were $n = 7_{II}$ (Figure 1 comprises a sample); meiosis appeared normal, as previously observed by Turner (1956).

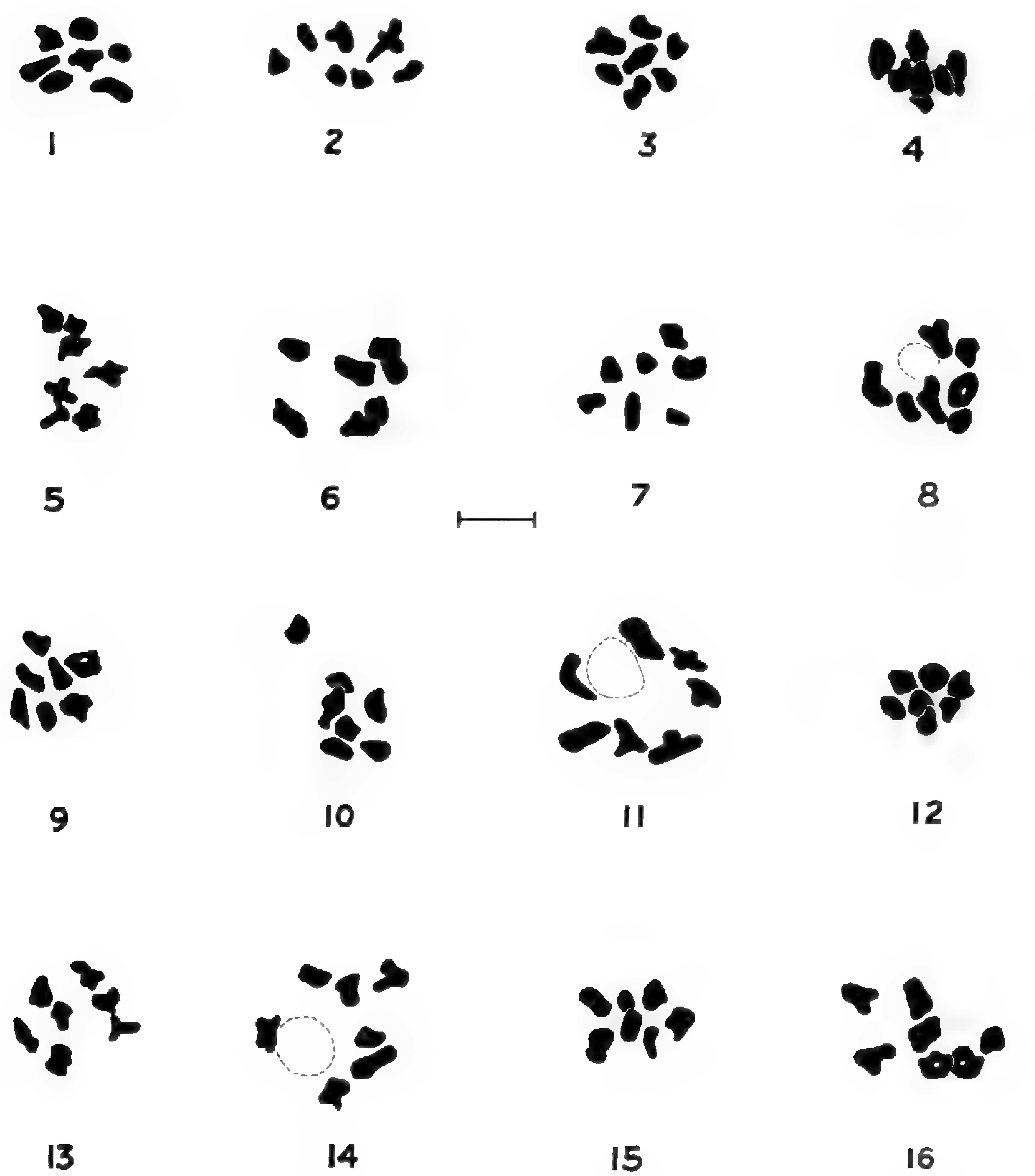
Previous to this study only three chromosome counts were reported in the literature. Turner (1956) reported three determinations of $n = 7$ for *Vicia ludoviciana* var. *typica* and one determination of $2n = 14$ for *V. leavenworthii* var. *typica.* Turner also listed an unpublished count of $n = 7$ by Johnston for *V. leavenworthii* var. *occidentalis.*

Figure 1. Meiotic chromosomes of *Vicia.* Line scale = 10 microns

1. *V. ludoviciana* var. *typica* (race 1). Voucher grown from seed from S. McDaniel 8881, Dauphin Island, Alabama, (FSU #124825).
2. *V. ludoviciana* var. *typica* (race 1). Lassetter 1760, Walker Co., Texas.
3. *V. ludoviciana* var. *laxiflora* (race 5). Lassetter 1721, Val Verde Co., Texas.
4. *V. ludoviciana* var. *laxiflora* (race 5). Lassetter 1851, Llano Co., Texas.
5. *V. ludoviciana* var. *texana* (race 2). Lassetter 1773, Aransas Co., Texas.
6. *V. leavenworthii* var. *typica* (race 6). Lassetter 1832, Hill Co., Texas.
7. *V. leavenworthii* var. *typica* (race 6). Lassetter 1847, Concho Co., Texas.
8. *V. leavenworthii* var. *occidentalis* (race 4). Lassetter 1731, Culberson Co., Texas.
9. *V. leavenworthii* var. *occidentalis* (race 4). Voucher grown from seed from D. Keil 1162, Maricopa Co., Arizona (ARIZ #38829).
10. *V. exigua* var. *exigua* (race 3). Voucher grown from seed collected by I. Marin, Riverside Co., California.
11. *V. exigua* var. *exigua* (race 3). Voucher grown from seed from D. H. Hoover s.n. San Diego Co., California, (CAS #514387).
12. *V. ludoviciana* var. *texana* (race 2). Lassetter 1779, Willacy Co., Texas.
13. *V. ludoviciana* var. *texana* (race 2). Lassetter 1783, Jim Wells Co., Texas.
14. *V. ludoviciana* var. *laxiflora* (race 5). Voucher grown from seed from M. Fechu and F. Martizen 160, Chihuahua, Mexico (TEX s.n.).
15. *V. exigua* var. *exigua* (race 3). Voucher grown from seed from R. N. Philbrick B65-1399 and M. Benedict, Santa Cruz Island, California (SBBG #29483).
16. *V. leavenworthii* var. *occidentalis* (race 4). Lassetter 1726, Brewster Co., Texas.

Most karyotyping of *Vicia* species has been done with those native to the Old World, for which much literature exists. Sveshnikova (1927) investigated 27 Old World species and found that almost every species had a different karyotype.

Shrivastava (1963) studied eight Old World species and found eight different karyotypes. Mettin and Hanelt (1968) studied 11 Old World and one South American species and concluded that most taxa in *Vicia* are characterized by different karyotypes, that chromosome sizes also are somewhat different, and that these differences seem to apply to both Old and New World species.



Stankevicz (1970) studied morphological, karyological, and ecological geographical characteristics of 53 Russian species of *Vicia.*

Very little karyotype work has been done with New World species. Turner (1956) illustrated $2n = 14$ chromosomes of *V. leavenworthii* var. *typica,* but the drawing does not show the satellited chromosomes that are present. It was presumably made for a count only and was not a karyotype preparation.

Lassetter (1975) utilized karyotypes and other data in a taxonomic treatment separating *Vicia hassei* from *V. exigua,* and Lassetter and Gunn (1979) used karyotypes in establishing relationships between *V. menziesii, V. nigricans,* and *V. gigantea.*

Veerasethakul and Lassetter (1981) presented a preliminary survey of native New World *Vicia* karyotypes and reviewed previous work with New World species.

Taxa of the *V. ludoviciana* complex all have the same basic karyotype (Veerasethakul and Lassetter, 1981). I believe pairs one, two, five, and seven (numbered from left to right) are the same in all karyotypes. Some minor variation in these pairs was observed in different preparations from the same taxon, and sometimes small variation from cell to cell in one preparation was observed. These differences are, I believe, due to slight inconsistencies in length and/or temperature of pretreatment, and to differences in the precise time of mitosis at which cells were fixed.

The differences in the other three pairs of chromosomes are believed to represent inherent karyological differences between taxa and are given in Table 1.

With regard to evolution of karyotypes, Levitskly (1931) formalized the concept of symmetrical karyotypes (chromosomes all metacentric or submetacentric and nearly equal in size) as contrasted to asymmetrical karyotypes, and he proposed a trend of increasing karyotype asymmetry in angiosperms.

According to Stebbins (1950), perennial vetches with $n = 7$ have mostly symmetrical karyotypes, while karyotypes of annuals with a reduced and derived $n = 6$ or $n = 5$ are highly asymmetrical.

Taxa in this complex are annuals with asymmetrical karyotypes which are $n = 7$ and presumably have achieved asymmetry without a reduction in chromosome numbers. Stebbins (1958, 1971) stated that karyotypes of species or taxa of lesser rank (all with the same chromosome number) that differ in size and form of individual

Table 1. Variation in three chromosome pairs within the *Vicia ludoviciana* complex.

Taxon	Pair three	Pair four	Pair six
V. ludoviciana var. *typica*	telocentric	sub-metacentric	telocentric
V. ludoviciana var. *laxiflora*	telocentric	sub-metacentric	sub-metacentric
V. ludoviciana var. *texana*	sub-telocentric	sub-metacentric	telocentric
Race 7 (has no traditional taxon name)	telocentric	sub-telocentric	telocentric
V. leavenworthii var. *typica*	telocentric	sub-telocentric	telocentric
V. leavenworthii var. *occidentalis*	telocentric	sub-telocentric	telocentric
V. exigua var. *exigua*	telocentric	sub-telocentric	sub-metacentric

chromosomes are best explained by an assumption of increasing asymmetry. In a group of taxa undergoing such a process, the most symmetrical karyotypes would be the most primitive, and vice versa.

From Table 1 and Veerasethakul and Lassetter (1981), the karyotype of *Vicia ludoviciana* var. *laxiflora* is the most symmetrical in the complex. The most asymmetrical karyotype is the one common to *V. leavenworthii* var. *typica, V. leavenworthii* var. *occidentalis,* and race 7 of this taxonomic treatment (this race has never received formal recognition and therefore has no traditional taxon name). These three taxa, however, are morphologically dissimilar. A similar situation was reported by Rousi (1961) who found small karyotype differences in different strains of *V. tenuifolia.*

Most attempts at hybridization of *Vicia* taxa have not been successful, and this lack of success has been attributed to karyotype differences. Most workers have been unsuccessful even in crossing different strains of a single species (Sveshnikova, 1927). Plitmann (1967) also stated that most workers have been unsuccessful in crossing different taxa of *Vicia.* Of the crosses evaluated by Plitmann (1967), most involved cultivated species of Eurasian origin, and most were intraspecific crosses between subspecific taxa. Gunn (pers. comm.) even rejected all reputed "successful hybridizations" in the literature and stated that the only successful ones have been between some varieties of "*Cracca*" species, and between *V. sativa* and *V. angustifolia*. These two closely related taxa are highly influenced cultivars and were shown by Sveshnikova (1927) and Hollings and Stace (1974) to have similar karyotypes. They have been considered as a single species by Ball (1968), Gunn (1970, 1979), and others.

Artificial hybridization

Reciprocal intraspecific crosses involving *Vicia ludoviciana* and *V. leavenworthii* were successful and produced fully viable F_2 plants, but those involving *V. exigua* were not successful. Dormancy in *V. exigua* seed is difficult to break. Seeds from crosses involving *V. exigua* were treated with 0.1 M thiourea (Ballard and Buchwald, 1971), which forced radicles to emerge, but no seedlings resulted. The same difficulty existed in germinating field-collected *V. exigua* seeds for cytological work. I believe the lack of F_1 *V. exigua* plants was largely because of faulty germination technique and not to inviability of the hybrid seed.

Reciprocal interspecific crosses were mostly unsuccessful; most seeds were shriveled, and seedlings were abnormal, with weak radicles and kinked, stunted epicotyls. In cross 1 (Table 2), fruits appeared normal but contained only shriveled, inviable seeds. No F_1 plants resulted from cross 1, 3, 4, or 6. One F_1 plant resulted from cross 2. The plant was very slow-growing, small, and stunted. It eventually flowered, and several young fruits were produced, but they quickly withered, and no seeds were set. Pollen from this plant was 51 percent sterile. Cross 5 (Table 2) produced a progeny of four F_1 plants. All were weak and lacked normal vigor. One plant grew for two weeks, became chlorotic, and died. The other three flowered, but produced no fruits or seed. Anthers were minute (ca. 0.15 mm) and did not dehisce. Almost no pollen grains stained with cotton blue in lactophenol, and most were spherical or elliptical as compared with the normal elongate appearance of mature grains. Evidently, the anthers and pollen ceased development before either matured. None of the five F_1 plants, therefore, produced any seed.

Anther squashes of the F_1 plants from cross 2 and cross 5 (Table 2) were not successful, and meiosis was not observed. Removal of

Table 2. Results of interspecific artificial hybridizations within the *Vicia ludoviciana* complex.

Taxa of cross	Number of crosses attempted	Number of crosses producing seed	Number of F_1 plants
1. V. ludoviciana var. *typica* × *V. leavenworthii* var. *typica*	39	18	0
2. *V. ludoviciana* var. *typica* × *V. exigua* var. *exigua*	32	13	1
3. *V. leavenworthii* var. *typica* × *V. exigua* var. *exigua*	28	13	0
4. *V. leavenworthii* var. *occidentalis* × *V. ludoviciana* var. *typica*	3	1	0
5. *V. leavenworthii* var. *occidentalis* × *V. leavenworthii* var. *typica*	8	4	4
6. *V. leavenworthii* var. *occidentalis* × *V. exigua* var. *exigua*	7	3	0

stem tips for fixation of buds adversely affected the plants and they never recovered.

From these data, outcrossing in individual populations seems entirely possible inasmuch as intraspecific crosses were successful. Hybridization between taxa seems much less likely because crosses between different taxa produced few F_1 plants, and they were all abnormal. Even progeny from *V. leavenworthii* var. *occidentalis* × *V. leavenworthii* var. *typica* (cross 5, Table 2) were sterile, indicating that at least some barriers to interbreeding exist between these supposedly closely related taxa.

No apomixis was indicated.

Breeding system

Observations on the breeding system were made from living plants in the field and greenhouse. All taxa are very efficient selfers;

pollen usually is released within the young bud before the flower opens. In wet mounts of styles from young buds, germinating pollen grains were common.

Bagging did not reduce fruit set. When all buds but one were removed from the peduncle and that single flower bagged, fruit set still was successful. Shaking the plant did not alter fruit set; self-fertilization seemed effective almost to the point of cleistogamy.

In all my field work, no pollinators were observed on these vetches. Pollinators were seen in the immediate area, but clearly preferred other flowers. The only record of actual insect manipulation seems to be a herbarium sheet notation by Shinners, "Visited by honeybees" (*Shinners 9793*, ARIZ, SMU).

It seems reasonable to conclude that a small proportion of flowers probably reach anthesis with intact anthers and are at least potential outcrossers. However, because pollinators would be required for successful outcrossing, and pollinators seem infrequent, outcrossing must be rare.

Plitman (1967), in studying 50 annual *Vicia* species of the Middle East, concluded that self-pollination occurs in young buds precisely as just described. He stated that self-pollination, cleistogamy, and cross-pollination may occur in the same species, even the same individual, but suggested no actual method by which cross-pollination might occur in a predominantly self-pollinated taxon.

Allard and Workman (1963) and others have shown that, in populations of many different self-fertilized species, some outcrossing does occur. Allard et al. (1968) reviewed data supporting the hypothesis that most inbreeders contain large stores of genetic variability and that genetic and morphological variation within species and within populations can be considerable.

A different system evidently operates in *Vicia leavenworthii* var. *typica* and other traditional taxa in part (*V. ludoviciana* subsp. *leavenworthii* of the following taxonomic treatment). These populations were the most homogeneous of the complex. These plants have a short style, the anthers at dehiscence are all positioned above the stylar pubescence (Figure 2), and pollen is released directly onto the stigma. In other taxa with longer styles (which represent *V. ludoviciana* subsp. *ludoviciana* of the following taxonomic treatment), anthers at dehiscence are at the level of stylar pubescence (Figure 2), and pollen is released upon the stylar hairs. The stylar hairs are antrorse, and in the confines of the folded keel, pollen is

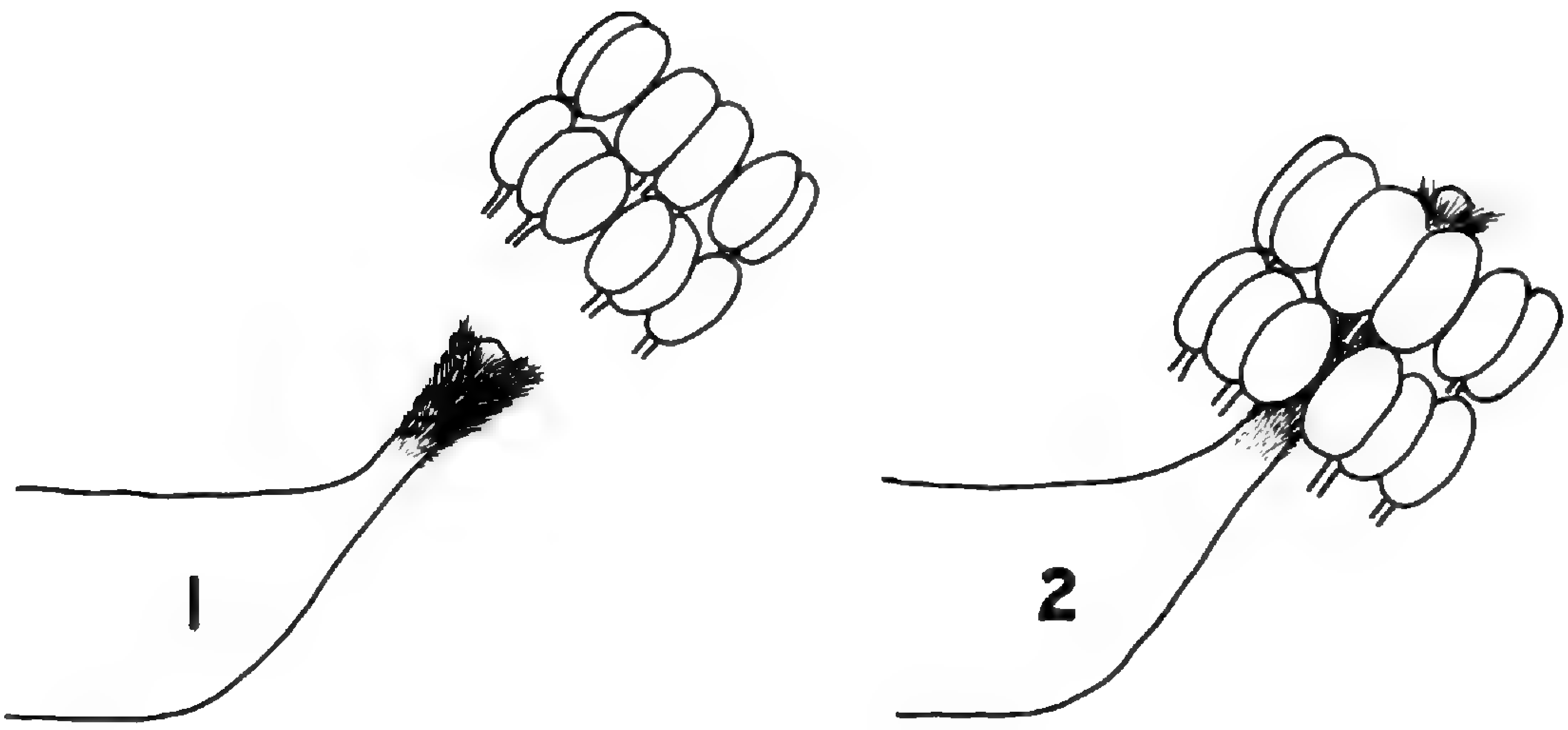


Figure 2. Anther positions of *Vicia*..
1. *V. ludoviciana* subsp. *leavenworthii* (of this taxonomic treatment, races 6 and 7).
2. *V. ludoviciana* subsp. *ludoviciana* (of this taxonomic treatment, races 1–5).

eventually worked apically to the pocket at the keel tip and effectively placed onto the stigma.

Anthers in *Vicia ludoviciana* subsp. *leavenworthii* are shorter (0.30–0.35 mm) than in subsp. *ludoviciana* (0.40–0.55 mm), this condition may reflect a more effective self-pollination system. In subsp. *leavenworthii,* anthers were always observed to dehisce well before flowers opened, and young fruits were most often already developing at anthesis. In addition, flowers open before peduncles and internodes elongate, and the flowers are inconspicuous among the leafy stem tips. Even if some flowers were potential outcrossers, they presumably would be inconspicuous to pollinators.

In *Vicia ludoviciana* subsp. *leavenworthii,* it seems that almost no flowers could be potential outcrossers, thus this taxon must be very highly self-pollinated.

TAXONOMIC TREATMENT

I am interpreting the *Vicia ludoviciana* complex as a single multiracial species because its elements are all confluent. An opposing position might be supported on the basis of karyotype differentiation and infraspecific incompatibility. I believe it better, however, to limit formal names to only two subspecies that can be relatively well defined. Several taxa which have previously been given formal species or varietal rank are recognized informally as geographical races.

The characters listed in the key and descriptions are those that have proved most useful in identification and recognition.

KEY TO SUBSPECIES AND RACES
OF *VICIA LUDOVICIANA*

1. Flowers opening after peduncles and internodes elongate, pinkish-white to deep bluish-purple, young fruit usually not present when flowers first open; styles (0.60) 0.80–1.40 (1.70) mm long; leaflets (5) 7–10 (13) . . . . A: subsp. *ludoviciana* 2
 2. Style length (0.6) 0.8–1.2 (1.3) mm: calyx tube (1.1) 1.4–1.8 (2.2) mm long; stems at midpoint glabrous to pubescent 3
  3. Flowers 1–19, averaging 5–9; fruiting peduncles (0.4) 0.6–0.9 (1.3) mm wide; hilum/circumference ratio in percent (22.5) 29.0–37.4 (42.4); plants of eastern Texas, Louisiana, Arkansas, and southern Mississippi and extreme Southern Alabama . . . . subsp. *ludoviciana* race 1
  3. Flowers 1–10, averaging 1–3; fruiting peduncles (0.2) 0.3–0.6 (0.8) mm wide; hilum/circumference ratio in percent (11.2) 17.4–23.7 (31.8) 4
   4. Flowers usually 3 with one terminal flower and a contiguous pair below; plants of the Gulf Coastal and Rio Grande Plains of Texas . . . . subsp. *ludoviciana* race 2
   4. Flowers 1–3, each flower usually arising at a separate point on the peduncle; plants of California and Baja California . . . . subsp. *ludoviciana* race 3
 2. Style length (0.9) 1.1–1.4 (1.7) mm; calyx tube (1.3) 1.7–2.1 (2.5) mm long; stems at midpoint glabrous to densely pubescent 5
  5. Peduncles 1–5 flowered, (0.9) 8–35 (47) mm long when flowers are open, usually about 1/3 the length of the subtending leaf; hilum/circumference ratio in percent (7.9) 10.4–18.1 (20.7); plants of western Texas, the Oklahoma panhandle, Colorado, Utah, New Mexico, Arizona, extreme southern Nevada, and extreme southeastern California . . . . subsp. *ludoviciana* race 4
  5. Peduncles 1–17 flowered, (15) 21–41 (120) mm long when flowers are open, about as long or longer than the subtending leaf; hilum/circumference ratio in percent (16.7) 18.7–20.9 (24.3); plants of central Texas, southern Oklahoma, and southern New Mexico . . . . . subsp. *ludoviciana* race 5
1. Flowers opening before peduncles and internodes elongate, pinkish-white to light lavender, often containing young fruit when flowers first open; styles (0.40) 0.60–0.80 (0.90) mm long; leaflets (7) 11–15 (17) . . . . B: subsp. *leavenworthii* 6
 6. Flowers 1–6; legumes mostly less than 30 mm long; length of hilum less than the seed diameter; leaflets 2.5–7.0 times as long as wide; plants of central Texas, Oklahoma, extreme northwestern Arkansas, and extreme southwestern Missouri . . . . subsp. *leavenworthii* race 6

6. Flowers 1–2; legumes mostly 30 mm long or longer; length of the hilum greater than the seed diameter; leaflets 2.0–3.0 times as long as wide; plants of Louisiana, Oklahoma (McCurtain Co.), scattered sites in Arkansas, and Mississippi (Claiborne Co. and Sharkey Co.) . . . . subsp. *leavenworthii* race 7

A: **Vicia ludoviciana** Nutt. ex T. & G. subspecies **ludoviciana**

Vicia ludoviciana Nutt. ex T. & G. Fl. N. Amer. 1: 271. 1838. LECTOTYPE NY!: Dr. Leavenworth, Near Nagodoches (sic!) and Natchitoches [Louisiana].
Cracca ludoviciana (Nutt. ex T. & G.) Alefeld. Bonplandia 9: 119. 1861.
Vicia ludoviciana var. *typica* Shinners. Field Lab. 16: 23. 1948.
Vicia caroliniana var. *texana* T. & G. Fl. N. Amer. 1: 271. 1838. LECTOTYPE NY!: Leavenworth, Texas.
Vicia texana (T. & G.) Small Fl. Se. U.S. p. 656 1903.
Vicia ludoviciana var. *texana* (T. & G.) Shinners. Field Lab. 16: 23. 1948.
Vicia thurberi S. Wats. Proc. Am. Acad. Sci. 25: 129. 1890. LECTOTYPE GH!; ISOLECTOTYPES GH!, NY!: *Thurber 299*, Dona Ana [Co., New Mexico]. SYNTYPES GH!: *Thurber 150*. SYNTYPES GH !, US!: *Wright 1350*. SYNTYPE ISC!, NY!: *Parry 33*, 1874, S. Utah.
Vicia producta Rydb. Bull. Torr. Bot. Club 28: 500. 1901. LECTOTYPE NY!, ISOTYPE NY!: *P. A. Rydberg and F. K. Vreeland 6006*, Butte, 5 miles southwest of La Veta, Colorado, May 22, 1900.
Vicia ludoviciana var. *laxiflora* Shinners. Field Lab. 16: 25. 1948. HOLOTYPE SMU!, ISOTYPE MO!: *Eula Whitehouse 15275*, April 13, 1946. About 3 miles north of Bridgeport on Highway 24, Wise County, Texas.
Vicia leavenworthii var. *occidentalis* Shinners. Field Lab. 16: 22. 1948. HOLOTYPE SMU! ISOTYPE MO! NY!: *C. H. Muller*, Chisos Mts., Boot Spring. July 29, 1932.
Vicia exigua Nutt. ex T. & G. Fl. N. AM. 1: 272. 1838. HOLOTYPE BM (photograph!). ISOTYPE PH!: *Nuttall*, Columbia Plains (see discussion below).
Cracca exigua (Nutt. ex T. & G.) Alefeld, Bonplandia 9: 119. 1861.

DESCRIPTION. Plants diminutive to robust, 0.8–20.0 dm tall, glabrous to pubescent, erect to sprawling, or climbing if support is available. Leaflets (5) 7–10 (13), (6) 10 19 (37) mm long, (0.9) 1.6–3.8 (11) mm wide, the length-width ratio (2.0) 3.7–8.7 (16.4), the apex acute to emarginate. Flowers opening after peduncles and internodes elongate, the flowering peduncles (0.9) 6–30 (101) mm long, as long as to shorter than the subtending leaf, the subtending leaf (10) 24–46 (75) mm long. Fruiting peduncles (1.1) 21.7–59.7 (150) mm long, from shorter than to equaling and longer than the subtending leaf, the subtending leaf (18) 31–60 (96) mm long. Flowers 1–19, the standard varying from short, stubby and not showy to long, broad and showy, the height of the reflexed standard (0.64) 0.94–1.40 (1.65) times the flower length from the calyx base to the tip of wings, length of flower from calyx base to tip of unreflexed standard (3.5) 5.1–6.9 (9.5) mm. Upper calyx teeth (0.4) 0.7–1.2 (2.6) mm long, usually shorter than the lower tooth, the lower tooth (0.6) 1.1–1.7 (3.0) mm long and usually shorter than the calyx tube, the tube (1.1) 1.6–2.0 (2.5) mm long. Styles (0.60) 0.83–1.23 (1.70) mm long, the apical (0.30) 0.52–0.74 (1.10) mm pubescent. Mature legume (2.0) 17.8–23.2 (32) mm long. Ovules up to 8, seeds 3–9, the hilum-circumference ratio in percent (8) 18–33 (42).

NOMENCLATURAL HISTORY AND DISCUSSION OF TYPE SPECIMENS. *Vicia ludoviciana* was based on collections by Leavenworth and Tainturier. The Leavenworth collection contains two specimens, both of which are traditional *V. ludoviciana* (*V. ludoviciana* subsp. *ludoviciana* race 1 of this treatment). I follow Shinners (1948) in considering this collection as the type. The Tainturier (PH!) gathering consists of four stems on a sheet also containing an unrelated California collection by Gibbons. This collection is *V. ludoviciana* subsp. *leavenworthii*, cannot be considered a type for subspecies *ludoviciana*, and is discussed under subspecies *leavenworthii*.

Vicia thurberi was based on four different gatherings. Twelve of these specimens were seen, and all are *V. thurberi*. However, all the duplicates of each gathering do not match exactly in label information or collection sites and probably represent plants from different locations. I have chosen one specimen of *Thurber 299* at GH as the lectotype of *V. thurberi* because it is typical, contains both flowers and fruits, and the collection is distributed in two major herbaria. Other types are indicated in the synonomy.

Only a photograph of the holotype of *Vicia exigua* was available for this study. Howell, in preparation of the first edition of his Marin Flora (1949) saw the holotype and affixed the following note:

> From the type description of *Vicia exigua* Nutt. (T. & G., Fl. N. A. 1: 272) it is obvious Nuttall saw plants from California as well as from the Columbia. I believe that the two speciens on this sheet are from these two regions and that the California label has been lost. From the type description it is easy to determine that the lefthand specimen is the one from "the Oregon", the one on the right from "Upper California". 8/26/35.
> John Thomas Howell.

Lassetter (1975), with only a photograph of the BM sheet available, designated the righthand specimen as the lectotype. Since that time C. R. Gunn has examined the sheet, and after a personal conversation with him, I consider both specimens on the sheet to be *Vicia exigua;* now the entire sheet may be considered holotype material.

The remaining names reduced to synonomy under *Vicia ludoviciana* subsp. *ludoviciana* were each based on only one element, and no problems with interpretation of type specimens were encountered.

The three earliest specific epithets of the complex all date from 1838. *Vicia ludoviciana* was chosen for the species name because it has been associated with the plants of the widest geographical distribution. Also, little conceptual confusion should result by choosing *V. ludoviciana* because the typical subspecies will retain the epithet *ludoviciana,* and the kinds of plants traditionally associated with this name will not be altered.

Subsp. **ludoviciana** race 1

DESCRIPTION. Plants diminutive to robust, 1.0–20.0 dm tall, glabrous to puberulent, erect to sprawling, climbing if support is available. Leaflets (5) 8–11 (13), (6) 12–16 (25) mm long, (1.2) 2.5–4.7 (11) mm wide, the length/width ratio (2.0) 2.8–4.6 (8.5), the apex acute to truncate or emarginate. Flowering peduncles (6.0) 16.0–44.0 (101.0) mm long, usually about as long as or longer than the subtending leaf, the subtending leaf (15) 24 50 (75) mm long. Fruiting peduncles (9) 26–65 (112) mm long, usually about as long as or longer than the subtending leaf, the subtending leaf (18) 45–69 (97) mm long. Flowers 1–19, averaging 4–9, the flowers solitary or in pairs at points on the peduncle, deep blue or bluish purple, the standard broad and showy, the height of the reflexed standard (0.81) 0.94–1.12 (1.22) times the length of the flower from calyx base to tip of wings, the length of flowers from calyx base to tip of unreflexed standard (4.2) 5.0 6.5 (8.2) mm. Upper calyx teeth (0.5) 0.8–1.2 (1.5) mm long, usually shorter, but varying to as long as the lower tooth, the lower tooth (0.7) 1.2–1.8 (2.7) mm long, about as long as the calyx tube, the tube (1.1) 1.4–1.7 (2.1) mm long. Styles (0.70) 1.00–1.20 (1.30) mm long, the apical (0.30) 0.60–0.80 (1.00) mm pubescent. Mature legumes (16) 18–24 (28) mm long. Ovules up to 8. Seeds 4–8, usually about 5, the hilum/circumference ratio in percent (23) 29–38 (42).

RANGE AND HABITAT. Eastern Texas, Arkansas, Louisiana, extreme southern Mississippi and Alabama. (Figure 3).

Dense woods and open woodland; thickets; grasslands and pastures; floodplains and low areas; railroad and highway rights-of-way; fence rows and field edges; weedy areas; shell ridges; wasteland; lawns and vacant lots.

Mostly in sandy soil, but also in loams, limestone, silty clay, clay.

PHENOLOGY. Flowering in (early February) March–early May (early July), fruiting in (late March) April–May (July).

DISCUSSION. Taxa which compose race 1 are *Vicia ludoviciana* var. *ludoviciana* sensu Hermann (1960) in part, and sensu Turner (1959) in part, and *V. ludoviciana* var. *typica* sensu Shinners (1948) in part.

Race 1 plants from Texas are typically many-flowered (averaging 7 or more) and usually have 10 or fewer lanceolate to elliptic or oblong leaflets. This race has the middle-sized flowers of the complex, with other races averaging shorter or longer. Race 1 plants in Louisiana and eastward usually are more robust, typically fewer-flowered (averaging 6 or less), the flowers usually are short and stubby, and leaflets are mostly 10 or more and oblong to ovate.

The range of race 1 is essentially the eastern portion of the range of the entire complex; this race extends west only as far as eastern Texas (Figure 3). The southwestern limit of distribution of this phase corresponds closely with the northeastern edge of the Rio Grande Plain.

Race 1 is sympatric in part with races 5, 2, 6, and 7, and intergrades with all but race 6. In the western portion of its range, race 1 tends to have longer upper calyx teeth and a slightly higher flower-length/standard-height ratio and resembles race 5. In the southern and southeastern portion of its range, flowers are smaller and fewer, and plants intergrade with race 2. The lush fewer-flowered race 1 plants of Louisiana and eastward resemble race 7.

Subsp. **ludoviciana** race 2

DESCRIPTION. Plants diminutive to robust, 2.1–19.0 dm tall, often spindly, glabrous to puberulent, erect to sprawling, climbing if support is available. Leaflets (7) 8–10 (13), (9) 13–21 (36) mm long, (1.3) 2.2–4.1 (6.4) mm wide, the length/width ratio (2.4)

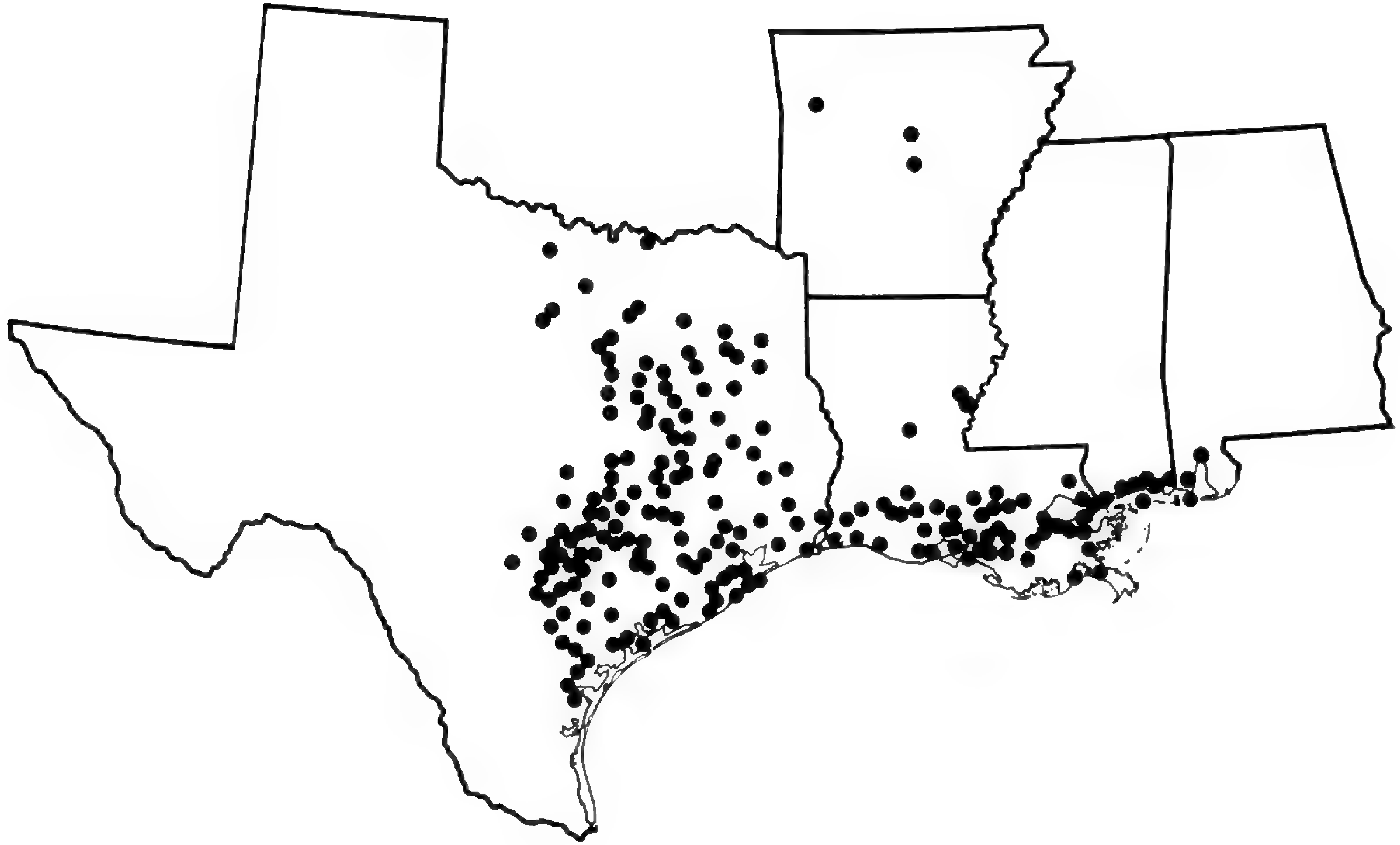


Figure 3. Distribution of *Vicia ludoviciana* subsp. *ludoviciana*, race 1.

3.8–7.6 (14.6), the apex acute to emarginate. Flowering peduncles (3.5) 11.0–29.0 (63.0) mm long, usually about 1/2 as long as to as long as the subtending leaf, the subtending leaf (12) 25–48 (64) mm long. Fruiting peduncles (4) 27–61 (106) mm long, about as long or longer than the subtending leaf, the subtending leaf (20) 31–53 (72) mm long. Flowers 1–10, usually 6 or less, often 2 with both flowers arising from the same point, and often 3 with 1 upper flower and 2 arising from a single point below, or flowers occurring singly at points on the peduncle, bluish to deep bluish-purple, the standard somewhat broad and showy, the height of the reflexed standard (1.00) 1.10–1.30 (1.39) times the flower length from the calyx base to tip of wings, the length of flowers from calyx base to tip of unreflexed standard (3.5) 4.5–5.8 (6.8) mm. Upper calyx teeth (0.4) 0.6–1.0 (1.5) mm long, usually shorter than the lower tooth, the lower tooth (0.6) 1.1–1.6 (2.1) mm long, usually shorter than the calyx tube, the tube (1.1) 1.4–1.8 (2.1) mm long. Styles (0.60) 0.80–1.10 (1.30) mm long, the apical (0.30) 0.45–0.65 (0.80) mm pubescent. Mature legumes (13) 16–22 (27) mm long. Ovules up to 8. Seeds 4–7, usually 6, but often fewer, the hilum/circumference ratio in percent (15) 18–24 (32).

Range and habitat. The Rio Grande Plain and Gulf Coastal Plain of southern Texas (Figure 4).

Open woodland; riverbanks and creek beds; mudflats; prairies and fields; the Gulf shore; roadsides; wasteland; ditches.

In sand, sandy silt, sandy loam, sandy clay, calcareous clay, clay, silt, over limestone, rocky soil.

Phenology. Flowering in (late February) March–April (early May), fruiting in (late March) April–May.

Discussion. Plants which are the most well-known members of race 2 are *Vicia ludoviciana* var. *texana* (Shinners, 1948; Hermann, 1960), but *V. leavenworthii* var. *occidentalis* sensu Turner (1959) in part is also included.

Typical three-flowered race 2 plants have one upper flower and two flowers arising from a common point below. On two-flowered peduncles, flowers may arise from the same point or from separate points. The stubby flowers, along with those of race 3, are the shortest of the complex.

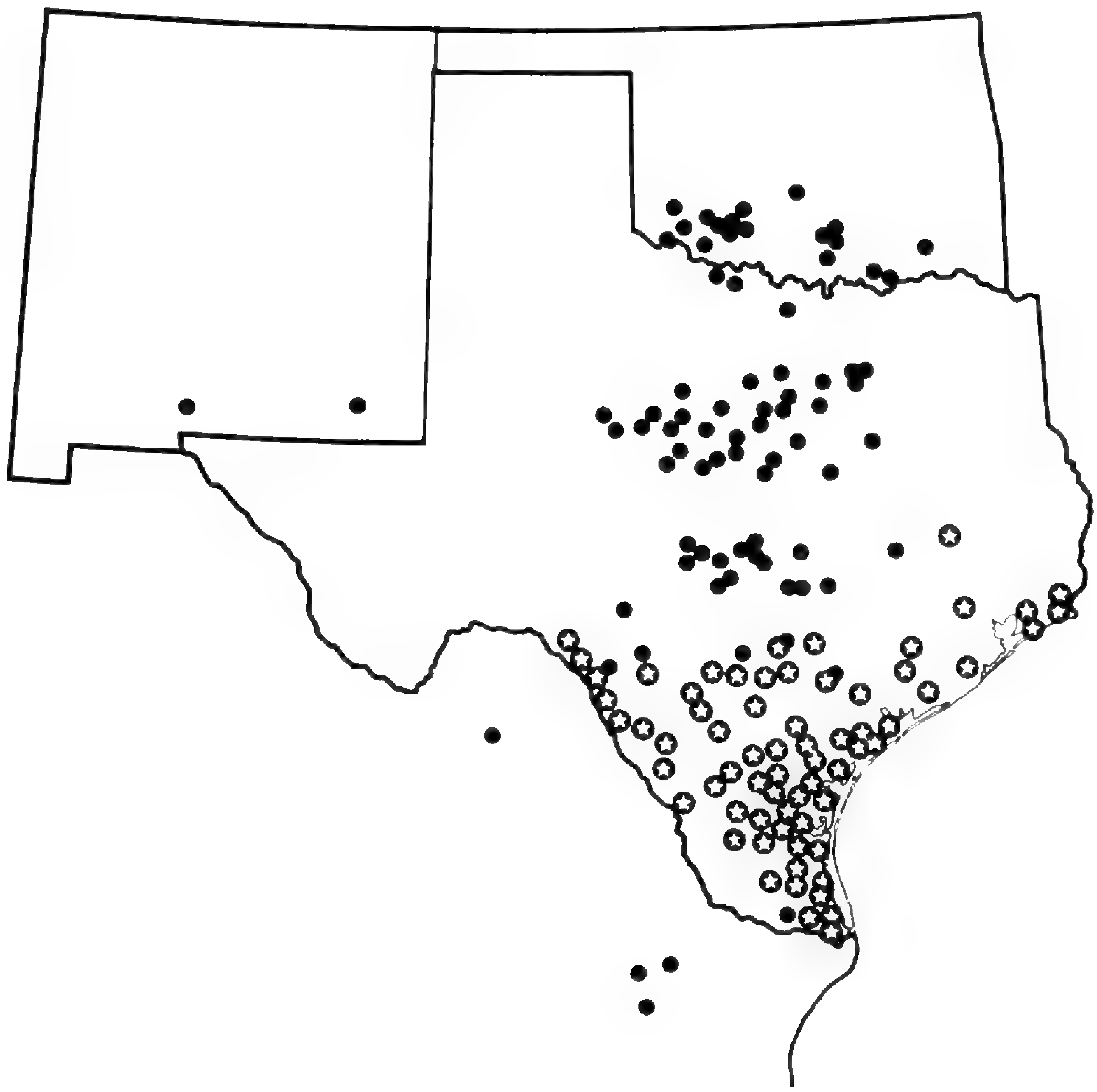


Figure 4. Distribution of *Vicia ludoviciana* subsp. *ludoviciana*, races 2 and 5. Stars = race 2, circles = race 5.

In southern Texas, the distributions of races 2, 4, 1, 5 and 6 overlap, and intergradation with race 2 occurs. As one progresses west up the Rio Grande Valley, race 2 steadily grades into race 4. Along the Gulf Coast, race 2 and 1 resemble each other. Race 2 also blends with race 6 in the Gulf Coast region. Although usually distinct from each other, race 2 (Figure 4) intergrades with the most southern race 5 forms.

Correll and Johnston (1970) stated that *Vicia ludoviciana* var. *texana* (my race 2) was particularly perplexing taxonomically. The distribution of race 2 in Texas is rather limited and, within much of that range, commonly overlaps and intergrades with other races.

Consequently, areas of intermediate race 2 probably outnumber areas of typical race 2. Typical race 2 populations are best found to the exclusion of intergrading forms in Kenedy, Willacy, and Cameron Counties.

Subsp. **ludoviciana** race 3

DESCRIPTION. Plants diminutive to robust, 1.6–11.0 dm tall, glabrous to pubescent, erect to sprawling, climbing if support is available. Leaflets (4) 6–9 (12), (9) 14–25 (37) mm long, (0.9) 1.6–3.4 (6.3) mm wide, the length/width ratio (3.6) 5.8–11.2 (16.4), the apex acute to truncate. Flowering peduncles (3.0) 10.0–32.0 (66.0) mm long, usually about 1/2 as long, but varying to as long as or much shorter than the length of the subtending leaf, the subtending leaf (18) 27–47 (65) mm long. Fruiting peduncles (3) 33–50 (71) mm long, from much shorter to as long as or longer than the subtending leaf, the subtending leaf (22) 32–57 (75) mm long. Flowers 1–3, rarely 4, occurring singly at points on the peduncles, or 2 flowers sometimes arising from the same point; bluish. The standard somewhat broad and showy, the height of the reflexed standard (0.91) 1.12–1.38 (1.47) times the flower length from the calyx base to tip of wings, the length of flowers from calyx base to tip of unreflexed standard (4.3) 4.4–6.5 (7.5) mm. Upper calyx teeth (0.6) 0.7–1.1 (1.4) mm long, usually slightly shorter than the lower tooth, the lower tooth (0.9) 1.1–1.5 (1.7) mm long, usually shorter than the calyx tube, the tube (1.3) 1.6–2.0 (2.2) mm long. Styles (0.70) 0.85–1.10 (1.20) mm long, the apical (0.30) 0.45–0.65 (0.70) mm pubescent. Mature legumes (15) 18–24 (26) mm long. Ovules up to 7. Seeds 3–7, usually 5 or 6, the hilum/circumference ratio in percent (11) 17–22 (27).

RANGE AND HABITAT. Southern California and Baja California, one distant collection from northern California seen (Figure 5).

Wooded areas; moist slopes, ravines, and canyons; foothills; along creeks; chapparal; beaches; dry wasteland.

Sand, rocky soil.

PHENOLOGY. Flowering in (February–March) April–May, fruiting in (February) April–May (June).

DISCUSSION. Race 3 is almost identical morphologically with race 2. However, geographical separation between the two races is

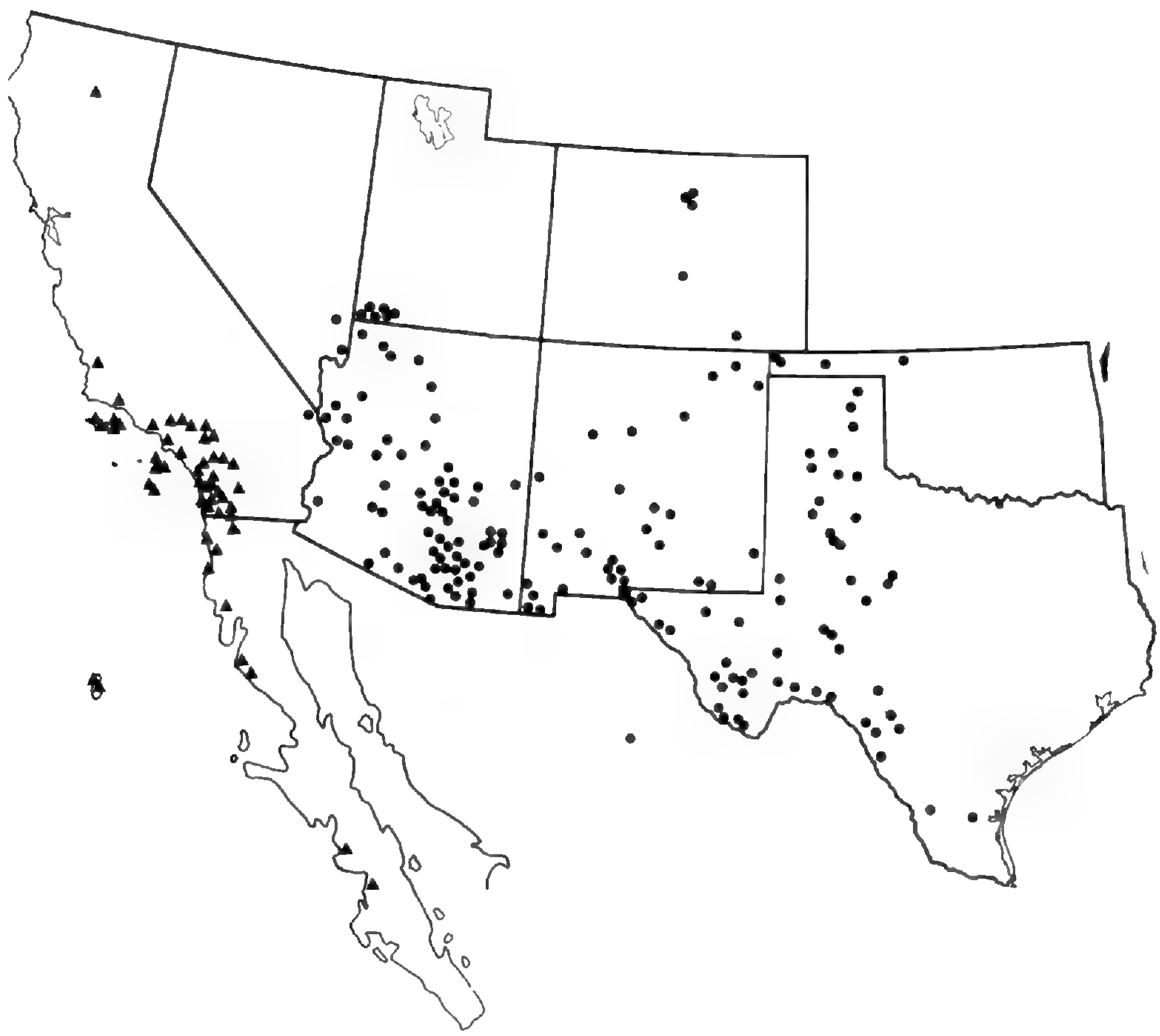


Figure 5. Distribution of *Vicia ludoviciana* subsp. *ludoviciana*, races 3 and 4. Triangles = race 3, circles = race 4.

great (Figures 4 and 5) and climatic conditions differ markedly between these two geographical areas. For these reasons, the two races are recognized separately.

Race 3 plants are west coast populations of The United States and Baja California and traditionally have been known as *Vicia exigua* var. *exigua* in part (see Lassetter, 1975) of various western authors, and *V. exigua* var. *exigua* sensu Hermann (1960) in part.

Typical race 3 plants have 1–3 flowers usually arising at separate points on the peduncle, but contiguous flowers are often found.

Race 3 is almost completely absent north of the Santa Barbara area (Figure 5), but is sympatric with *Vicia hassei* (Lassetter, 1975) in southern California. No intergradation between the two occurs. Race 3 and race 4 intergrade in the western portion of the range of the latter.

Subsp. **ludoviciana** race 4

Description. Plants diminutive to robust, 0.8–12.0 dm tall, glabrous to pubescent, erect to sprawling, climbing if support is available. Leaflets (5) 7–9 (11), (7) 10–17 (39) mm long, (1.0) 1.4–2.2 (4.2) mm wide, the length/width ratio (3.4) 5.9–9.7 (16), rarely up to 28 times as long as wide, the apex acute to truncate. Flowering peduncles usually short, (0.9) 4.0–11.0 (47.0) mm long, usually about 1/3 the length of the subtending leaf, the subtending leaf (10) 23–41 (60) mm long. Fruiting peduncles (1) 8–36 (47) mm long, about 1/2 or less the length of the subtending leaf, the subtending leaf (22) 28–67 (71) mm long. Flowers 1–5, averaging 1–3, usually only one flower occurring at any one point on the peduncle, pinkish-white to light lavender or bluish, the keel sometimes with a blue spot at apex, the standard not broad or showy, the height of the reflexed standard (.62) .67–.78 (1.02) times the flower length from calyx base to tip of wings, the flower length from calyx base to tip of unreflexed standard (4.8) 6.1–7.4 (8.4) mm. Upper calyx teeth (0.5) 0.7–1.0 (1.7) mm long, about subequal with the lower tooth, the lower tooth (0.9) 1.3–1.9 (2.2) mm long, slightly shorter than the calyx tube, the tube (1.4) 1.8–2.1 (2.4) mm long. Styles (0.90) 1.05–1.30 (1.70) mm long, the apical (0.40) 0.50–0.75 (0.85) mm pubescent. Mature legumes (20) 21–24 (26) mm long. Ovules up to 8 (rarely 9). Seeds 5–9, usually 7, the hilum/circumference ratio in percent (8) 11–18 (21).

Range and habitat. Western Texas and the Oklahoma panhandle, west and north to Colorado, Utah, New Mexico, Arizona, extreme southeastern Nevada, and extreme southeastern California (Figure 5).

Woodlands; rocky slopes and hillsides; canyons and dry washes; stream and creek beds; plains and grasslands; desert chaparral; roadsides; waste areas; fence rows; lawns; ditches.

In sand, limestone, gravel, calcareous clay loam, sandy loam, sandstone rubble, lava rock seams.

Phenology. Flowering in (late February) March–April (early May), fruiting in (late March) May–June (early August).

Discussion. Race 4 encompasses phenotypes which are best known traditionally as *Vicia producta*. Other taxa which are also included in race 4 are *V. thurberi* Watson, *V. exigua* var. *exigua* sensu Hermann (1960) in part, *V. leavenworthii* var. *occidentalis* sensu Shinners (1948), and *V. leavenworthii* var. *occidentalis* sensu Turner (1959) in part.

Typical plants have one to four flowers on peduncles which are rather short at fruiting. Individuals with short peduncles are typical in xeric microhabitats. More robust individuals with longer peduncles can be found throughout the range (Figure 5). Flowers usually occur singly at points on the peduncle, and the flower-length/standard-height ratios are rather low.

Race 4 is fairly well separated from other races throughout most of its range, but in southwestern Texas is sympatric with and intergrades into races 2, 5, and 6. Race 4 plants with long peduncles appear in the Chisos Mountains and continue southeast down the Rio Grande Valley where flowers progressively become contiguous; race 4 there intergrades into race 2. Going northeast from the Chisos and Davis Mountains, standards of race 4 become more showy and flowers more numerous as intergradation into race 5 occurs. A similar transition occurs in western Oklahoma. Some race 4 specimens blend into and closely resemble five- or six-flowered race 6 plants. Kinney County, Texas is an area where a great diversity of all these types of intergrading forms can be observed.

At the western edge of its range, race 4 intergrades with race 3. Calyx tube length of the two is about the same, and flowers are usually one or two per peduncle, but three-flowered plants in both races are not uncommon.

Subsp. **ludoviciana** race 5

Description. Plants diminutive to robust, 1.2–8.3 dm tall, glabrous to pubescent, erect to sprawling, climbing if support is available. Leaflets (6) 7–10 (13), (6) 9–17 (26) mm long, (0.9) 1.6–3.8 (8.0) mm wide, the length/width ratio (2.2) 4.5–7.5 (10.0), the apex acute to truncate or emarginate. Flowering peduncles (2.5) 30.0–60.0 (91.0) mm long, usually about as long as or longer than the subtending leaf, the subtending leaf (12) 28–62 (94) mm long. Fruiting peduncles (15) 34–96 (150) mm long, about as long or longer than the subtending leaf, the subtending leaf (21) 35–65 (82) mm long. Flowers 1–17, averaging 5–15, solitary or in pairs at points on the peduncle, mostly separated from each other when fruit is present, pinkish-white to deep lavender-purplish, occasionally white, the keel often with a blue spot at the apex, the standard broad and showy, the height of the reflexed standard (0.65) 0.69–1.06 (1.45) times the length of the flower from calyx base to tip of wings, the length of flowers from the calyx base to tip of unreflexed standard (5.3) 6.0–7.3 (9.5) mm. Upper calyx teeth (0.7) 1.1–1.6 (2.6) mm long, slightly shorter than the lower tooth, the lower tooth (1.2) 1.5–2.1 (3.0) mm long, about as long as to longer than the calyx tube, the tube (1.3) 1.6–2.0 (2.5) mm long. Styles (1.0) 1.2–1.4 (1.6) mm long, the apical (0.55) 0.60–0.80 (1.10) mm pubescent. Mature legumes (19) 20–25 (30) mm long. Ovules up to 8. Seeds 5–7, usually 6, hilum/circumference ratio in percent (14) 19–23 (29).

RANGE AND HABITAT. Central Texas and southern Oklahoma, plus two distant collections from southern New Mexico (Figure 4).

Open woods; river bottoms; rock seams and rocky slopes; prairies; railroad and highway rights-of-way; waste areas; lawns and vacant lots.

In granitic and limestone soils, serpentine and travertine, sand, sandy loam,silty clay, rocky limestone soil, fine gravel.

PHENOLOGY. Flowering in (late February) March–April (early May), fruiting in April–May.

DISCUSSION. Typical members of race 5 are characterized by large, showy standards and flower-length/standard-height ratios of (0.65) 0.69–1.06 (1.49), and are typified by *Vicia ludoviciana* var. *laxiflora* sensu Shinners (1948), Turner (1959), and Hermann (1960). Calyx teeth are typically relatively long and nearly subequal. The largest and showiest flowers of the entire complex are found in race 5 individuals from Llano County and a few other scattered locations in Texas, and from the mountainous areas of Oklahoma. Race 4 flowers are about the same length, but the standard is not as high as race 5, and therefore not as showy.

The major distribution of this race (Figure 4) appears to be three discrete areas with two distinct gaps in Texas. Although it is possible that the gaps reflect an artifact of incomplete collecting, I feel this explanation is not very probable since central Texas is a rather well-collected area. I have not been able to correlate the breaks in the distribution with geographical regions or with vegetation areas.

This race overlaps in range with and intergrades into races 1, 4, 6, and 2. In the eastern part of its range, race 5 intergrades into race 1, and in the western and southwestern part, a change to race 4 occurs. Few-flowered forms in central Texas often resemble race 6, and in southern Texas, few-flowered forms grade into race 2 and race 2–4 intermediates.

B. **Vicia ludoviciana** Nutt. ex T. & G. subspecies **leavenworthii** (T. & G.) Lassetter & Gunn (as stat. nov. in USDA Tech. Bull. No. 1601: 16. 1979.)

Vicia leavenworthii T.& G. Fl. N. Amer. 1: 271. 1838. HOLOTYPE NY!: Dr. Leavenworth. Arkansas.

Vicia leavenworthii var. *typica* Shinners. Field and Lab. 16: 22. 1948.

Cracca erotanthos Alefeld. Bonplandia 9: 118. 1861.

DESCRIPTION. Plants diminutive to robust, 1.0–12.0 dm or more tall, glabrous to pubescent, erect to sprawling, or climbing if support is available. Leaflets (7) 11–14 (17), (5) 10–23 (25) mm long, (1.2) 2.2–9.4 (11.0) mm wide, the length/width ratio (2.1) 2.2–5.0 (6.9), the apex acute to emarginate. Flowers opening before peduncles and internodes elongate, the flowering peduncles (0.8) 3.0–11.0 (28.0) mm long, usually much shorter than the subtending leaf, the subtending leaf (9) 20–65 (69) mm long. Fruiting peduncles (12) 26–70 (91) mm long, usually shorter than the subtending leaf, the subtending leaf (19) 30–92 (105) mm long. Flowers 1–6, pinkish white to light lavender, the standard not broad or showy, the height of the reflexed standard (0.57) 0.63–0.78 (1.04) times the flower length from calyx base to the tip of wings,length of flower from calyx base to tip of unreflexed standard (4.5) 5.1–6.8 (7.5) mm. Upper calyx teeth (0.5) 1.1–1.6 (2.0) mm long, shorter than to almost as long as the lowest tooth, the lowest tooth (1.0) 1.4–2.0 (2.2) mm long, and about as long as the calyx tube, the tube (1.3) 1.6–1.9 (2.2) mm long. Styles (0.40) 0.65–0.80 (0.90) mm long, the apical (0.20) 0.30–0.40 (50.0) mm pubescent. Mature legumes (18) 21–33 (35) mm long. Ovules up to 8, seeds 4–8, the hilum/circumference ratio in percent (15) 18–49 (55).

NOMENCLATURAL HISTORY AND DISCUSSION OF TYPE SPECIMENS. The holotype of *Vicia leavenworthii* is good, typical and traditional *V. leavenworthii,* and is a good example of race 6.

There is little doubt that *Cracca erotanthos* of Alefeld (1861) is the same as race 7 of this study. Alefeld stated that he obtained specimens from a Dr. Hexamer in New York and that Hale had collected the plant in Louisiana. There is an 1840 collection by Hale at NY. This sheet bears no locality designation but is race 7, which is centered in Louisiana. While it is possible (or probable) this represents the gathering seen by Alefeld, evidence and necessity scarcely warrant designating it a lectotype.

Alefeld specifically mentioned the fact that *Cracca erotanthos* does not fit the description of *Vicia ludoviciana* (Nutt. ex T. & G., 1838), and that it should not be confused with *V. ludoviciana*, as *Cracca erotanthos* possesses a long hilum. The hilum/circumference ratio of race 7 is by far the largest of the complex (Lassetter, 1978a).

The specimen at PH gathered by Tainturier from Louisiana, which was mentioned earlier, has been considered a type of *Vicia ludoviciana*. This is race 7 of this study [*V. ludoviciana* Nutt. ex T. & G. subsp. *leavenworthii* (T. & G.) Lassetter and Gunn], and should not be thought to be representative of the typical subspecies. It is typical race 7 of subsp. *leavenworthii*.

Subsp. **leavenworthii** race 6

DESCRIPTION. Plants diminutive to robust, 1.0–10.0 dm tall. Leaflets (7) 11–14 (17), (5) 10 15 (20) mm long, (1.2) 2.2–4.1 (6.3) mm wide, the length/width ratio (2.5) 3.4–5.0 (6.9), the apex acute to retuse. Flowering peduncles (0.8) 3.0–11.0 (28.0) mm long, usually much shorter than the subtending leaf, the subtending leaf, (9) 20–41 (57) mm long. Fruiting peduncles (12) 26–56 (91) mm long, slightly shorter than to longer than the subtending leaf, the subtending leaf (19) 30–50 (63) mm long. Flowers 1–6, averaging 2–4, most often one upper flower and 2 or 3 flowers arising from a common point below, or when 2 flowered, the 2 flowers arising from the same point. Upper calyx teeth (0.5) 1.1–1.6 (2.0) mm long, almost as long as the lower tooth, the lower tooth (1.0) 1.4–1.8 (2.1) mm long, about as long as the calyx tube. Mature legumes (18) 21–24 (29) mm long, the seed hilum/circumference ratio in percent (15) 18–22 (27).

RANGE AND HABITAT. Central Texas, Oklahoma, extreme northwestern Arkansas, extreme southwestern Missouri. (Figure 6)

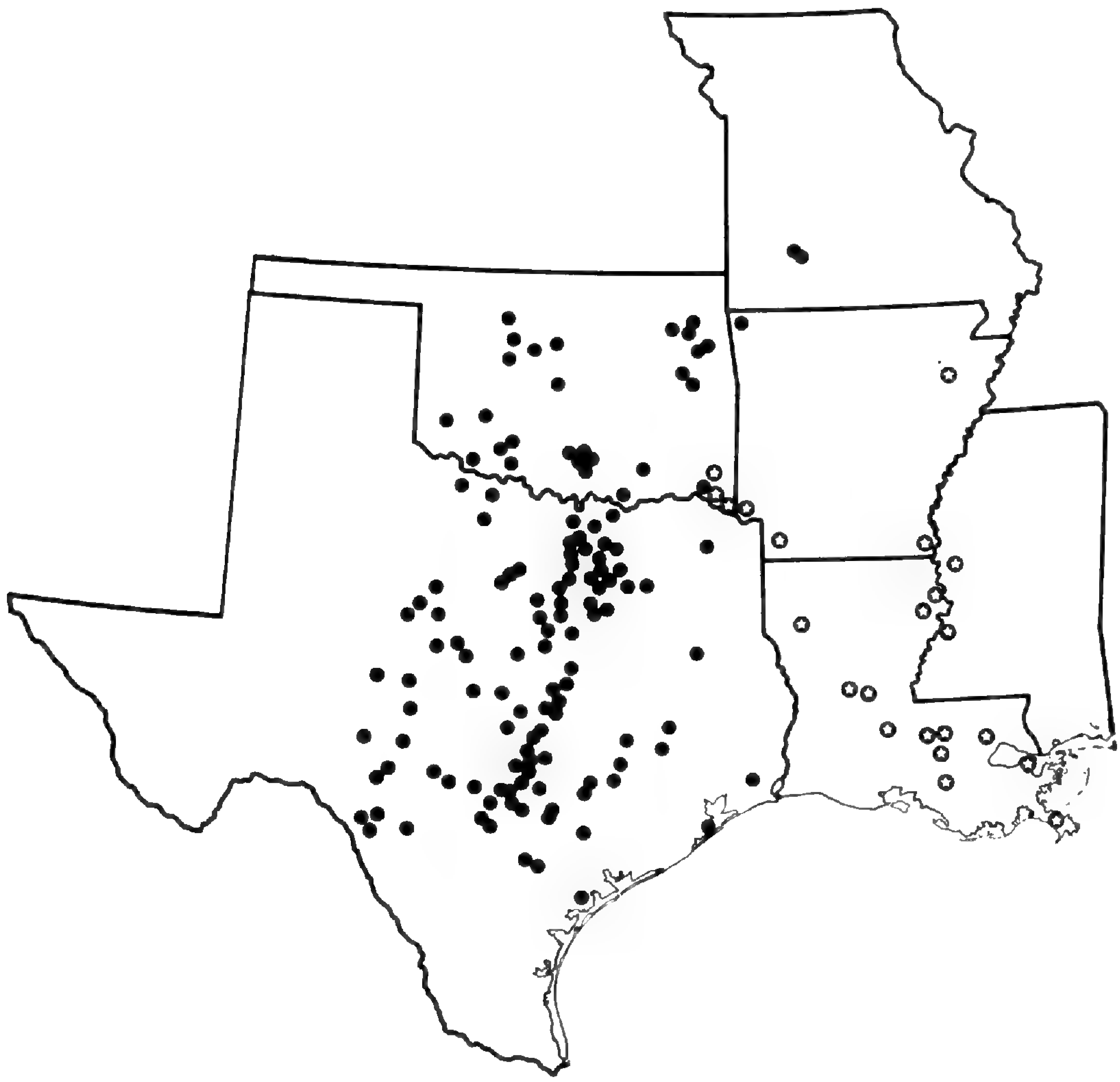


Figure 6. Distribution of *Vicia ludoviciana* subsp. *leavenworthii*, races 6 and 7. Circles = race 6, stars = race 7.

Open woods; wooded hills; limestone hills; cedar brakes; pastures; creek banks, river banks, stream beds, and flood plains; prairies; railroad and highway rights-of-way; waste ground; vacant lots and lawns.

PHENOLOGY. Flowering in April–early May, fruiting in April–May.

DISCUSSION. Excluding race 7, this race is the easiest to recognize, in spite of intergradation with several others. Typical race 6 usually has three or four pale flowers (one upper flower and two or three flowers from a common point below), very short styles, and numerous leaflets. Traditional taxa included in race 6 are *Vicia* *leavenworthii* var. *typica* (Shinners, 1948), *V. leavenworthii* var. *leavenworthii* (Turner, 1959), and *V. leavenworthii* (Hermann, 1960).

Race 6 is centered in Texas in the Blackland Prairie (Figure 6) as previous authors have stated. It also occurs on the Edwards Plateau, but is absent from an area known as the Central Basin or Central Texas Granite. Race 5, however, is prevalent on these soils which are derived from granitic parent material. Race 6 plants are most often found on clay loam soils with moderate amounts of calcium (Lassetter, 1978b).

Race 6 blends into race 2 on the Gulf Coast, into race 4 in western and southwestern Texas, and into race 5 in central Texas. It shares many characteristics with race 7, but because the two are sympatric only in McCurtain Co., Oklahoma, confusion should be minimal.

Subsp. **leavenworthii** race 7

DESCRIPTION. Plants usually robust, 3.0–12.0 dm or more tall. Leaflets (10) 11–13 (14), (13) 15–23 (25) mm long, (4.5) 5.8–9.4 (11.0) mm wide, the length/width ratio (2.1) 2.2–2.8 (3.1), the apex acute to emarginate, usually rounded or retuse. Flowering peduncles (3.0) 3.0–9.0 (12.0) mm long, much shorter than the subtending leaf, the subtending leaf (20) 23–65 (69) mm long. Fruiting peduncles (28) 30–70 (85) mm long, usually shorter than the subtending leaf, the subtending leaf (63) 63–92 (105) mm long. Flowers 1–2, from the same point or separate points on the peduncle. Upper calyx teeth (1.1) 1.2–1.4 (1.7) mm long, shorter than the lower tooth, the lower tooth (1.5) 1.8–2.0 (2.2) mm long, about as long as the calyx tube. Mature legumes (29) 29–33 (35) mm long, seed hilum/circumference ratio in percent (37) 41–49 (55).

RANGE AND HABITAT. Louisiana, McCurtain County, Oklahoma, scattered sites in Arkansas and Mississippi (Figure 6).

Deciduous woods and bottomland forests; along wooded streams; prairies and glades; fields; roadsides; levee banks.

Mostly in heavy (clay) soils, but also in sandy soils.

PHENOLOGY. Flowering in (late February) March–April (late May), fruiting in late March–May.

DISCUSSION. Race 7 is the most distinctive. Most plants are very robust, have large ovate leaflets, only one or two flowers per peduncle, large legumes, and the greatest hilum/circumference percentage. Plants included in race 7 have traditionally been recognized as *Vicia ludoviciana,* not *V. leavenworthii.* This race includes *V. ludoviciana* var. *typica* (Shinners, 1948, in part), and *V. ludoviciana* var. *ludoviciana* (Turner, 1959; Hermann, 1960) in part.

The distribution appears to be very limited (Figure 6); however, more complete collecting in the northern Louisiana area would be desirable in establishing the distribution more precisely. One 19th century collection from Florida (no specific location) was seen, but no recent material from that state was obtained.

Hermann's (1960) distribution map of *Vicia ludoviciana* var. *ludoviciana* contains a dot in east-central Mississippi. I presume this is based on *S. M. Tracy 1627,* Starkville, Mississippi (MISSA, US). Labels of several duplicates of this collection are marked "cultivated", and one sheet, US #67561, bears the caption "Native of Louisiana". This collection is race 7, and represents an introduction outside its natural range.

The other Mississippi sites are thought to be natural sites.

The few-flowered, robust forms of race 1 found in Louisiana and Mississippi resemble race 7, but no major problem should exist in distinguishing between the two. The relationship with race 6 is previously mentioned, and both races 6 and 7 (subsp. *leavenworthii*) can easily be separated from the 5 races of subsp. *ludoviciana,* because in subsp. *leavenworthii* the flowers open before the peduncles elongate.

ACKNOWLEDGMENTS

I express sincere gratitude to Dr. Duane Isely for his suggestion of the initial dissertation problem, and his guidance throughout this study, which represents a portion of a dissertation submitted as partial fulfillment of the Degree of Doctor of Philosophy in Botany, Iowa State University, Ames, Iowa. 1972. The facilities of the Iowa State Herbarium, supported by the Science and Humanities Research Institute, were used in the preparation of this paper. The Iowa State University Agriculture and Home Economics Experiment Station provided funds for laboratory supplies and some field travel. My graduate work was supported by an NSF Traineeship, and I was the recipient of NSF Grant GB-27935 (Grants for Improving Doctoral Dissertations in the Field Sciences). Extensive field travel was made possible by this grant, which also provided additional financial support. I express appreciation to the curators of the Herbaria mentioned herein for their generosity in allowing use of herbarium facilities, for arranging loans, and for permission to take seed samples. The following persons collected seed for me: James M. Lang, John Lassetter, William F. Mahler, Ingrid L. Marin, and Robert M. Stuart. Clare B. Hardham and the late Ernest C. Twisselmann provided sound advice during my field work in California. William Warde, formerly at Iowa State University, and Bruce Lewis, formerly at Eastern Kentucky University, assisted in computer handling of data.

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APARTADO AEREO #18512
CALI, VALLE
COLOMBIA, AMERICA DEL SUR

A REVISION OF THE GENUS *KYLLINGA* ROTTB. (CYPERACEAE) IN MEXICO AND CENTRAL AMERICA

Gordon C. Tucker

ABSTRACT

A revision based on herbarium study of the six species of *Kyllinga* occurring in Mexico and Central America is presented. Each species is described and discussed. Distribution maps, a key to the species, and a detailed discussion of taxonomically useful characters in the genus are included.

Key Words: Cyperaceae, *Kyllinga*, Mexico, Central America

The genus *Kyllinga* consists of some 40 to 45 species (Kükenthal, 1935–36; Lye, 1981). Nearly all are tropical, with no more than ten occurring in temperate regions. The greatest diversity is in tropical Africa and Madagascar, where as many as 35 species are found. In the New World, there are eight species, two of which, *K. brevifolia* and *K. odorata*, are pantropic. Three of the species occurring in the New World, *K. odorata, K. pumila* and *K. brevifolia*, occur in the United States (Delahoussaye and Thieret, 1967). One species, *K. nudiceps*, is endemic to Cocos Island, Costa Rica.

Some workers include *Kyllinga* as a subgenus of *Cyperus*. However, *Kyllinga* differs from *Cyperus* in its two-scaled, one-flowered spikelets. The dense, sessile spikes of *Kyllinga* give the plants a different aspect from most species of *Cyperus* with their usually open, branched inflorescences. The majority of recent specialists on *Cyperus* and on the Cyperaceae have recognized *Kyllinga* as a distinct genus. Some proponents of *Kyllinga* as a distinct genus include: Standley and Steyermark (1958); Koyama (1978) in the *Flora of the Lesser Antilles;* Raynal (1973) who worked at different times on the Cyperaceae of Africa, Madagascar and New Caledonia; Vorster unpubl. Ph.D. dissertation, U. Pretoria, 1978 who studied the southern African species, as well as the genus *Cyperus;* and Lye (1981) who studied the East African Cyperaceae.

Raynal (1973) hypothesized that *Kyllinga* probably represented an advanced group derived from *Cyperus*. He based this conclusion on a similarity of habit of certain African species of Section *Mariscus* (Vahl) Bentham of *Cyperus* to that of some species of *Kyllinga*. I know of no other evidence to support Raynal's conjecture, but am willing to agree that *Kyllinga* is closely related to *Cyperus*. A satisfactory understanding of the phylogenetic relationships of *Kyllinga* must await adequate study of the African species.

Several regional treatments have been published for Mexico and Central America. O'Neill (1940) provided a treatment of the three species (*Kyllinga pumila, K. brevifolia* and *K. tibialis*) occurring in the Yucatan Peninsula, which included the Mexican states of Campeche, Yucatan and Quintana Roo, the Guatemalan department of Petén, and all of Belize. Ayers (1946) included *K. odorata, K. pumila* and *K. brevifolia* in his taxonomic treatment of the genus *Cyperus* in Mexico. Standley and Steyermark (1958) included *K. pumila, K. brevifolia, K. vaginata* and *K. tibialis* in their account of the Cyperaceae of the *Flora of Guatemala*. However, they overlooked *K. odorata*, misdetermining the three sheets of it at F as "*K. pumila*" or "*K. brevifolia.*" Svenson (1943) treated *K. pumila, K. brevifolia, K. odorata* and *K. tibialis* in the *Flora of Panama;* the present treatment adds one species, *K. vaginata,* to the flora of that country. Standley (1938) included all six species of the present treatment in his *Flora of Costa Rica*. Spellman *et al.* (1975) listed for Belize only two out of the five species found there in the present treatment. Molina R. (1975) omitted *K. odorata* from his enumeration of the plants of Honduras. Standley (1931) recognized six species of *Kyllinga* in his account of the Cyperaceae of Central America.

Need for the present treatment of this genus is shown by lack of any recent study covering the entire area from Mexico to Panama. Many of the treatments made for a particular single country, while useful, usually are based on few collections. Unless specializing in the genus or family in question, an author usually does not see enough collections to observe and describe adequately the variation within each species. Further, species represented in a country by only a very few collections may be overlooked because a nonspecialist has not had sufficient opportunity to learn to recognize the species. About 40% of the specimens seen during the present study had been misidentified, a state of affairs which emphasizes the need for an up-to-date revision of the genus for the region.

The present treatment has been made in conjunction with a taxonomic revision of *Cyperus* in Panama and Costa Rica (Tucker, 1983) and northern Central America and Mexico. Several comparisons can be made between the two genera, *Kyllinga* and *Cyperus*. In general, the author has found fewer taxonomically useful characters in *Kyllinga* as compared with *Cyperus*, owing in large part to the differences in inflorescence structure between the two genera. The inflorescences of *Kyllinga*, composed of a sessile spike or spikes, lack the rays, branches and various arrangement of spikes and spikelets that are useful in recognizing species in *Cyperus*. Also, the two-scaled, one-flowered spikelets of *Kyllinga* show comparatively little variation throughout the genus, whereas in *Cyperus* the spikelets exhibit considerable variation in length, width, imbrication of scales, and presence of rachilla wings, as well as others.

The habitats of the six species of *Kyllinga* treated here are in general very similar. Label data indicate they are plants of open, often disturbed and usually moist situations. Such habitats include roadside ditches, pastures, marshes but not wooded swamps, newly graded roadbanks, gravel pits, river and lake shores, and thickets. In addition, *K. odorata* occurs in pine and oak forests, and in thorn woodlands. The most specific in habitat is *K. tibialis*. It is always found close to the Caribbean on coastal dunes, under littoral trees and shrubs, and in swales behind the dunes.

The present treatment includes a key designed to be useable on specimens with or without underground parts. The descriptions are based on examination of some 600 herbarium specimens from the institutions listed in the Acknowledgments. A summary of the distribution and phenology follows each species description, as well as a listing of representative specimens. For the rare species, *Kyllinga vaginata* and *K. nudiceps*, all specimens seen are cited in detail. A citation of all specimens examined for this study is made in the Index of Exsiccatae.

Comments on Taxonomically Useful Characters

RHIZOMES. Five of the six species of the present treatment are rhizomatous. Only *Kyllinga pumila* lacks rhizomes, being instead densely cespitose. In *K. nudiceps*, *K. tibialis* and *K. vaginata*, the rhizomes are always conspicuous provided that underground parts have been gathered intact. In *K. brevifolia*, the internodes of the rhizome are sometimes very short, about 1 mm in length, thus producing a tuft of approximate culms that suggests the cespitose species *K. pumila*. Such tufted plants of *K. brevifolia* will often also produce elongate rhizomes with the culms spaced 5–15 mm apart. Tufted plants of *K. brevifolia* can be distinguished from *K. pumila* by their longer anthers (0.8–1.1 mm *vs.* 0.2–0.4 mm) and the vertical orientation of the longest inflorescence bract in *K. brevifolia;* the longest inflorescence bract in *K. pumila* is horizontal to reflexed.

LEAVES. All species except *Kyllinga nudiceps* have been observed with leaf blades. Three species, *K. brevifolia, K. pumila* and *K. odorata* always bear leaf blades, and these leaf blades are linear-lanceolate with acute apices. The remaining two species, *K. vaginata* and *K. tibialis,* usually lack leaf blades. In these two species, the leaf blades, when present (on about 1/3 of the collections seen in this study), are linear, with the apex broadly rounded and usually mucronate. The presence or absence of leaf blades has been a source of confusion between *K. tibialis* and *K. vaginata* (see comments under *K. vaginata*).

INFLORESCENCES. The inflorescence of *Kyllinga* consists of 1–4 sessile spikes subtended by 2–5 usually leaf-like bracts. The shape and number of the spikes is useful in dividing the Mexican and Central American species into two major groups, as indicated in the Key to the Species. The inflorescence bracts are an easily observed character useful in several instances. For example, the extreme reduction of the bracts in *K. nudiceps* separates this species from *K. vaginata* and *K. tibialis.* The erect orientation of the longest inflorescence bract in *K. brevifolia* separates that species from *K. pumila* and *K. odorata,* in which all the bracts are borne horizontally to reflexed. The length of the inflorescence bracts relative to the length of the spike has been a source of confusion between *K. tibialis* and *K. vaginata* (see comments under *K. vaginata*).

RACHIS. The rachis is that portion of the summit of the culm along which the spikelets are borne. In most species it is cylindrical to conical. A notable exception is *Kyllinga tibialis,* in which the rachis is a low dome-shaped to nearly spherical structure that is a distinctive character of this species. The shape of the rachis might seem a difficult or tedious character to observe, but such is not the case. In collections with several culms from a rhizome system, there is nearly always at least one older culm from which the spikelets have fallen, revealing the rachis. Shape of the rachis is the most reliable character separating *K. tibialis* from *K. vaginata* (see comments under *K. vaginata*).

SPIKELETS. Spikelets show little morphological variation in the genus *Kyllinga,* at least as it is represented in the New World. The kind of variation that does occur is mostly in dimensions of the spikelet. These differences have not been of much value in distinguishing related species or groups of species.

SCALES. Some variation in dimensions and in number of nerves has been noted, but none of this variation has proven to be of sufficient magnitude to distinguish species of *Kyllinga.* Color of scales is useful in one instance: the whitish scales of *K. odorata* distinguish it from other New World species which all have pale greenish, brownish or hyaline scales.

Presence of spinulose teeth on keels of the scales has been a source of confusion in descriptions of species. All the species of this treatment, with the exception of *Kyllinga nudiceps,* have been observed to have either smooth or spinulose-scabrellate keels. Plants of the same collection, and occasionally spikelets of the same plant, may have both smooth and scabrellate keels. Ayers (1946) used the character of smooth versus scabrellate keels to distinguish *K. odorata* from *K. brevifolia* and *K. pumila.* All three of these species have been observed either with smooth or with scabrellate keels. Thus Ayer's observation is not a reliable means of recognizing *K. odorata.*

STAMENS. A survey of the published descriptions of *Kyllinga* species usually reveals more than one count of the number of stamens per flower. For example, *K. brevifolia* has been reported to have one stamen per flower (Delahoussaye & Thieret, 1967); 3 to 1 stamens (Kükenthal, 1935–36; O'Neill, 1940); and 1–2 (–3) stamens (Kern, 1974). In the present study, about two-thirds of the flowers of *K. brevifolia* checked had 2 stamens; the remainder had a single stamen. These various reports suggest that stamen number is probably not a useful character in delimiting species.

The length of the anthers has been found to be a genuinely helpful and reliable character. In a collection with several to many culms, usually in at least one inflorescence spike the anthers will be exserted, and can thus be readily observed and measured. The small anthers of *K. pumila* provide a quick and reliable means of distinguishing that species from *K. brevifolia* (see key and comments under *K. pumila*).

ACHENES. Delahoussaye and Thieret (1967) stated that specimens of *Kyllinga* ought to be collected with mature achenes for critical determination. It is my observation that, in general, the achenes are less important to the taxonomy of *Kyllinga* than in any genus of the Cyperaceae with which I am familiar. O'Neill (1940) stated that *K. brevifolia* and *K. pumila* differ in achene width, but the present study cannot support this claim (see comments under *K. brevifolia*).

Delahoussaye and Thieret (1967) observed that the dark achenes of *Kyllinga odorata* with their contrasting whitish stipitate bases and apiculi are distinctive of the species. This is indeed a reliable means of recognizing this species, but the achenes must fully mature before the coloration pattern is apparent. This is the only instance in which the writer has found mature achenes to be helpful in determination. However, ripe achenes are not essential for critical identification since the whitish color of the scales, a characteristic unique to this species in Mexico and Central America, is evident even before anthesis.

Variation of length and width of achenes falls within a rather narrow range, 0.5 and 0.4 mm, respectively. The differences in dimensions are not sufficiently great to be useful or reliable in delimiting species (see discussion under *K. brevifolia*).

NOTES ON MEASUREMENTS

1. Height of the plant is given as length of the culm from its base to insertion of the inflorescence bracts. Height does not include length of the spike or inflorescence bracts.
2. Width of leaves, culms and spikes is measured at mid-length. Achenes are measured at the widest point.
3. Width of scales was measured at the widest point, in abaxial view, of a detached, rehydrated scale pressed flat against a flat surface. The width may be estimated as twice the distance from keel to margin of an intact scale viewed laterally.

TAXONOMIC TREATMENT

Kyllinga Rottb., Descr. Icon. Rar. Nov. Pl. 12. 1773. (nom. et orthogr. cons.). TYPE species: *K. brevifolia* Rottb.

Cyperus subgenus *Kyllinga* (Rottb.) Valck. Sur., Gesl. Cyp. Mal. Arch. 42. 1898.

Herbaceous cespitose annuals or more frequently rhizomatous perennials. Culms smooth, trigonous or roundly trigonous, (5–) 20–50 (–100) cm tall, 0.5–3 mm thick. Leaves with blades (1–) 5–25 cm long, 1–5 mm wide, the margins and keel scabrellate; or leaf blades lacking, the base of the culm with 1–5 scarious-margined brownish sheaths. Inflorescence bracts 2–4, leaflike, up to 20 cm long and 6 mm wide, or greenish brown to brown, reduced, shorter than to equalling the spike. Inflorescence of 1–4 densely cylindrical to ovoid or spherical sessile spikes 6–15 mm long, 4–10 mm wide. Rachis slenderly cylindrical, conical or very nearly spherical. Spikelets usually very numerous, not readily distinguishable to the unaided eye, (15–) 50–150, densely packed on the rachis, ovate to lanceolate, (1.8) 2.2–3.8 (4.5) mm long, (0.7) 1–1.2 (1.4) mm wide, consisting of four scales: the two basal scales minute, brownish, sterile, 0.2–0.8 mm long; the two distal scales much longer, the lower of these two (the third of the spikelet) subtending a bisexual flower, the fourth scale slightly smaller, sterile, or infrequently bearing 1 or 2 stamens only. The fertile scale ovate, mucronate or mucronulate, (1.8) 2.4–3 (3.4) mm long, (0.8) 1.2–2 (2.6) mm wide, laterally 2–4 nerved, hyaline, whitish or pale greenish or reddish brown; keel greenish or whitish, smooth or spinulose-scabrellate, 1–3 nerved. Stamens 1, 2 or 3 per flower; filaments ribbon-like, reddish brown; anthers oblong-elliptic to linear, (0.2) 0.3–1.1 (1.3) mm long. Styles (0.4) 0.8–1.2 (1.8) mm long; stigmatic branches 2, (0.3) 0.6–1.5 mm long. Achenes lenticular, laterally flattened, narrowly ovate to oblong or elliptic, 1–1.2 (1.5) mm long, (0.4) 0.6–0.8 mm wide, apiculate, base cuneate to rounded, substipitate to decidedly stipitate, puncticulate, surface light brown to dark brown or reddish or brown.

KEY TO SPECIES OF *KYLLINGA* IN MEXICO AND CENTRAL AMERICA

1. Culms densely cespitose, rhizome lacking; anthers 0.2–0.4 mm long . . . . 1. *K. pumila.*
1. Culms approximate to widely spaced on a usually conspicuous rhizome; anthers 0.4–1.1 mm long . . . . (2)
   2. Longest inflorescence bract 4–10 times longer than the longest spike; spikes 1–4, ovoid to densely cylindrical . . . . (3)
      3. Scales whitish; achenes dark with contrasting whitish stipitate base and apiculus; rhizome short, knotted, culms

approximate; inflorescence bracts all horizontal to reflexed; culms bulbous-thickened at the base .... 2. *K. odorata.*

3. Scales hyaline, pale brownish to greenish; achenes uniform light to medium brown; rhizome elongate, the culms (1–) 5–15 mm apart; the longest inflorescence bract erect, looking like a continuation of the culm, the other bracts ascendent to horizontal; culms slender at base .... 3. *K. brevifolia.*

2. Longest inflorescence bract at most 3 times longer than the longest spike; spikes solitary (rarely a much smaller sessile one borne at the base of the spike), spherical to subglobose or hemispherical .... (4)

4. Culms 0.8–2 mm thick at the apex, leafless or with leaf blades 2–5 mm wide; spikelets about 75–200; rhizomes horizontal, (2–) 3–5 mm thick; inflorescence bracts lanceolate, equalling or exceeding the spike .... (5)

5. Spikes subglobose to ovoid; denuded rachis cylindrical to conical; scales of rhizome lanceolate.... .... 4. *K. vaginata.*

5. Spikes spherical to globose; denuded rachis spherical to hemispherical; scales of rhizome ovate-lanceolate .... 5. *K. tibialis.*

4. Culms 0.4–0.9 mm thick at the apex; always leafless; spikelets 15–45; rhizomes oblique, 0.5–3 mm thick; inflorescence bracts broadly ovate, shorter than the spike .... 6. *K. nudiceps.*

TREATMENT OF THE SPECIES

1. **Kyllinga pumila** Michaux, Fl. bor.-amer. 1: 28. 1803. TYPE: U.S.A., southern Illinois, August 1795, *Michaux* (HOLOTYPE: P, Herb. Michaux, photo, DUKE; ISOTYPE: P, Herb. E. Drake, photo, DUKE).

K. caespitosa Nees, Fl. bras. 2: 12. 1842. TYPE: BRAZIL. Bahia, *Martius s.n.* (SYNTYPE: M!); Minas Gerais, *Martius s.n.* (SYNTYPE: M!); Pará, *Martius s.n.* (SYNTYPE: M!); Rio Nigri, *Martius s.n.* (SYNTYPE: M!).

K. caespitosa var. *major* Nees, Fl. bras. 2: 12. 1842. TYPE: BRAZIL. *Sellow* (not located).

K. laxa Schrad. ex Nees, Fl. bras. 2: 14. 1842. TYPE: BRAZIL. Rio de Janeiro, Sebastianopolis, *Martius s.n.* (HOLOTYPE: M!).

K. pumila β b. *elatior* Kunth, Enum. pl. 2: 132. 1837. TYPE: TRINIDAD. *Sieber 2* in 1825 (HOLOTYPE: B!).

K. tenuifolia Steud., Syn. Glum. 69. 1854. *C. tenuifolius* (Steud.) Dandy, Catal. Vasc. Pl. S. Tomé 363. 1944. TYPE: not located; type locality, Senegal.

K. pumila var. *elatior* Boeck., Linn. 35: 413. 1868. TYPE: none specified; type locality: "In Americae region calidior."

K. flexuosa Boeck., Cyp. nov. 2: 1. 1890. TYPE: JAMAICA. Bellevue, 27 Jan. 1888, *Eggers 3753* (HOLOTYPE: B!).

Cyperus densicaespitosus Mattf. & Kükenth., Pflanzenreich 4(20): 597. 1936. Based upon *K. pumila*.

Cespitose annual (or short-lived perennial), (5) 15–30 (55) cm tall. Roots fibrous, brownish, rhizome none. Culms trigonous, smooth, 0.7–1.3 mm thick throughout. Leaves 1–3 (7), 4–20 (30) cm long, 1.5–3 (3.6) mm wide, flat to v-shaped, the margins and keel scabrellate, especially distally. Inflorescence bracts (3) 4 (5), (1) 3–10 (22) cm long, (0.5) 1–2.5 (3) mm wide, the margins and keel ciliate-scarbrellate, horizontal to ascendent at 30° at or before anthesis, becoming horizontal to strongly reflexed in maturity. Spikes 1–3, globose-ovoid to cylindric, 5–8 (11) mm long, 5–7 mm wide; secondary spikes smaller, globose-ovoid, 3–5 mm long, 2.5–4 mm wide; rachis slenderly cylindrical, 3–5 mm long, 0.4–0.7 mm thick; spikelet pedicels 0.1–0.2 mm long, about 0.1 mm thick, separated by one to two times their thickness. Spikelets 50–150, lanceolate to oblong-lanceolate, (1.9) 2.4–2.8 (3.8) mm long, 0.6–0.9 mm wide, contracted below into a stipitate base 0.2–0.4 mm long. Scales ovate (1.8) 2.2–3.1 (3.4) mm long, the mucro 0.1–0.3 mm long, 1–1.7 mm wide, pale brownish to hyaline, laterally 2–3 (4) nerved; keel green, with 3–10 spinulose teeth up to 0.2 mm long, or infrequently smooth. Stamens 2; anthers elliptic, (0.2) 0.3–0.4 mm long, the connective not prolonged; filaments (1.8) 2.4–3 mm long. Styles 0.5–0.8 mm long; stigmatic branches 2, 0.5–0.9 mm long. Achenes oblong, lenticular, 1–1.2 (1.4) mm long, 0.5–0.6 (0.7) mm wide, apex subtruncate, apiculate, base cuneate to rounded, the stipitate portion 0.1–0.2 mm long, about 0.1 mm wide, surface finely papillose, light brown.

DISTRIBUTION. (Figure 1). Eastern United States from Pennsylvania and Kansas to Florida and eastern Texas; the West Indies; eastern and central Mexico south through Central America to Argentina; also in tropical Africa. Moist disturbed open soils, wet pastures, roadsides, croplands and thickets, from sea level to about 2000 m.

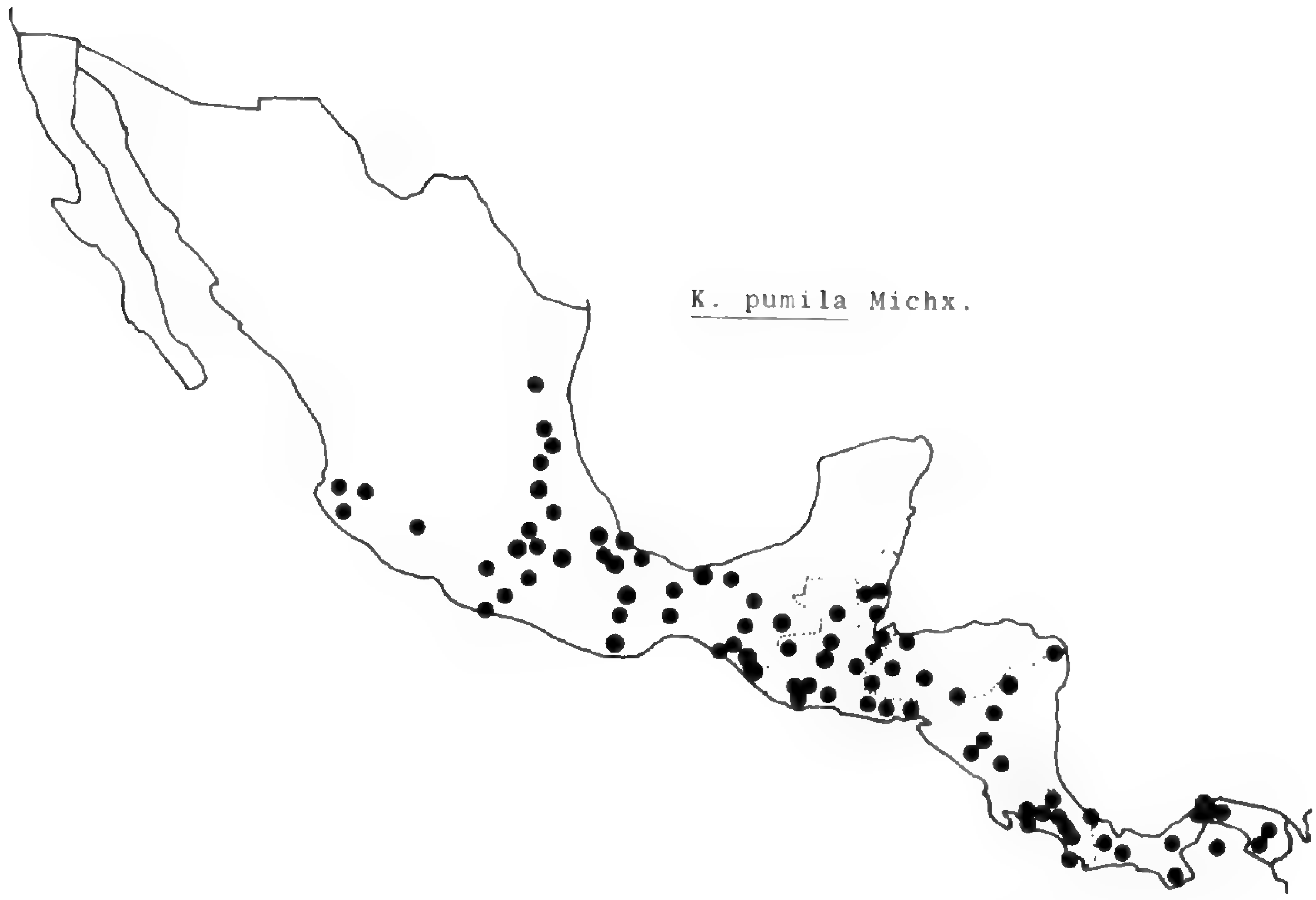

Figure 1. Distribution of *K. pumila* in Mexico and Central America.

PHENOLOGY. Flowers and fruits throughout the year.

DISCUSSION. This species is distinguished by its cespitose annual habit. Specimens of *Kyllinga brevifolia* collected without rhizomes are frequently misdetermined as this species, but can be distinguished by their much longer anthers, 0.8–1.1 mm long, versus 0.2–0.4 mm long in *K. pumila.* The cespitose plants of *K. pumila* often have 10–20 culms, and usually several culms will have the anthers exserted and readily visible.

ILLUSTRATIONS. Kükenthal (1935–36), p. 596, fig. 63 E–G; Gleason & Cronquist (1952), v. 1, p. 250; Standley & Steyermark (1958), p. 167, fig. 30 A–C.

REPRESENTATIVE SPECIMENS. MEXICO. **Chiapas:** Sta. Anita Huixtla, *Boege 1078* (MEXU); Mpio. Villa Corzo, *Breedlove 37674* (DS); Mpio. La Independencia, 45–50 km E of Lagos de Montebello, *Breedlove & Almeda 57709* (CAS); Mpio. Pueblo Nuevo Solistahuacán, *Breedlove & Thorne 21536* (DS, ENCB); Escuintla, *Matuda 297* (MEXU). **D. F.** Pelouse du Pedregal près Mexico, *Bourgeau 662* (K, with *K. odorata*). **Guerrero:** Dis. Adama, Temisco, *Mexia 8795* (B, GH, LCU); Dis. Mina, Petlacala, *Mexia 9042* (B, GH, K, LCU). **Hidalgo:** Mpio. San Bartolo Tutotepec, Santiago, *Gimate 629* (ENCB, MEXU); Dis. Molango, Lake Atexca, *Moore 2953* (BH). **Jalisco:** 4.5 mi NNE of Talpa de Allende, *McVaugh 20232* (BM, DUKE, ENCB, TEX, MICH); Mpio. de Talpa, SE of Cuale, *González T. 459* (ENCB). **Mexico:** Amatepec, *Matuda 31275* (MEXU). **Michoacán**: 22 km S of Uruapan, *King & Soderstrom 4876* (MICH, TEX, US). **Morelos:** Cuernavaca, *Deam 10* (GH). **Nayarit:** between Chapalilla and Ixtlán on Hwy. 15, *Kral 25659* (ENCB). **Oaxaca:** S of Valle Nacional, *King 2133* (DUKE, MEXU, TEX); between Pochutla and Miahuatlán, near Puente San Juan, *Tucker 2252* (DUKE). **Puebla:** 2 km E of Villa Juárez, *González Quintero 195* (ENCB, MSC). **San Luis Potosí:** 4 km ESE of Tamazunchale, *Rzedowski 9777* (ENCB); Mpio. Xilitla, 5 km W of Ahuacatlán, *Rzedowski 27714 (ENCB).* **Tabasco:** Mpio. Cárdenas, campo de investigación CSAT, *Cowan 2468* (CAS, ENCB, MEXU). **Tamaulipas:** Mpio. Gómez Farias, Rancho del Cielo, *Puig 3245* (ENCB). **Veracruz:** Orizaba, *Botteri 194* (BM, CGE); *Bourgeau 2737b* (C, GH, M); Colipa, *Liebmann s.n.*, March 1841 (C, with *K. brevifolia;* K); Mpio. Santiago Tuxtla, Tepalapa, *Martínez-Calderón 1480* (CAS, DS, ENCB); 16 km E of Jalapa on the road to Cuauhtémoc, *Tucker 2135* (DUKE).

BELIZE. Belize Dis.: Boomtown, *O'Neill 8974* (C, DS, GH, K, LCU, US). El Cayo Dis.: near Camp 6, *Gentle 2370* (F, GH, K, LCU, MEXU). Stann Creek Dis.: Stann Creek Town, *O'Neill 8972* (LCU).

GUATEMALA. Alta Verapaz: Oliva prope Coban, *von Türckheim 6* (BM, G, K, US); Coban, *von Türckheim II 2271* (E, GH). Escuintla: San Andrés Osuna, *Seler 2566* (GH). Huehuetenango: about Laguna de Ocubila, *Standley 82650* (F). Izabal: Quebradas, *Pittier 8562* (GH, US). Guatemala: between Guatemala and San Raimundo, *Standley 63023* (F). Petén: La Libertad, *Lundell 2498* (CAS, LCU). Sacatepéquez: NW of Antigua, *Standley 64664* (F). Santa Rosa: Santa Rosa, *Heyde & Lux 3550* (GH, K, M, US). Zacapa: vic. of Zacapa, *Standley 74272* (F).

HONDURAS. Atlántida: vic. La Fragua, *Standley 55701* (F, US). El Paraíso: N of Yuscaran, *Standley 25710* (F). Gracias a Dios; orillas del Río Dursuna, *Nelson 855* (BM); Intibucá: 9 km E of La Esperanza, *Molina & Molina 13997* (F). Morazán: vic. of El Zamorano, *Molina 1591* (F, GH), *Standley 21558* (F). Ocotepeque: Cordillera Merendón, 10 km from Nueva Ocotepeque, *Molina R. 22240* (F).

EL SALVADOR: Ahuachapán: vic. of Ahuachapán, *Standley 19842* (GH). San Miguel: vic. of San Miguel, *Standley 21088* (GH). San Salvador: vic. San Salvador, *Standley 23291* (BM, GH). Sonsonate: vic. Sonsonate, *Standley 21791* (GH, US).

NICARAGUA. Chontales: Santo Tomas, *Seymour 2785* (MSC). Jinotega: 10 km NE of Jinotega, *Atwood 2093* (F). Managua: El Rodeo, 12 km E of Managua, *Garnier 4472* (GH, LCU). Matagalpa: Sta. Mariá de Ostuma, *Williams et al. 27960* (F). Zelaya: Rama, *Seymour 718* (BM, F, GH).

COSTA RICA. Alajuela: waterfall of Río Paz, *Wilbur 33200* (DUKE); vic. Capulin on Río Grande de Tarcoles, *Standley 50090* (US). Cartago: Río Grande de Orosi, *Wilbur 32938* (DUKE); *22319* (DUKE); bords du Río Tuis, *Tonduz 8180* (US); vic. of Tres Ríos, *Godfrey 67181* (DUKE, FLAS). Heredia: Paa Vulkanen Barba, *Oersted 14500* (C); La Selva, OTS Field Sta., *Folsom 10113* (DUKE), *Sperry 1114* (DUKE). Limón: near Cahuita, *MacDougal 1163* (DUKE). Puntarenas: Osa Peninsula, vic. Casa Medio Camino, *Godfrey 66865* (FLAS); 19 km E of Esparza, *Wilbur 29946* (DUKE); 4 km S of Las Alturas, *Wilbur 22707* (DUKE). San José: Ochomogo, *Wilbur 33629* (DUKE); about 3 km E of San Marcos, *Wilbur 32125* (DUKE); Los Yoses, *Wilbur 29439* (DUKE); in the saddle between Barba and Irazú, *Wilbur 14701* (DUKE); El General, Kupper 1394 (M).

PANAMA. Canal Zone: Near Gatun, *Standley 27276* (US); Barro Colorado Is., *Standley 41120* (US); Ancon Hill, *Standley 25168* (NY). Coclé: vic. El Valle de Antón, *Allen 106* (GH). Colón: Empire Sta., *Hayes 300* (BM); Chagres, *Fendler 343* (GH, NY). Chiriquí: 4 miles NE of El Hato del Volcán, *Wilbur et al. 15316* (DUKE); 6.6 km NNE of Boquete, *Wilbur & Luteyn 19275* (DUKE); vic. of Monte Lirio, *Seibert 237* (GH, LCU, NY); Campamento Fortuna, *Correa A. et al. 2610* (DUKE); Darién: Río Chucunaque above Río Tuquesa, *Stern et al. 836* (GH, US); 1 mile N of Rio Sabana, *Tyson et al. 4794* (FLAS). Los Santos: 25 miles SW of Tonosi, *Lewis et al. 2984* (NY). Panamá: Cerro Jefe, *Tyson et al. 4301* (FLAS); Río Tecumen, *Standley 29434* (US); Isla San José, *Johnston 1188* (GH, NY, US).

2. **Kyllinga odorata** Vahl, Enum. pl. 2: 382. 1806. TYPE: America meridionali, *von Rohr* (HOLOTYPE: C, not seen).

K. monocephala H. B. K., Nov. Gen. Sp. 2: 211. 1816. TYPE: VENEZUELA. Caracas, HUMBOLDT (HOLOTYPE: P; IDC microfiche Herb. H. B. K.!), nom. illeg. Art. 63.1.

K. leucocephala Baldw., Trans. Amer. Philos. Soc. Philad. n. s. 2: 170. 1825. TYPE: URUGUAY. Maldonado, *Baldwin* (HOLOTYPE: PH!).

K. sesquiflora Torr., Ann. Lyceum Nat. Hist. New York 3: 287. 1836. *Cyperus sesquiflorus* (Torr.) Mattf. & Kükenth., Pflanzenreich 4 (20): 591. 1936. TYPE: U. S. A. Middle Florida, *Chapman 12* (HOLOTYPE: NY!).

K. martiana Schrad. ex Nees, Fl. bras. 2: 14. 1842. TYPE: BRAZIL. Prov. Pará, *Martius* (HOLOTYPE: M!).

K. odorata var. *minor* Boeck., Linnaea 35: 411. 1868. TYPE: MARTINIQUE. *Sieber 18* (HOLOTYPE: not located; ISOTYPE: M!).

K. odorata var. *rigida* Boeck., Vidensk. Meddel. 1894: 271. 1895. TYPE: BRAZIL. São Paolo, Franca, *Löfgren* & Edwall 2105 (SYNTYPE: C!).

Tufted perennial (5) 10–25 (45) cm tall. Rhizome (rarely collected) horizontal, oblique just below the culms, 3–6 mm thick, internodes 5–12 mm long. Culms triquetrous, smooth, 0.5–1.2 mm thick just above the sheaths, 0.5–1.2 (1.5) mm thick at the apex, bulbous-thickened at the base, clothed with remnants of previous year's leaf sheaths. Leaves (1) 3–7 (10), (6) 10–18 (30) cm long, 2–3 (4) mm wide, erect or arching, ciliate-scabrous along the margins and keel, especially apically. Bracts (2) 3–4, 1–7 (9) cm long, (0.5) 1–3 (4.5) mm wide, ciliate-scabrous along the margins and keel, horizontal to ascendent before anthesis, horizontal to reflexed downward parallel to the culm in maturity. Spikes 1–3 (4), whitish, the central one the largest, densely ovoid to cylindrical, 6–12 (17) mm long, (4) 5–7 (8) mm wide, the other spikes smaller, shorter, ovoid, 3–5 (6) mm long, 3.5–5 mm wide. Rachis slenderly cylindrical, (4) 5–7 mm long, (0.6) 0.8–1 mm thick; spikelet pedicels very short, about 0.2 mm wide, 0.1 (−0.2) mm high, decurrent by a somewhat spongy thickened ridge.

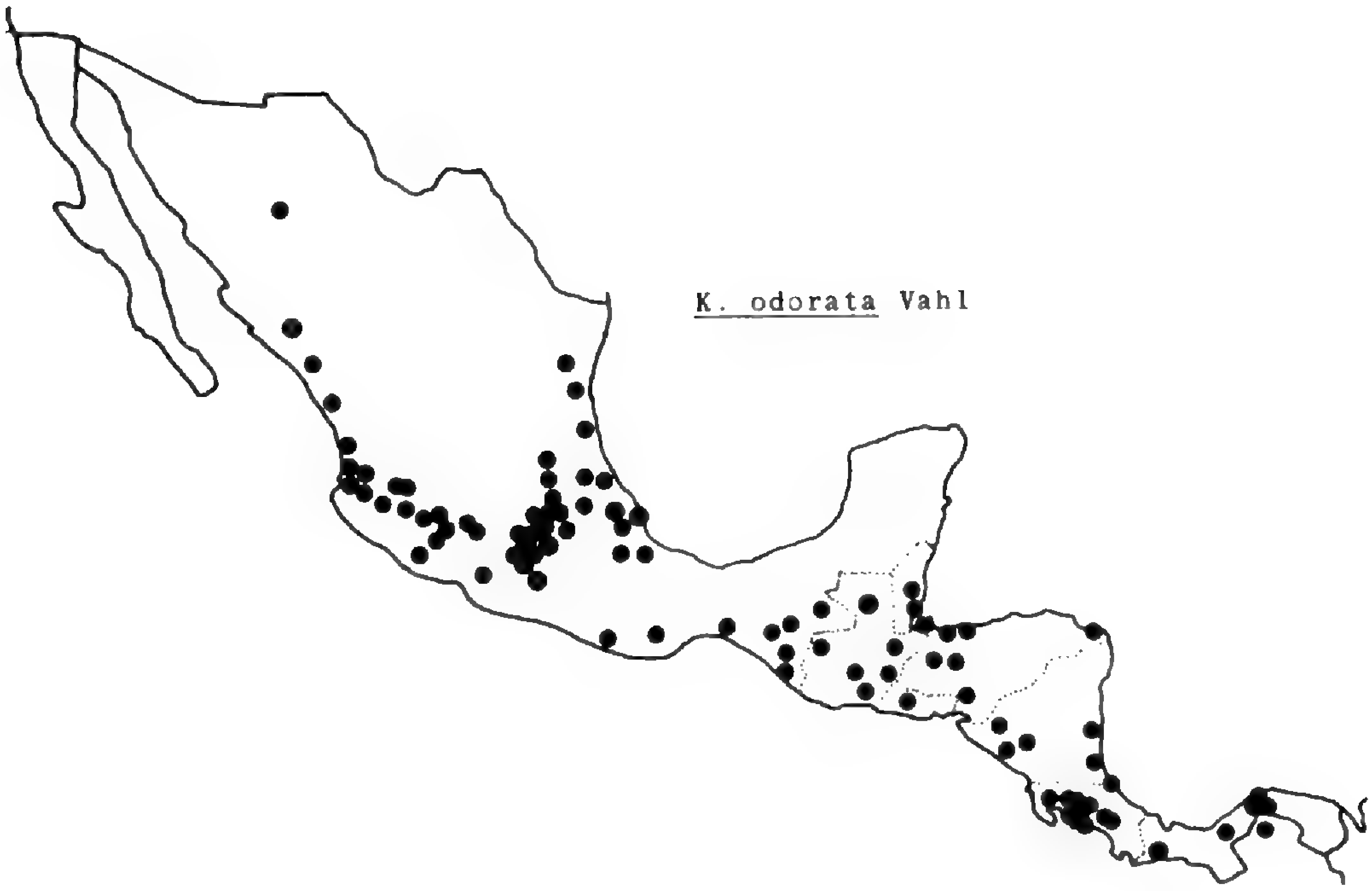

Figure 2. Distribution of *K. odorata* in Mexico and Central America.

Spikelets (50) 75–150, ovate to ovate-lanceolate, whitish, (1.8) 2.3–2.8 (3.6) mm long, 1–1.3 mm wide. Scales broadly ovate, 2–2.5 mm long, (1.2) 1.8–2.6 mm wide, whitish, often red-speckled, mucronate, the apex often excurved, (5) 7 (9) nerved, the keel smooth or with 1–6 spinulose prickles in the distal half, whitish to greenish. Stamens 2; anthers (0.4) 0.6–0.8 (1.0) mm long, linear; filaments 2–2.4 mm long. Styles 0.6–1 mm long; stigmatic branches 2, 0.3–0.6 mm long. Achenes lenticular, oblong-ovate, 1.2–1.5 mm long, 0.7–0.8 (0.9) mm wide, apex broadly rounded to subtruncate, apiculate, the stipitate base 0.1–0.2 mm long, about 0.2 mm wide, surface papillose, reddish brown to dark brown, strongly contrasting with the whitish base and apiculus.

Distribution. (Figure 2). Pantropic; in the New World in the southern United States from North Carolina to Florida and eastern Texas; the West Indies; Mexico and Central America to Argentina; in Mexico from southern Tamaulipas (Tampico region), eastern San Luis Potosí, Distrito Federal, southeastern Sonora (Yécora) to Nayarit and Chiapas; absent from the Yucatán Peninsula, although it occurs in Belize: croplands, river banks and gravel bars, roadsides, open pine, oak or thorn woodlands from sea level to about 2500 m.

PHENOLOGY. Flowers and fruits from May to September, and sporadically as late as January.

DISCUSSION. The whitish color of the inflorescence generally is distinctive. As the achenes mature and darken, they become visible through the sides of the scales; thus the inflorescence at maturity is often darker than at anthesis. The broad dark achenes, with conspicuous whitish apiculus and stipitate base when fully mature distinguish this species from others of the genus in the New World.

The size of the anthers varies geographically in this species. In collections from Central America (excluding Guatemala), the average length of the anthers is 0.5–0.6 mm (range: 0.4–0.8 mm), while in Mexico the average is 0.7–0.8 mm (range: 0.6–1.0 mm). The ranges of anther length for these two above regional populations do overlap. Moreover, the average length for Guatemalan specimens was 0.6–0.7 mm, exactly intermediate between the averages for Mexico and the remainder of Central America. Thus there seems to be continuous variation in anther length from Mexico through Central America. The recognition of either the Mexican or Central American populations at varietal rank would be arbitrary. No such formal taxonomic rank is here offered.

ILLUSTRATIONS: Godfrey & Wooten (1979), p. 246, fig. 137.

REPRESENTATIVE SPECIMENS. MEXICO. **Chiapas:** Mpio. Angel Albino Corzo, above Jaltenango, *Breedlove 28562* (DS); La Florida, between Oxchuc and Ocosingo, *Tucker 2222* (DUKE). **Distrito Federal:** Tlalpam, *Fisher s.n.*, 31 July 1926 (DS, DUKE, US); Cerro Xochitepec, *Rzedowski 24248* (DS, ENCB, MSC). **Guerrero:** Dis. Mina, Manchón, *Hinton 9429* (DS, K, MEXU, MICH, NY); about 10 miles from Taxco on Cuernavaca road, *MacDaniels 125* (BH, F). **Hidalgo:** near Trinidad Iron Works, *Pringle 8959* (C, CU, E, ENCB, K, GH, M, MEXU, MSC, NY, US); 6 km N of Pachuca, *Garcia 103* (ENCB). **Jalisco:** Guadalajara, *Palmer 253a* in 1886 (GH, MICH, NY); 3 miles S of Mazamitla, Sierra del Tigre, *McVaugh 12980* (MICH); 5 road miles SW of Santa Cruz de Las Flores, *McVaugh 16290A* (MICH). **México:** Mpio. de Texcoco, 8 km E of Coatlinchán, *Cruz Cisneros 1314* (ENCB); Mpio. Zumango, 1 km SE of San Juan Zitlaltepec, *Cruz V. 71* (ENCB); 60 miles W of Toluca, near Michoacán border, *Manning 531121* (GH); Temascaltepec, Volcán, *Hinton 1176* (BM, ENCB, F, K, NY); Cerro de Sacramonte, cerca de Amecameca, *Rzedowski 24202* (ENCB); 5 km W de Progreso Nacional, *Rzedowski 35296* (ENCB). **Michoacán:** Mpio. Tancitaro, 1 mile S of Tancitaro, *Leavenworth 376* (F, MICH, MO, NY); 0.8 miles W of Morelia on Hwy. 15, *Kral 25583* (ENCB); Dis. Zitacuaro, Loma Larga, *Hinton 13103* (DS, ENCD, K, MICH, NY); 8–10 km SW of Jiquilpan, *Feddema 4* (DS, DUKE, ENCB, MICH, TEX); 6–7 km N of Uruapan, *Dieterle 4402* (ENCB, MICH); Morelia, *Arsène* 5752 (B). **Morelos:** 1.5 miles SE of Huitzilac, *Smith 55*

(MEXU); 12 km NW of Cuautla, *Thomas 66* (MEXU). **Nayarit:** 9 miles N of Compostela, *McVaugh 16559* (MEX, MICH); Mpio. Acaponeta, near Labra W of Jesús María, *Norris & Taranto 14170* (MICH); 10 miles SE of Ahuacatlán, on the road to Barranca del Oro, *Feddema 254* (DS, DUKE, ENCB, MICH, TEX); 12 miles SE of Tepic, *Feddema 588* (DS, DUKE, ENCB, MICH, TEX); 1.5 miles W of Mazatán, *Feddema 1073* (DUKE, ENCB, MICH, TEX). **Oaxaca:** 53 km N of Puerto Escondido on the road to Zimatlán, *Roe et al. 560* (F); 16 km NE of Zanatepec, *King 505* (ENCB, MICH). **Puebla:** 1 km W of Villa Juárez, *Galván s.n.*, 7 Sept. 1963 (ENCB). **San Luis Potosí**: Huichihuayón, *Grant 540* (GH, MICH). **Sinaloa:** Sierra Surutato, 3 miles N of Los Ornos, *Breedlove & Thorne 18409* (CAS); San Ignacio, *Montes & Salazar 471* (US); near Colomas, *Rose 1803* (US). **Sonora:** Yécora, *Pennington 108* (TEX). **Tamaulipas:** Rancho del Cielo, 6 km NW of Gómez Farias in Sierra de Guatemala, *Sharp et al. 52029* (MSC). **Veracruz:** near Tampico, *Berlandier 2137* (GH); near Orizaba, *Bourgeau 2589* (C, GH, K); 5.4 miles N of Jalapa on road to Misantla, *Tucker 2077* (DUKE).

BELIZE. Belize Dis.: Sibun River, Graig Point, *Gentle 1398* (NY); low pine ridge near Manatee Lagoon, *Peck 39* (GH, K).

GUATEMALA. Alta Verapaz: Cubilguitz, *von Turckheim 7691* (K). Chimaltenango: on road to Chichicastenango, *Dunn et al. 22960* (MO). Chiquimula: Volcán Ipala, *Steyermark 30529* (F). Guatemala: near Guatemala City, *Tonduz 672* (GH, NY, US). Huehuetenango: Cerro Victoria, *Steyermark 49592* (F, NY). Izabal: vic. Puerto Barrios, *Standley 25057* (NY). Petén: La Libertad and vic., *Aguilar H. 6* (MICH, in part, with *Cyperus ischnos* Schlecht.); 1 km N of Poptun, *Harmon & Dwyer 2719* (MO). Santa Rosa: Santa Rosa, *Heyde & Lux 3540* (GH, K, M, MICH, US). Zacapa: Sierra de las Minas, between Río Hondo and summit of mtn.. above Finca Alejandra, *Steyermark 29708* (F).

HONDURAS. Atlántida: between Tela and Lancetilla, *Yuncker 4581* (MICH, with *K. pumila*). Copan: Hac. Espíritu Santo, *Blake 7438* (US). Gracias a Dios; Puerto Lempira, *Proctor 38922* (BM). Morazán: El Zamorano, *Standley 12857* (F); Las Flores, Cerro de Uyuca, *Standley 21696* (F); region of Las Mesas, *Standley 24069* (F). Yoro: N end of Lake Yojoa, *Kamb 2049* (A).

EL SALVADOR. San Salvador: San Salvador, *Fassett 28259* (F, GH, WIS).

NICARAGUA. Esteli: 10.6 km W of bridge at La Trinidad to San Nicolas, *Stevens 10299* (MO). Managua: Sierra de Managua, *Garnier s.n.*, 1930–1940 (F). Zelaya: Puerto Isabel, *Seymour 2972* (F, GH).

COSTA RICA. Alajuela: between Rios Pilos and Zacaros, *Brenes 17319* (F, NY); about 4 km E of Naranjo on the new road to San Ramón, *Wilbur 29960* (DUKE). Cartago: south slope of Volcán Turrialba near Santa Cruz, *Holm & Iltis 132* (A, NY); Cartago, *Oersted 14499* (C). Guanacaste: Bagaces, *Opler 280* (F). Limón: delta du fleuve San Juan, *Pittier 2580* (US). Puntarenas: outskirts of Chomes, *Davidse & Pohl 1327* (MO); Cascajal, *Holm & Iltis 239* (A, NY). San José: 1 km S of San Pablo towards San Marcos, *MacDougal 861* (DUKE); vic, El General, *Skutch 2643* (GH, K, MICH, NY, US); San José; *Tonduz 434* (DS, F, GH, PH).

PANAMA. Canal Zone: Frijoles, *Ebinger 79* (F); Mt. Hope Cemetery, *Standley 28807* (US); Miraflores Lake, *Tyson 1410* (FLAS). Chiriquí: Savanne bei David, *Wagner 1 1/2* (M). Coclé: El Valle de Antón, *Seibert 474* (GH, NY). Colón: Colón, *Rose 22086* (GH, NY). Panamá: near Matías Hernández, *Standley 28988* (US); Isla San José, Bald Hill, *Johnston 39* (GH).

3. **Kyllinga brevifolia** Rottbøll, Descr. Icon. Rar. Nov. Pl. 13. t. 4. fig. 3. 1773. *Cyperus brevifolius* (Rottb.) Hassk., Cat. Hort, Bogor. 24. 1844. TYPE: EAST INDIES, *König* (HOLOTYPE: C!; ISOTYPE, C!).

K. monocephala Thunberg, Fl. Japon. 35. 1784. TYPE: JAPAN, *Thunberg* (not located).

K. elongata H. B. K., Nov. gen. sp. 2: 211. 1816. TYPE: PERU. Between Gonzana and Loxa, *Humboldt & Bonpland* (P; IDC microfiche Herb, H. B. K.!).

K. cruciformis Schrad. ex Schult., Mant. 2: 137. 1824. TYPE: VIRGIN ISLANDS. St. Thomas, *Ehrenberg 69* (HOLOTYPE: B!; ISOTYPES: C! HAL!).

K. tenuis Baldwin, Trans. Amer. Philos. Soc. Philad. n.s. 2: 168. 1825. TYPE: ARGENTINA. Buenos Aires, , *Baldwin* (HOLOTYPE: PH!).

Perennial, (5) 12–25 (55) cm tall, the culms tufted or widely spaced along a conspicuous rhizome. Rhizome (1) 3–12 (30) cm long, (0.5) 1–2 mm thick, clothed with lanceolate scales 6–13 mm long, the internodes (2) 5–12 (30) mm long. Culms trigonous, smooth, 0.6–1.2 (1.5) mm thick throughout. Leaves 1–3, (2) 6–15 (21) cm long, 1.5–3.5 mm wide, flat, scabrellate along the margins and keel especially distally. Bracts 3–4, (1.5) 4–12 (18) cm long, 1–3.3 mm wide, margins and keel ciliate-scabrellate, the longest bract nearly always erect, appearing as a continuation of the culm, the remaining ones ascendent to horizontal. Spikes 1–3, globose-ovoid to cylindric, 4–7 mm long, about 4 mm wide, greenish; rachis slender, 1.5–3.5 (4.1) mm long, 0.4–0.9 mm thick; spikelet pedicels about 0.1 mm long and about 0.1 mm thick. Spikelets (20) 40–60 (100), oblong-lanceolate, (2.2) 2.5–2.8 (3.2) mm long, (0.6) 0.7–0.8 (1.2) mm wide, the base stipitate, 0.1–0.3 mm long. Scales elliptic to ovate, (1.8) 2.2–3.0 mm long, the mucro an additional 0.2–0.3 mm long, (0.8) 1.1–1.6 mm wide, laterally dull whitish to pale brownish or greenish, 2 (3) nerved, occasionally red spotted; keel greenish, 1 (3) nerved, smooth or with 3–6 (−12) spinulose teeth up to 0.2 mm long. Stamens 2 (rarely 1); filaments (1.7) 2–3 mm long. Styles 0.6–1.2 mm long; stigmatic branches 2, 0.5–1.5 mm long. Achenes elliptic to oblong-elliptic, lenticular, 1–1.2 (1.3) mm long, 0.6–0.8 mm wide, apex broadly rounded to subtruncate, base substipitate to decidedly stipitate, 0.1–0.2 mm long, 0.1 (0.2) mm wide, whitish, surface papillose, brownish.

DISTRIBUTION. (Figure 3). Pantropical; in the New World from North Carolina to Texas and Florida; also in California; southern

Figure 3. Distribution of *K. brevifolia* in Mexico and Central America.

and western Mexico south through Central America and the West andies to Brazil and Argentina. Roadsides, pastures, ditches, marshes and streambanks, from sea level to about 2500 m.

PHENOLOGY. Flowering and fruiting throughout the year.

DISCUSSION. Delahoussaye and Thieret (1967) reported this species to have only one stamen per flower. However, the majority (about 2/3 of the specimens seen in the present study) had two stamens per flower; the remainder had one. Occasionally plants of the same collection had flowers with both one or two stamens.

O'Neill (1940) in addition to the difference in habit of the two species, separated *Kyllinga brevifolia* from *K. pumila* by a difference in achene width, 0.8 mm in the former, 0.6 in the latter. Apparently this supposed distinction was based upon relatively few collections. I cannot corroborate such a difference. The achenes of *K. brevifolia* are 0.6–0.8 mm wide, while those of *K. pumila* are 0.5–0.6 (0.7) mm wide. The slight difference in the widths of the achenes is hardly a useful means of distinguishing these two species.

ILLUSTRATIONS: Gleason & Cronquist (1952) v.1, p. 250; Kern (1974) p. 658, fig. 70; Godfrey & Wooten (1979) p. 246, fig. 137.

REPRESENTATIVE SPECIMENS. MEXICO. **Chiapas:** Mpio. La Independencia, 6–10 km NNE of La Soledad, *Breedlove 53203* (CAS); Mpio. Arriaga, 13 km N of Arriaga on Hwy. 195, *Breedlove & Davidse 54145* (CAS); Mpio. Pueblo Nuevo Solistahuacán, *Ton 2755* (DS, ENCB, LL); between San Cristóbal and Ocosingo, near Abasolo, *Tucker 2219* (DUKE). **Michoacán:** Morelia, Arsène s.n., April 1912 (E). **Nayarit:** Mpio. de Tepic, *Norris & Taranto 13255* (MICH); Mpio. de Compostela, 5 miles W of Compostela, *Norris & Taranto 13921* (MICH); just E of San Blas, *Philbrick 733* (BH). **Oaxaca:** Cerro Pelón, 47 km N of Ixtlán de Juárez, *González 1016* (ENCB); between San Pedro Pochutla and Miahuatlán, near Puente San Juan, *Tucker 2253* (DUKE). **Puebla:** 1 km W of Villa Juárez, *Rzedowski 17203* (ENCB). **Tabasco:** Tenosique, Boca Cerro, *Matuda 3559* (F, GH, LCU, MEXU, MICH); Santa Unita, *Rovirosa 708* (K, PH). **Veracruz:** near Santiago Tuxtla, *Dressler & Jones 184* (F, GH, NY, US); Colipa, *Liebmann s.n.*, March 1841 (C, K); Cordoba, *Matuda 310* (MICH).

BELIZE. Belize Dis., Belize, *Lundell 1906* (LCU, MICH, MO, TEX). Corozal Dis.: Corozal-Consejo Rd., *Lundell 4973* (B, LCU, MICH, MO, NY).

GUATEMALA. Chimaltenango: near San Martín Jilotepeque, *Standley 64513* (F, MICH). Chiquimula: Montaña Nonoja, 3–5 miles E of Comotán, *Steyermark 31729* (F). Izabal: vic. of Quiriguá, *Standley 24066* (GH, NY); vic. Puerto Barrios, *Standley 24777* (GH, NY). Jalapa: Laguna de Ayarza, *Heyde & Lux 3897* (GH, K, M, MO, NY, US). Petén: Sayaxché, *Steyermark 46279* (F, MICH). Retalhuleu: 9 km N of Champerico, *Harmon 2303* (ENCB, MO). Sacatepéquez: near Las Lajas, *Standley 58106* (F). San Marcos: W of Tajamulco, *Steyermark 36724* (F, US).

HONDURAS. Atlántida: between Tela and Lancetilla, *Yuncker 4581* (F, MICH). Cortés: San Pedro Sula, *Garcia 22* (MO). Distrito Central: San Juancito and vic., *Pfeifer 2008* (US). Gracias a Dios: Puerto Lempira, *Proctor 38922* (BM, with *K. odorata*). Morazán: El Jicarito, *Standley 20484* (F), *20788* (F). Olancho: Culmí, *Nelson & Romero 4652* (MO).

EL SALVADOR. Ahuachapán: vic. Ahuachapán, *Standley 20290* (GH, NY, US). La Libertad: vic. La Libertad, *Standley 23205* (GH, MO, NY, US). San Miguel: south side of Lake Olomega, *Tucker 850* (F, GH, K, MO, NY). San Vicente: vic. San Vicente, *Standley 21157* (GH, NY, US). Santa Ana: N of Metapám, *Rohweder 2176, 2185* (MO).

NICARAGUA. Bluefields: Waspam, *van der Sluijs S. 791* (F). Managua: vic. Managua, *Narvaez 258* (F, GH). Matagalpa: Matagalpa, *Zelaya M. 2298* (CAS, GH, MSC). Zelaya: Puerto Isabel, *Narvaez S. 2883* (DUKE).

COSTA RICA. Alajuela: Carrillos de Poas, *Brenes 19330* (NY); near Río Peñas Blancas, *Hepper 106* (BM). Cartago: Río Grande de Orosi, *Wilbur 30752* (DUKE); Tuis, *Tonduz 11388* (MO, US). Guanacaste: Liberia, *Wilbur 31027* (DUKE). Heredia: La Selva, OTS Field Sta., *Wilbur 33275, 33277* (DUKE). Limón: Talamanca, border of river at Shirores, *Tonduz 9218* (US); 28 miles on R. R. from Puerto Limón, *Cufodontis 642* (F). Puntarenas: vic. of Esparta, *Godfrey 66977* (FLAS, MO). San José: NE of San Jerónimo, *Burger & Stolze 5336* (F, MO, NY, PMA); El General, *Skutch 2859* (GH, K, MICH, MO, NY, US); Los Yoses, *Wilbur 26327* (DUKE). Isla del Coco: Wafer's Creek, *Gómez P. 3279* (F, MO, NY, PMA).

PANAMA. Bocas del Toro: Changuinola, *Lazor et al. 2608* (FLAS, PMA); vic. Laguna de Chiriquí, *Hart 82* (K, US). Canal Zone: 3 miles W of Gamboa, *Nee & Mori 3601* (MEXU, PMA, US, WIS). Chiriquí: Finca Lerida to Boquete, *Woodson et al. 1155* (GH, NY); 2.5 miles S of Cerro Punta, *Sawyer s.n.*, 2 March 1967 (DS, WIS). Colón: Portobelo, *Wilbur & Luteyn 11650* (DUKE, with *K. pumila*). Coclé: between Las Margaritas and El Valle, *Woodson et al. 1773* (GH, NY), 1774 (BM). Los Santos: 25 miles SW of Tonosí, *Lewis et al. 2944* (NY, US). San Blas: Marraganti, *Williams 1040* (NY, US). Veraguas: 5 miles W of Santa Fé, *Liesner 945* (GH, PMA, WIS).

4. **Kyllinga vaginata** Lam., Tabl. encycl. 1: 148. 1791. TYPE: PERU. *Dombey* (LECTOTYPE: here designated: P-LA; photo: DUKE!; ISOLECTOTYPE: C!).

K. peruviana Lam., Encycl. 3: 366. 1792. *Cyperus peruvianus* (Lam.) F. N. Williams, Bull. Herb. Boiss. 2 sér. 7: 90. 1907. TYPE: PERU. *Dombey*, the same as *K. vaginata* (nom. illeg., Art. 63.1).

K. rigida Baldw., Trans. Amer. Philos. Soc. Philad. n.s. 2: 169. 1825. TYPE: BRAZIL. Rio de Janeiro, *Baldwin* (HOLOTYPE: PH!).

K. pungens Link, Hort. Berol. 1: 326. 1827. TYPE: not located.

K. obtusata Presl, Reliq. Haenk. 1: 183. 1828. *Cyperus obtusatus* (Presl) Mattf. & Kükenth., Pflanzenreich 4(20): 585. 1936. TYPE: PERU. "In montanis Huanoccensibus," *Haenke* (PR!).

K. obtusata var. *cylindrostachyus* Boeck., Linnaea 35: 419. 1868. *Cyperus obtusatus* var. *cylindrostachyus* (Boeck.) Kükenth., Pflanzenreich 4 (20): 586. 1936. TYPE: BRAZIL. Prov. Bahia, *Sellow* (HOLOTYPE: B!).

K. tenuis Boeck., Linnaea 35: 423. 1868. TYPE: BRAZIL. *Sellow*, (HOLOTYPE: B, Herb. Kunth!).

Perennial, 20–60 cm tall. Rhizome indurate, 2–3 mm thick, clothed with arched, cucullate, ovate-lanceolate, brown to reddish-brown scales 8–12 mm long, 4–7 mm wide, the internodes 2–12 mm long. Culms single at each node, 0.8–2 mm thick just above the leaf sheaths, 0.9–1.5 (1.8) mm thick at the apex, trigonous, hollow, usually flattened in drying, glabrous. Leaves with short blades 2–10 cm long, 2–4 mm wide, scabrellate on the margins and keel; or, lacking blades, the lower culm with 2–3 (4) bladeless sheaths 2–10 cm long, the sheaths with a conspicuous hyaline to light brown, speckled border 0.5–1.2 mm wide. Inflorescence bracts 2–4, greenish, 1–3 (8) cm long, 1.2–3.5 mm wide, horizontal to reflexed, usually erect and clasping the rachis after the spikelets fall, the margins and keel scabrellate. Inflorescence a solitary subglobose to ovoid head 7–11 mm long, 7–9 mm wide, rounded at the apex, truncate below. Rachis cylindrical to conical, 3.2–5 mm long, 1–1.7 mm wide. Spikelet pedicels rather closely spaced, separated by about or less than their own width, 0.3–0.4 mm long, about 0.2 mm wide. Spikelets 75–130, lanceolate, stipitate at the base, 2.5–4 mm long, 1–1.3 mm wide. Scales ovate, 2.7–3.4 mm long, 1.6–2.2 mm wide, laterally 3–4 (5) nerved, off-white to pale reddish brown; keel whitish to greenish, 3-nerved, with 2–3 (4) spinulose teeth. Stamens 3 (the upper scale occasionally bearing 2 stamens without gynoecium); filaments brownish, 1.5–3 mm long; anthers linear (0.9) 1.1–1.3 mm long, the connective tip reddish, usually conspicuous, but less than 0.1 mm long. Styles 1–1.8 mm long; stigmatic branches 2, 1–1.5 mm long. Achenes lenticular, oblong-ellipsoid, 1–1.2 mm long, 0.4–0.6 mm wide, the apex broadly rounded, apiculate, the base cuneate, substipitate, about 0.1 mm long, puncticulate, light brown.

DISTRIBUTION. The Greater Antilles; Belize to Panama; Surinam to Peru, Brazil and northern Argentina; tropical Africa. Brackish marshes; wet, sunny soil and riverbanks; sea level to about 200 m. This species is not yet known to occur in Mexico. It is apparently rare in Central America; only the six collections cited below have been seen. However, it is fairly common in South America, especially in eastern Brazil, Paraguay, Uruguay and northern Argentina.

PHENOLOGY. Flowering and fruiting in April, May and June.

DISCUSSION. This species is separated from *Kyllinga tibialis* chiefly by characters of the inflorescence. In *K. vaginata*, the spike is truncate at the base, while in *K. tibialis* the spike is spherical, rounded at the base. The cylindrical rachis of this species is strikingly different from the spherical one of *K. tibialis*.

Kükenthal (1935–36) and Standley (1938) treated this species as *Cyperus obtusatus* (Presl) Mattf. & Kükenth. Kükenthal apparently did not examine the type of *Kyllinga vaginata*. Lamarck cited two collections in his description, Dombey from Peru, and Roussillon from Senegal. The latter, however, is actually a plant of *K. tibialis*. The Dombey collection is here selected as the lectotype of *K. vaginata*. Two phrases in Lamarck's description indicate such a choice, "culmo inferne vaginato" and "involucro brevi triphyllo". The Roussillon collection lacks a lower culm and has only one involucral bract, while the Dombey collection has a clearly visible sheath on the lower culm, as well as three involucral bracts.

The binomial *Kyllinga peruviana* belongs in the synonymy of this species. Since it was also based on Dombey's collection, it is an illegitimate name, which Kükenthal mistakenly placed in the synonymy of *K. tibialis* Ledeb.

One might confuse *Kyllinga vaginata* with *K. brevifolia,* since both species are rhizomatous. However, *K. brevifolia* has long leaf blades (up to 21 cm long) longer inflorescence bracts (up to 18 cm long) and has only one leafless sheath at the base of the culm, while *K. vaginata* has 2–4.

Not all the characters used by Kükenthal (1935–36) to separate *Kyllinga tibialis* from *K. vaginata* are reliable. He separated the two species as follows:

Leaf blades 1–4; bracts longer than the spike; rachis cylindric .... *K. vaginata*
Leaf blades none; bracts shorter than the spike; rachis hemispherical .... *K. tibialis*

Both species may have leaf blades or lack them, often on adjacent culms from the same rhizome. Similarly, the inflorescence bracts may be longer or shorter than the spike, sometimes on adjacent culms. The difference in the shape of the rachis holds up well, and combined with the combined with the characters in the key used in the present treatment, show that *K. vaginata* is a species amply distinct from *K. tibialis.*

ILLUSTRATION. Pedersen (1970) p. 376, fig. 69 A–C.

SPECIMENS EXAMINED. BELIZE: Stann Creek Dis.: Stann Creek Town, 20 Feb. 1890, *Robertson 103* (BM), and 19 Sept. 1936, *Redmond 8969* (LCU).

GUATEMALA: Depto. Izabal: brackish marsh near Puerto Barrios, 25 April 6 May 1939, *Standley 72157* (F, MICH).

NICARAGUA: Depto. Río San Juan: Greytown (San Juan del Norte), 1867 68, *Tate 506* (BM, K).

COSTA RICA: Prov. Alajuela: Muelle de San Rafaël-San Carlos, June 1890, *Pittier 2587* (BR, US).

PANAMA: Prov. Bocas del Toro: Bocas; along runway bordering mangrove swamp, 17 April 1969, *Lazor, Tyson & Loftin 2408* (FLAS).

5. **Kyllinga tibialis** Ledeb., Diss. bot. pl. doming., p. 6. [May] 1805. TYPE: DOMINICAN REPUBLIC. *Poiteau* (HOLOTYPE: LE!).

K. aphylla (Vahl) Kunth, Enum. pl. 2: 127. 1837. *Mariscus aphyllus* Vahl, Enum. pl. 2: 373 [October] 1805. TYPE: SENEGAL. *Dupuis* (HOLOTYPE: C!).

K. capitata P.-Beauv., Fl. Oware 1 (6), t. 31. 1806. TYPE: not located.

K. globosa P.-Beauv., Fl. Oware 1 (6), t. 31. 1806. TYPE: Palisot de Beauvois, Herb. Fl. Oware (G!).

K. peruviana Lam. var. *foliata* Kükenth., Fedde Rep. 12: 92. 1913. *Cyperus peruvianus* var. *foliatus* (Kükenth.) Kükenth., Pflanzenreich 4 (20: 587. 1936. TYPE: JAMAICA. Ocho Rios, near sea shore, 4 April 1908, *Britton & Hollick 2705* (HOLOTYPE: B; ISOTYPE: NY!).

Perennial, 25–70 (85) cm tall. Rhizome indurate, 3–5 mm thick, clothed with arched, cucullate, broadly ovate-triangular, brown to reddish-brown scales, 3–6 mm long, the internodes (2) 5–10 (15) mm long. Culms single at each node, (1.6) 2.5–3.5 mm thick just above the leaf sheaths, (1.2) 1.6–2 mm thick at the apex, roundly trigonous, hollow, flattened in drying, glabrous. Leaves usually bladeless, the lower culm with 3–7 bladeless sheaths 1–5 (7) cm long, the sheaths with a conspicuous cinnamon-brown, scarious border 0.5–1.2 mm wide; leaf blade infrequently present, 1–5 (8) cm long, 3–7 mm wide, marginally scabrellate near the tip. Inflorescence bracts 3–4, brownish or greenish, 3–6 (20) mm long, (1.5) 3–4 (4.5) mm wide, at anthesis loosely clasping the spikelets, in maturity often deflexed. Inflorescence a solitary, globose head 7–12 mm in diameter; rachis spherical to hemispherical, 1.5–3 (4.2) mm high, 2–3 (4.2) mm wide. Spikelet pedicels closely spaced, separated by less than their own width, 0.4–0.8 mm long, 0.2 (0.3) mm wide. Spikelets about 100–200, broadly to narrowly lanceolate, 3.2–3.8 (4.5) mm long, 1–1.4 mm wide. Scales ovate, 2.5–3.3 mm long, 1.6–2 mm wide, dull greenish or brownish white, (5) 7–9 nerved; keel whitish or greenish, smooth or infrequently with 1–3 spinulose teeth less than 0.1 mm long. Stamens 3; filaments whitish, ribbon-like, 2.7–3.3 mm long; anthers linear, 1–1.5 mm long, the connective tip red, up to 0.1 mm long. Styles 0.4–1 mm long; stigmatic branches 2, 1.3–2.3 mm long. Achene lenticular, oblong-obovate, 1–1.5 mm long, 0.7–0.8 mm wide, apiculate, the apex broadly rounded to subtruncate, the base cuneate to substipitate, the surface puncticulate, brown to reddish brown.

DISTRIBUTION. (Figure 4). Caribbean Islands from Jamaica and Hispaniola to Trinidad; Belize to Panama and Colombia on the Carribean coast only; not recorded from Mexico. Also in tropical West Africa. Sandy beaches, among littoral vegetation of the upper beach, dunes and swales; margins of mangrove swamps and river-banks up to about 70 m.

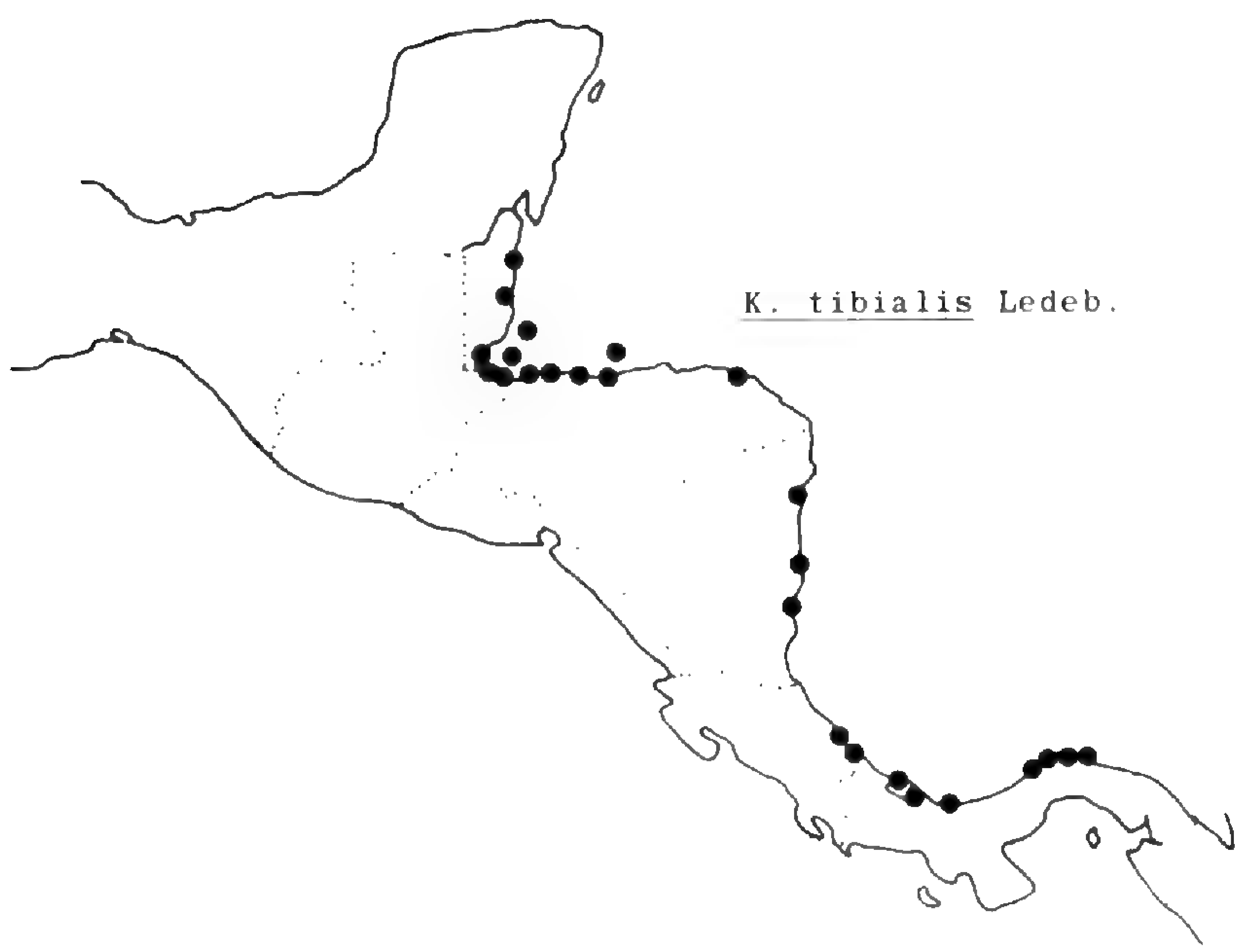

Figure 4. Distribution of *K. tibialis* in Mexico and Central America.

PHENOLOGY. Flowering and fruiting throughout the year.

DISCUSSION. A discussion of the differences between this species and *Kyllinga vaginata* is given under the latter species.

This species is usually easily recognized by its littoral habitat, and its dense globose inflorescence. In collections with several culms on one rhizome, there is usually at least one old culm from which the spikelets have fallen. The spherical rachis thus revealed is a unique character allowing positive identification of *Kyllinga tibialis*.

Kükenthal (1935–36) treated this species as *Cyperus peruvianus* (Lam.) F. N. Williams, based on the illegitimate name *Kyllinga peruviana* Lam. (*see* discussion under *K. vaginata*). Thus, *K. tibialis* is the oldest available epithet for this species, antedating *Mariscus aphyllus* Vahl by a few months.

REPRESENTATIVE SPECIMENS. BELIZE. Belize Dis.: Pine ridge near Manatee Lagoon, *Peck 40* (GH, K). Stann Creek Dis.: Middlesex, *Schipp 382* (F, GH, K, MICH, MO, NY); Dangriga, *Proctor 36595* (MO); Hatchet Cay, *Fosberg 54376* (F, NY); Stann Creek Town, *Croat 24111* (MO). Toledo Dis.: Nicolas Cay, *Spellman & Stoddart 2343* (MO, US); Punta Gorda, *Hedger 271* (BM).

GUATEMALA. Izabal: Livingston, *Deam 72* (GH, MICH, MO, NY); Puerto Barrios, *Kellerman 5133* (MEXU, US), *Standley 25139* (NY, US); NE of Livingston, *Steyermark 39710* (F).

HONDURAS. Atlántida: Tela, *Davidse & Pohl 2176* (MO, US), *Molina R. 25727* (F, MO); vic. of Ceiba, *Yuncker et al. 8247* (F, GH, MICH, MO, NY). Colón: Trujillo Beach, *Saunders 142* (BM, MO). Cortés: Puerto Cortés, *O'Neill 8970* (GH, K); Gracias a Dios; alrededores de Puerto Lempira, *Castro T. 191* (MO). Islas de la Bahía: Roatan Is., Flower Bight Beach, *Molina R. 20671* (ENCB, F, US).

NICARAGUA. Bluefields: El Bluff, *Seymour 641* (BM, F, GH). San Juan del Norte: vic. of San Juan del Norte, *Smith 56* (ENCB). Zelaya: Puerto Cabezas, *Molina R. 14851* (GH, US); Puerto Isabel, *Narvaez S. & Atwood 2944* (F, MSC).

COSTA RICA. Limón: Cahuita, *Baker & Burger 22* (F); between Limón & Río Banano, *Davidse & Pohl 1236* (F, MO); Isla La Uvita, *Echeverría* 45 (F); 15 km S of Puerto Limón, *MacDougal 1190* (DUKE), *Wilbur 30599* (DUKE); 5 km S of Puerto Limón, *Wilbur 30676* (DUKE).

PANAMA. Bocas del Toro: Santa Catalina, *Blackwell et al. 2697* (NY); Changuinola Valley, bar mouth, *Dunlap 520* (F, US); Bocas, *Godfrey 66317* (FLAS); Laguna de Chiriquí and vic., *Hart 79* (US); Canal Zone: Colón to Empire, *Crawford 579* (PH, NY); Caladonia Harbor, *Elmore L36* (MICH, US); 1.5 km SW of mouth of Chagres River, *Nee 8927* (GH, PMA); France Field, *Standley 28585* (US); vic. Fort Sherman, *Standley 31208* (US); Colón: Colón, *Asplund 15157* (NY); vic. Río Piedras near Porto Belo, *Blum et al. 2537* (FLAS); Colón, *Debeaux 44* (PRC); María Chiquita, *Ebinger 451* (F); vic. Santa Isabel, *Pittier 4175* (US).

6. **Kyllinga nudiceps** C. B. Clarke ex Standley, Field Mus. Nat. Hist. Ser. Bot. 4: 199. 1929. *Cyperus nudiceps* (Standl.) O'Neill, Lflt. West. Bot. 4: 38. 1944. TYPE: COSTA RICA, Isla del Coco, *Pittier 16272* (US!; ISOTYPES F!, GH!, LCU!, NY!).

Tufted perennial, (10) 25–40 (55) cm tall. Rhizome short, oblique, 1–3 cm long, (0.5) 2–3 mm thick, closely covered with overlapping, reddish-brown, broadly ovate scales 1–3 mm long. Roots brownish, finely pubescent especially near the rhizome. Leaves bladeless, the base of the culms with about 3 reddish-brown, scarious sheaths (0.6) 2–8 cm long, densely reddish spotted along the apical margins. Culms 0.4–0.8 mm thick just above the apex of the longest sheath, 0.4–0.6 (0.9) mm thick just below the inflorescence. Inflorescence bracts 2 or 3, rather broadly ovate, 1.3–2.8 (3.5) mm long, the cusp an additional 1–2 mm long, 1.5–2.5 mm wide, light reddish-brown to sordid whitish, smooth or often sparsely scabrous along the keel distally, erect to ascendent at anthesis, stiffly erect and clasping the rachis after the spikelets fall. Spike loosely hemispherical, 3.5–4.5 mm high, 5–6 mm wide. Rachis cylindric, (0.9) 1.3–1.8 mm long, (0.4) 0.6–0.8 mm thick; spikelet pedicels rather densely packed, separated by less than their own width, 0.2–0.35 mm long, 0.15–0.2 mm wide, abaxially with a conspicuous toothlike scar from the lowest sterile scale. Spikelets 15–45, elliptic, 2–2.8 mm long, 0.7–1.2 mm wide, dull white to light, greenish-brown. Scales 2–2.4 mm long, 1.4–2.1 mm wide, 7–11 nerved, keel green to dull whitish, smooth, the apiculate apex up to 0.1 mm long. Stamens 1, 2 or 3; filaments dirty white to light brown, 2–3 mm long; anthers linear-oblong, 0.8–1.1 mm long, the connective tip reddish, up to 0.1 mm long. Styles 0.4–1.4 mm long; stigmatic branches 2, 1.4–2 mm long. Achenes lenticular, broadly ovate, 1.1–1.2 mm long, 0.75–0.8 mm wide, the apex obtuse, the style persistent, the base cuneate to substipitate, surface essentially smooth, light brown.

Distribution. Endemic to Isla del Coco (Cocos Island), Costa Rica (5°31′N lat., 87°03′W long.), in the Pacific Ocean. No collection data on habitat or elevation are available, but the highest point on the island, Cerro Yglesia, is 634 m.

Phenology. Collections have been made in January, July and December.

Discussion. Standley in the publication of the species, suggested it was most closely related to *K. tibialis,* as indicated by the leafless culms. In the material cited, it was noted that *K. nudiceps* and *K. tibialis* both also have pedicellate spikelets. All other New World species have spikelets that are nearly sessile on the rachis. Standley stated also that *K. nudiceps* could be distinguished from *K. tibialis* by the former's lack of inflorescence bracts. This is inaccurate, for although the inflorescence bracts in *K. nudiceps* are small, these parts are no smaller in proportion to the height of the inflorescence than in *K. tibialis.* The bracts of *K. nudiceps* do differ in their cuspidate, rather than blunt, apices, smooth margins and brownish color from those of *K. tibialis.* Also, the bracts of *K. nudiceps* are not "perfectly smooth," as O'Neill and Ayers (1944) state, since the keel is usually distally scabrellate.

Specimens examined. Only three collections have been seen. Costa Rica: Isla del Coco: July 1889, *Snodgrass & Heller 944* (GH, K, US); Jan. 1902, Pittier 16272 (Holotype: US; isotypes: F, GH, LCU, NY); 5 Dec. 1959, *Klawe 1501* (US).

ACKNOWLEDGMENTS

I thank Prof. Robert L. Wilbur for his advice and support in the research and writing of this study, and for his continuing help in my studies of the Cyperaceae in Mexico and Central America. He, along with Charlotte M. Taylor and John M. MacDougal, made numerous collections in Costa Rica in 1980 and 1981, which have been of much importance. Sue Dickerson and Debbie Gooch typed the manuscript. Dr. P. J. Vorster, University of Stellenbosch, South Africa, provided a microfiche copy of his thesis. Prof. H. Merxmuller, Director of Botanische Staatssammlung, München (M), kindly sent a copy of Ledebour's "Dissertatio botanica...". Mr. N. Hallé, sous-Directeur, Laboratoire de Phanérogamie, Paris, sent photographs of the types of Michaux and Lamarck. Specimens of *Kyllinga* were borrowed from the following herbaria: A, B, BH, BM, BR, C, CAS, CGE, CR, CU, DS, DUKE, E, ENCB, F, FLAS, G, GH, HAL, K, LCU, LE, LL, M, MEXU, MICH, MO, MSC, NY, PENN, PH, PMA, PR, PRC, S, TEX, US, WIS, and Z. My thanks go to the curators of these institutions for making the specimens available on loan.

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APPENDIX I

INDEX OF EXSICCATAE

Abbreviations of *Kyllinga species*

b. . . . *K. brevifolia*	t. . . . *K. tibialis*
n. . . . *K. nudiceps*	p. . . . *K. pumila*
o. . . . *K. odorata*	v. . . . *K. vaginata*

Acosta, M. & J. Dorantes. 185 b. Aguilar H., M. 6 o. Arsene, Fr. 5646 o; 5752 o; 10110 o; 11815 b; 11896 b; 12045 b; 7 8-1910 (E) o; Apr. 1912 (E) b. Abbott, R. Q. 242 o. Allen, P. H. 106 p; 887 p; 1379 (GH) p, (NY) b, p; 6114 p. Asplund, E. 15157 t. Atwood, J. 2093 p.

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APPENDIX II

INDEX TO NAMES IN THIS TREATMENT

The number in parentheses following each binomial tells to which species it is referred in the present treatment.

(C = *Cyperus;* K = *Kyllinga;* M = *Mariscus*)

C. brevifolius (Rottb.) Hassk. (3)
C. densicaespitosus Mattf. & Kükenth. (1)
C. nudiceps (Standl.) O'Neill (6)
C. obtusatus (Presl) Mattf. & Kükenth. (4)
C. obtusatus var. *cylindrostachyus* (Boeck.) Kükenth. (4)
C. peruvianus (Lam.) F. N. Williams (4)
C. peruvianus var. *foliatus* (Kükenth.) Kükenth. (5)
C. tenuifolius (Steud.) Dandy (1)
K. aphylla (Vahl) Kunth (5)
K. brevifolia Rottb. (3)
K. caespitosa Nees (1)
K. caespitosa var. *major* Nees (1)
K. capitata P.-Beauv. (5)
K. cruciformis Schult. (3)
K. elongata H. B. K. (3)
K. flexuosa Boeck. (1)
K. globosa P.-Beauv. (5)
K. laxa Schrad. ex Nees (1)
K. leucocephala Baldw. (2)
K. martiana Schrad. ex Nees (2)
K. monocephala Thunb. (3)
K. monocephala H. B. K. (2)
K. nudiceps Standl. (6)
K. obtusata Presl. (4)
K. obtusata var. *cylindrostachyus* Boeck. (4)
K. odorata Vahl (2)
K. odorata var. *minor* Boeck. (2)
K. odorata var. *rigida* Boeck. (2)

K. peruviana Lam. (4)
K. peruviana var. *foliata* Kükenth. (5)
K. pumila Michx. (1)
K. pumila β. b. *elatior* Kunth (1)
K. pumila var. *elatior* Boeck. (1)
K. pungens Link (4)
K. rigida Baldw. (4)
K. sesquiflora Torr. (2)
K. sororia Kunth (3)
K. tenuifolia Steud. (1)
K. tenuis Baldw. (3)
K. tenuis Boeck. (4)
K. tibialis Ledeb. (5)
K. vaginata Lam. (4)
M. aphyllus Vahl (5)

NEW ENGLAND NOTE

THE RE-DISCOVERY OF *SOLIDAGO ODORA* AIT. (ASTERACEAE) IN VERMONT

PETER F. ZIKA

Solidago odora Ait. is at the northern limit of its range in southeastern Vermont and is on the Vermont rare and endangered species list (Countryman, 1978). Oakes (1842) mentioned the species in his catalogue of Vermont plants, but by the time Brainerd et al. (1900) compiled the Vermont flora, the vouchers could not be located. The only specimens that have survived are those W. H. Blanchard collected in September 1901 from Vernon, Windham Co. (Eggleston et al., 1915). Blanchard found "one large clump of plants", in the vicinity of *Lespedeza* ×*nuttalii* Darl. and *Aureolaria pedicularia* (L.) Raf., at the border of Line's Woods. In October of 1982 I rediscovered a colony of 30 *S. odora* at the edge of open, dry oak woods about one mile north of Lily Pond, in the central part of Vernon [*Zika 6758* (VT)]. Nearby were *Aureolaria pedicularia*, *Lespedeza hirta* (L.) Hornemann and a small colony of *Bartonia virginica* (L.) BSP. All of these species are rare plants in Vermont.

Blanchard also collected *Solidago odora* in 1901 from the east side of the Connecticut River, on the Drewsville Plains and on Fall Mountain, in Walpole, Cheshire Co., New Hampshire [*Blanchard s.n.* (VT)]. In view of the species persistence in Vernon, it seems likely it will be rediscovered in nearby Walpole as well.

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NOTICE OF PUBLICATION

THE CONNECTICUT BOTANICAL SOCIETY, INC.

Memoirs of the Connecticut Botanical Society
No. 1. April, 1984

A CONVERSATION WITH HARRY AHLES
(1924–1981)

Harry Ahles was well-known in the world of botanists as an indefatigable collector and a person of unusually broad knowledge. As the curator for the University of Massachusetts Herbarium, Amherst, he was composing a flora of New England at the time of his death. In August of 1980, three Connecticut Botanical Society members met with Ahles and recorded his comments on the flora of Connecticut. As the species were discussed (in phylogenetic order) he revealed many clues to aid in field identification and to the separation of confusing look-alikes. He described key characters, habitat requirements, and ranges and also gave his opinions on the status of various taxa in Connecticut and Massachusetts. A transcript was made of that lengthy conversation and is presented in this *Memoir* in edited and annotated form. It is the first publication of a series devoted to providing information to all who study and appreciate plants. *To order:* send check or money order for $3.50 to:

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AN AWARD FOR THE SUPPORT OF BOTANICAL RESEARCH IN NEW ENGLAND, U.S.A.

The New England Botanical Club is offering an award of $1,000 in support of botanical research to be conducted in the New England region during 1985. It is being made to stimulate and encourage botanical research on the New England flora and to make possible visits to the New England region by those who would not otherwise be able to do so. The award will be given to the graduate student submitting the best research proposals dealing with field studies in systematic botany and plant ecology, but proposals for research in other areas of botany will also be considered. This award is not limited to graduate students at New England institutions. The NEBC's support must be acknowledged in any publications resulting from this study. It is encouraged that papers based on this research be submitted to RHODORA, the Club's journal, for possible publication—subject to standard review processes. The New England Botanical Club hopes to be able to make this award on an annual basis.

Applicants should submit a proposal of no more than three double spaced pages, including a budget (the budget will not affect the amount of the award), and their *Curriculum Vitae*. Two letters, one from the student's major professor, in support of the proposed research are also required. Proposals and supporting letters should be sent before 28 February 1985 to: Awards Committee, The New England Botanical Club, 22 Divinity Avenue, Cambridge, MA 02138. The recipient of the award will be notified by 30 April 1985.

Joint Meeting: June 23–27, 1985

The annual Joint Field Meeting of
The Northeastern Section of the Botanical Society of America
The Torrey Botanical Club, and
The Philadelphia Botanical Club
will be held in East Stroudsburg, PA. Accommodations will be at East Stroudsburg University.

There will be field trips to boreal bogs, limestone dells, upland forests and swamps at various sites in the Pocono Mountains and Delaware Water Gap area of Pennsylvania, as well as adjacent New Jersey.

Space is limited and PRIOR registration is required. Full details will be available after February 1, 1985, by writing the chairman:

James K. McGrath, Vice President
Delaware Valley Conservation Society
Box 393
Lansdowne, PA. 19050

MEETING ANNOUNCEMENT

EIGHTH ANNUAL CONFERENCE ON THE CONNECTICUT RIVER ECOSYSTEM

The Eighth Annual Research Conference on the Connecticut River Ecosystem will be held on Saturday, 27 April 1985. Anyone currently conducting research on the geology, botany, zoology, or ecology of the Connecticut River, its floodplain, or associated wetlands is encouraged to present a paper at the meetings.

The conference will be held at the Mountain School in Vershire, Vermont. The school is easily accessible from Route 91 in rural eastern Vermont, and is located on a tributary of the Connecticut River. The Mountain School has had a long-standing commitment to environmental education, and presently serves as focal point for the environmental issues and farm programs of Milton Academy.

For additional information contact:

Dr. Kevin Mattingly	or	Dr. Marjorie Holland
Environmental Sciences		Dept. of Biology
The Mountain School Program of Milton Academy		School of Arts and Sciences
Vershire, Vermont 05079		College of New Rochelle
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Submission of a manuscript implies it is not being considered for publication simultaneously elsewhere, either in whole or in part.

Manuscripts should be submitted in **triplicate** (an original and two xerox copies) and *must be double-spaced* (at least 3/8 of an inch) **throughout** including footnotes, figure legends, and references. Please do not use corrasable bond. The list of legends for figures and maps should be provided on a separate page. Footnotes should be used sparingly. Do not indicate the style of type through the use of capitals or underscoring, particularly in the citation of specimens. Names of genera and species may be underlined to indicate italics in discussions. Specimens citations should be selected critically, especially for common species of broad distributions. Systematic revisions and similar papers should be prepared in the format of "A Monograph of the Genus Malvastruın", S.R. Hill, Rhodora 84: 1–83, 159–264, 317–409, 1982, particularly with reference to indentation of keys and synonyms. Papers of a floristic nature should follow, as far as possible, the format of "Annotated list of the ferns and fern allies of Arkansas", W. Carl Taylor and Delzie Demaree, Rhodora 81: 503–548, 1979. For bibliographic citations, refer to the Botanico-Periodicum-Huntianum (B-P-H, 1968), which provides standardized abbreviations for journals originating before 1966. All abbreviations in the text should be followed by a period, except those for standard units of measure and direction (compass points). For standard abbreviations and for guidance in other matters of biological writing style, consult the *CBE Style Manual,* 5th ed. (original title: *Style Manual for Biological Journals*). In preparing figures (maps, charts, drawings, photos, etc.) please remember that the printed plate will be 4 x 6 inches; be sure that your illustrations are proportioned to reduce correctly, and indicate by blue pencil the intended limits of the figures. (Some "turn-page" figures with brief legends will be 3 1/2 x 6 in.) Magnification/reduction values given in text or figure legends should be calculated to reflect the actual printed size. An Abstract and a list of Key Words should be supplied at the beginning of each paper submitted, except for a very short article or note.

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JOURNAL OF THE

NEW ENGLAND BOTANICAL CLUB

VOLUME 86

1984

The New England Botanical Club, Inc.
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Vol 86, No. 847, including pages 239–395, was issued September 26, 1984

U.S. POSTAL SERVICE

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(Required by 39 U.S.C. 3685)

1. TITLE OF PUBLICATION	A. PUBLICATION NO.	2. DATE OF FILING
RHODORA	0 0 3 5 4 9 0 2	Sept.25,1984

3. FREQUENCY OF ISSUE	A. NO. OF ISSUES PUBLISHED ANNUALLY	B. ANNUAL SUBSCRIPTION PRICE
Quarterly	4	$20.00

4. COMPLETE MAILING ADDRESS OF KNOWN OFFICE OF PUBLICATION *(Street, City, County, State and ZIP Code) (Not printers)* Middlesex County

New England Botanical Club, Harvard University Herbarium,22 Divinity Ave.Cambridge,Mass. 02138

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New England Botanical Club,Inc.,c/O Harvard University Herbarium,22 Divinity Ave.,Cambridge, Mass.,02138

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