Herbert John Webber (see page 193)

Copy of a portrait by his daughter, Mrs. Fera Ella Shear.

Frontispiece to Volume 8, Madroño.

MADROÑO

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CONTENTS

ERRATA

Page 29, line 15: for *L.* read *Lepidium.*
Page 56, line 16: for *rhombifolia* read *rhombifolium.*
Page 62, line 17: *for* 60 m. *read* 60 ft.
Page 62, line 38: *for* 60 meters *read* 60 feet.
Page 80, line 12: for *Gilia* read *Navarretia.*
Page 80, line 13: for *G. virgata* read *N. virgata.*
Page 141, line 29: for *viriginicum* read *virginicum.*
Page 196, line 31: *for* 1–5 mm. *read* 1–5 cm.
Page 196, line 42: *for* 1–5 mm. *read* 1–5 cm.

VOLUME VIII NUMBER 1

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A CYTO–TAXONOMIC STUDY OF THE NORTH AMERICAN SPECIES OF MELICA

W. S. Boyle

Recent students of experimental taxonomy have made it evident that a clear understanding of the taxonomy of any group of plants will be greatly facilitated by a knowledge of the cytology and breeding behavior of the species in question. The present study is an attempt to apply such data with the invaluable evidence gained from a study of morphology and geographic distribution, in order to define the specific lines and probable relationships of the North American species of *Melica.*

This group has had no revision since Scribner's brief synopsis in 1885 (9). A considerable mass of specimens which have never been studied as a unit has accumulated in the various herbaria of the country. The absence of polyploidy in the species of *Melica* studied by Stebbins and Love (11) made it desirable to investigate the cytology of as many species as possible in view of the fact that every other large, widespread, perennial genus in the Festuceae has polyploid species.

The problem has been approached from the following points of view. (1) The problem was first posed in relief by the usual herbarium study. (2) Karyotypes of fourteen of the seventeen species were obtained. In most species both haploid and diploid chromosome complements were studied and recorded. (3) The breeding behavior of the *Melica imperfecta–M. Torreyana–M. californica* complex was studied. (4) Thirteen of the seventeen species were observed in culture. (5) Eight of the western species were studied extensively in the field. No living material of *Melica Smithii, M. montezumae* or *M. spectabilis* has been seen.

It is a pleasure to acknowledge the substantial help which has been received during the course of this study. Dr. Herbert L. Mason has very generously given most valuable advice and direction. Dr. Lincoln Constance has extended very considerable help and encouragement throughout the study. In connection with the cytogenetic section and certain phases of the systematic treatment I am particularly indebted to Dr. G. Ledyard Stebbins, Jr.

Sincere thanks are also due to the curators of the following institutions (designated in the text by indicated initials) who have permitted me the loan of specimens under their care: Provincial Museum of Natural History, Victoria (BC); California Academy of Sciences (CA); Gray Herbarium, Harvard University (G); Missouri Botanical Garden (M); New York Botanical Garden (NY); University of Oregon (O); Dudley Herbarium, Stanford University (S); University of California (UC); United States National Herbarium (US); Vegetation Type Map Herbarium,

Madroño, Vol. 8, pp. 1–32. February 15, 1945.

California Forest and Range Experiment Station, United States Forest Service, University of California (VTM); Rocky Mountain Herbarium, University of Wyoming (W); State College of Washington (WS).

Cytogenetic Investigations

Cytology

Diploid karyotypes were studied largely from root-tip sections and haploid from the first division of the pollen grain nucleus. Smears of root tips and intercalary meristems were utilized to a minor extent but these were much less satisfactory for study than the cut sections. The division of the generative nucleus proved less suitable than the division to form the generative and tube nuclei.

Anthers were taken from plants in the field or from plants grown in the greenhouse. Root tips were taken from potted plants either grown from seed or transplanted from the field. Collection stations and a key to the illustrated karyotypes are indicated in Table 1.

Table 1. Key to Illustrations of Melica Karyotypes and Sources of Material

Figure number	Species	Source of material
1	*M. Geyeri*	Napa County, California, *W. S. Boyle 1075*
2	*M. imperfecta*	Santa Clara County, California, *W. S. Boyle 1066*
3	*M. fugax*	Nevada County, California, *W. S. Boyle 1105*
4	*M. frutescens*	San Diego County, California, *A. A. Beetle 3151*
5	*M. Harfordii*	San Benito County, California, *G. L. Stebbins 2763*
6	*M. bulbosa*	Elko County, Nevada, *K. H. Beach 1564*
7	*M. stricta*	Elko County, Nevada, *K. H. Beach 1512*
8	*M. Torreyana*	Santa Clara County, California, *W. S. Boyle 1068*
9	*M. nitens*	Bexar County, Texas, *W. A. Silveus*
10	*M. mutica*	Durham, North Carolina, *G. L. Church*
11	*M. Porteri*	El Paso County, Colorado, *W. A. Silveus*

Root tips were killed and fixed according to Randolph's (8) modification of Navashin's fixative. After embedding in paraffin the tips were sectioned at 10 microns and stained with gentian violet. Smear preparations were made according to the iron-aceto-carmine method (4).

Drawings were made with the aid of a camera lucida at a magnification of 5000 ×. They are reproduced at 2500 ×.

The principal data obtained from the cytological study may be summarized as follows:

1. The diploid number eighteen, and haploid number nine, is constant in all species investigated.
2. There is little variation in karyotype between species.

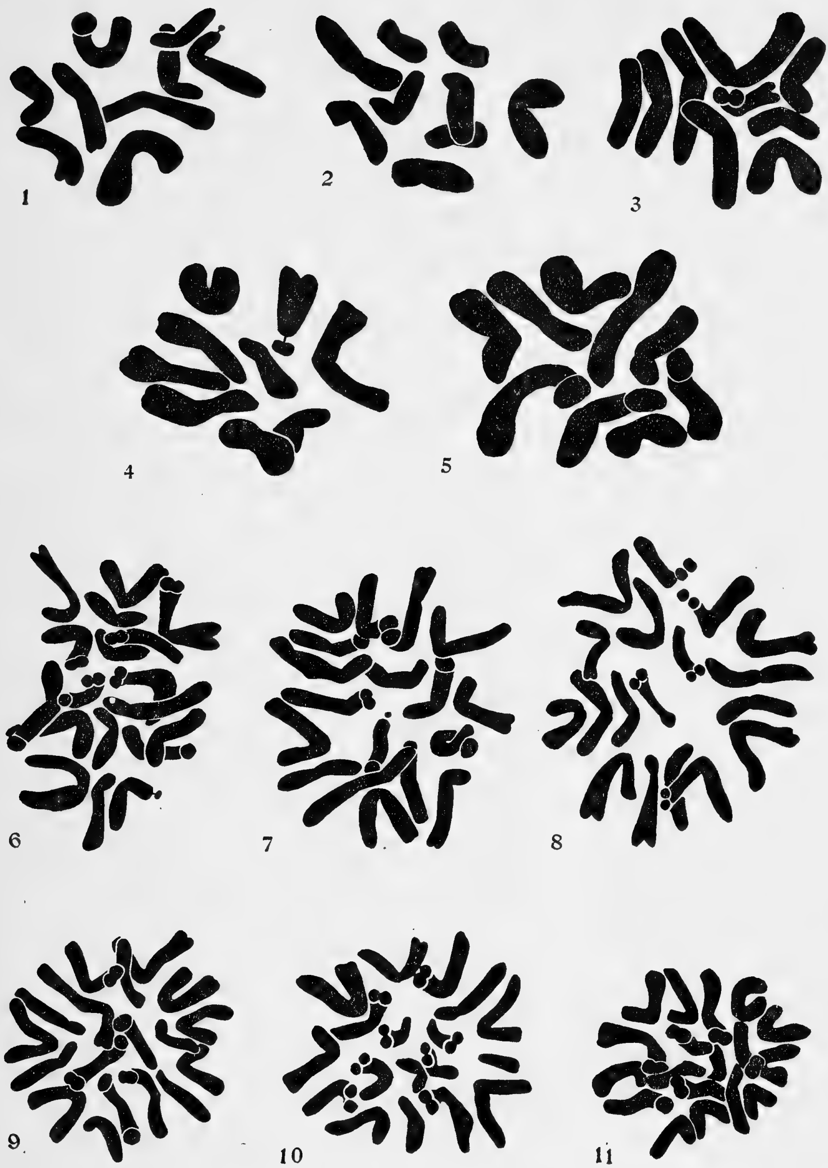

Plate 1. Chromosomes of Melica. 1, *M. Geyeri;* 2, *M. imperfecta;* 3, *M. fugax;* 4, *M. frutescens;* 5, *M. Harfordii;* 6, *M. bulbosa;* 7, *M. stricta;* 8, *M. Torreyana;* 9, *M. nitens;* 10, *M. mutica;* 11, *M. Porteri.* Haploid karyotypes from first division of the pollen grain nucleus; diploid, from root tip sections. All drawings made with camera lucida at 5000× and reproduced at 2500×.

3. The marked uniformity and stability of the chromosome complement in *Melica* constitute important evidence for retaining *Melica* as a distinct and well-marked genus.

4. Chromosome morphology and number have been of relatively small value in aiding the differentiation of specific lines within the genus.

The absence of polyploidy in *Melica* is most remarkable in view of the fact that practically all other large, widely distributed perennial genera of the Festuceae have polyploid species. Artificially induced autotetraploids and allotetraploids have been studied by Joranson (7). *Melica* will offer an almost unequalled opportunity for studying the differentiation and evolution of species in the Gramineae unencumbered by the complex problems of polyploidy and gross chromosome alteration.

The earliest cytological study of this genus was made by Avdulov (1), who investigated four European species. The karyotypes illustrated by Avdulov are basically similar to those of the North American species thus far known. The cytology of the North American species was completely unknown until as recently as 1941 when Stebbins and Love (11) studied seven species in connection with a cytological survey of California forage grasses. Karyotypes of *Melica aristata, M. subulata* and *M. californica* were illustrated. Since study of these three species by the author disclosed no additional information, illustrations of their karyotypes are omitted in this study.

Breeding Experiments

Aspects of the breeding behavior of one species complex (*Melica californica, M. Torreyana, M. imperfecta*) within the genus have been studied as far as the F_2 generation. The latter two species are very closely related and at the beginning of this study were thought probably to represent one ecospecies.

Two principal methods were used in producing the hybrids. (1) Interspersing the two species freely with one another as they approached anthesis. Hybrids were relatively easily detected by an intermediate condition of the rudiment, spikelet size and floret number. (2) Emasculation of the panicle of one species and surrounding this plant with members of the other species with which the cross was desired. Hybrids between *M. Torreyana* and *M. californica* were difficult to obtain. A sufficient number for reliable data was not obtained.

Hybrids were self-pollinated by enclosing the panicle in a glassine sack or by allowing the plant to reach anthesis and fruiting state in the open. Spikelets were harvested when mature and examined for seed content. The breeding results are summarized in Table 2. Each of the species was allowed to reproduce in order to afford evidence regarding fertility within the species. Representative results are indicated in Table 3.

TABLE 2. SUMMARY OF BREEDING RESULTS BETWEEN SELECTED SPECIES OF MELICA, F_1 GENERATION

	Florets produced	Caryopses produced
M. imperfecta and *M. Torreyana*		
Total selfed *imperfecta* × *Torreyana*	954	13
Total open *imperfecta* × *Torreyana*	3660	9
Total selfed *Torreyana* × *imperfecta*	523	9
Total open *Torreyana* × *imperfecta*	617	2
Grand total number of florets produced	5754	..
Grand total number of caryopses produced	....	33
Sterility: 99.4%		
M. imperfecta and *M. californica*		
Total selfed *imperfecta* × *californica*	194	14
Total open *imperfecta* × *californica*	877	6
Total selfed *californica* × *imperfecta*	133	12
Total open *californica* × *imperfecta*	173	19
Grand total number of florets produced	1377	..
Grand total number of caryopses produced	....	51
Sterility: 96.2%		

TABLE 3. SUMMARY OF BREEDING RESULTS WITHIN SELECTED SPECIES OF MELICA, F_1 GENERATION

	Florets produced	Caryopses produced
M. imperfecta		
Total selfed	161	144
Total open	800	605
Grand total	961	749
Sterility: 22.0%		
M. Torreyana		
Total selfed	373	320
Total open	110	57
Grand total	483	377
Sterility: 21.8%		
M. californica		
Total selfed	452	178
Total open	43	21
Grand total	495	199
Sterility: 59.8%		

The F_1 hybrids were vigorous in all crosses; heterosis was usually exhibited. Pollen sterility of the hybrids ranged from 75 per cent to 86 per cent. Pollen sterility of the species ranged from 2 per cent to 9 per cent.

The more significant characteristics of these three species are summarized in the following points:

1. *Melica Torreyana* and *M. imperfecta* are able to cross. The hybrids are vigorous and almost completely sterile.

2. *Melica imperfecta* and *M. californica* are able to cross. The hybrids are likewise vigorous and almost completely sterile.

3. The F_2 generation exhibits a definite decrease in vigor.

4. The species are relatively highly fertile: *M. Torreyana,* 78 per cent; *M. imperfecta,* 75 per cent; *M. californica,* 40 per cent.

5. Herbarium and field studies indicate marked morphological discontinuity between *M. imperfecta, M. Torreyana, M. californica.*

6. A moderate but not marked amount of geographic and ecologic segregation exists between these species.

Each of these three entities is worthy of specific rank. They have morphological discontinuity; their hybrids are nearly sterile and have weakened vigor in the F_2 generation; they exhibit a moderate amount of geographic and ecologic segregation.

Relationships and Phylogeny

The natural relationships of *Melica* present a perplexing problem. Morphologically, the monotypic genus *Schizachne* most closely approaches *Melica.* It has in fact been united with *Melica* by some authors. Investigation of the cytology of *Schizachne* by the author (2) afforded evidence for its exclusion from *Melica.*

Skorniakov and co-workers (10) have suggested that *Melica, Schizachne, Pleuropogon, Glyceria* and *Anthocloa* constitute a natural group and should be segregated as the tribe Melicineae. As thus constituted the Melicineae, in their opinion, serve as a connecting link between the Aveneae and Bromeae. In addition, they are of the opinion that the true relationships of *Melica* are with the Aveneae and not the Festuceae.

This viewpoint has much to recommend it. The common possession by the above genera of united, collar-like lodicules, dichotomously branching stigmas, glabrous caryopses, weak glumes and firm lemmas strongly suggests closer genetic relationship than students of the Gramineae have thus far ascribed to these genera.

The most primitive features of the genus are exhibited by *M. Smithii, M. subulata* and *M. Harfordii.* They have large spikelets with several florets, lemmas awned or long attenuate and sterile florets similar to the fertile. The most highly specialized features are exhibited by *M. mutica, M. montezumae, M. imperfecta* and *M. Torreyana.* Their characteristics include convolute and club-shaped sterile florets, development of articulation below the glumes (in the former two species), and reduction in size and number of florets. The section Eumelica as herein defined, is regarded as a specialized offshoot from the other more primitive North American species.

While a discussion of the relationships of the South American, European and Asiatic species of *Melica* is outside the scope of this study, certain general relationships can be indicated. These species all seem clearly to belong to specialized groups judging from their similarity to the North American *M. mutica, M. nitens* and *M. montezumae.* With the exception of *M. subulata* (which is probably an introduction) all of the South American species apparently belong to the section *Eumelica.*

Although investigations upon the geologic history of this group are incomplete, the author is inclined to believe that *Melica* had its origin in northwestern America and that there was a subsequent migration eastward and southward.

Taxonomic Treatment

The earliest taxonomic study involving North American species of *Melica* was contained in a short discussion of the Californian species by Bolander (3) in 1870. The North American species were first treated as a unit by Scribner (9) in 1885. Scribner divided the genus into three sections based on floret number, texture and nervation of the lemma and presence or absence of awns. This division of the genus is here considered unsound since these criteria do not provide a basis for a natural division of the genus. Scribner's concept of species within the genus, however, is largely satisfactory.

Farwell (5) proposed the genus *Bromelica* to include certain species of *Melica* and *Schizachne purpurascens.* Species in *Bromelica* were then presumably characterized by non club-shaped rudiments, membranous glumes and lemmas, and awned or notched lemmas. These criteria were found not to be distinctive when compared with the remaining *Melica* species. Cytological evidence previously discussed indicates that *Schizachne* should be segregated from *Melica* and that *Melica* as defined in the present study constitutes a natural unit.

Hitchcock (6, 193–204) followed Scribner's treatment closely in delimiting specific lines. The significant changes are rearrangement of the subgenera and keys, a more detailed review of the synonomy and additional information on the distribution of the species. Two of Scribner's subgenera are retained by Hitchcock but their descriptions were emended as follows: *Bromelica* with narrow spikelets, acute or awned lemmas (except *Melica Harfordii*); *Eumelica* with broad spikelets and obtuse or awnless lemmas. This division of the genus is likewise considered faulty. The character of narrow spikelets applies to *Melica Porteri, M. Torreyana, M. fugax, M. californica, M. frutescens* and *M. bulbosa,* all of which were placed in *Eumelica* by Hitchcock. Acute lemmas are not uncommon in *M. Torreyana, M. spectabilis* and *M. bulbosa,* yet these species were placed in *Eumelica.*

It is evident that a new arrangement of the species in the sections is necessary. The genus may be divided naturally and easily on the basis of striking differences in the articulation of the spikelets. In five species the articulation is almost invariably below the glumes, allowing the spikelet to fall as a whole at maturity. In the remainder of the species the articulation is almost invariably above the glumes. It is here proposed, therefore, that the species in which the articulation is below the glumes be segregated as the Section *Eumelica* and those in which the articulation is above the glumes as the Section *Bromelica*.

Melica L. Fl. Lappon. 23. 1737. *Chondrachyrum* Nees, Lindl. Introd. Nat. Cyst. 11: 449. 1836. *Dalucum* Adans. Fam. ii: 323. 1763. *Bromelica* Farwell, Rhodora 21: 77. 1919.

Perennial; culms frequently bulbous at the bases, often attached to a rhizome; sheaths closed, blades flat; ligule 1 to 10 mm. long, often lacerate and decurrent; panicle simple or compound, very narrow to widely spreading; spikelets 1- to 6-flowered, articulation above or below the glumes; terminal floret or florets sterile, similar to fertile florets or reduced to an obovoid, blunt rudiment; glumes less firm than the lemmas, margins and apices hyaline or papery, not keeled, obtuse to acute, 3- to 5-nerved, in some species equaling the spikelet; lemmas firm, not keeled, the apices and upper margins hyaline, usually 7-nerved, awned or awnless; awn if present straight, occasionally from a bifid apex; palea usually three-fourths the length of lemma, rarely as short as one-half as long; callus glabrous; lodicule a truncate, collar-like scale; stigmas dichotomously branched; caryopsis smooth and shining, free.

Key to the North American Species of Melica

Articulation above the glumes and between the florets . . . Section 1. *Bromelica*
Articulation below the glumes, spikelet at maturity falling entire . . . Section 2. *Eumelica*

Section 1. Bromelica

A. Lemmas awned.
B. Awn short, usually less than 4 mm. long; blades long and narrow; lemma narrowing to an obtuse and often emarginate apex; lower margin of lemma usually densely ciliate-pubescent . . . 3. *M. Harfordii*
BB. Awn longer, usually 5–9 mm. long, blades short, or if long at least 6 mm. wide; apex of lemma not obtuse; lower margin of lemma glabrous, scabrous or only slightly ciliate.
C. Panicle narrow, the branches appressed to ascending; blades short, usually about 9 cm. long, very rarely more than 5 mm. wide; brownish swelling in axils of panicle branches none . . . 4. *M. aristata*
CC. Panicle broad; branches widely spreading to often reflexed; blades long, usually about 18 cm. long and from 6 to 15 mm. wide; a small brownish swelling present in axils of panicle branches . . . 5. *M. Smithii*
AA. Lemmas not awned.
D. Culms bulbous at the bases.

E. Lemmas tapering-acuminate, usually strongly so, almost invariably ciliate-pubescent on the nerves .... 1. *M. subulata*

EE. Lemmas merely acute or obtuse, glabrous.

F. Rachilla swollen, usually wrinkled in drying .... 6. *M. fugax*

FF. Rachilla normal, not swollen.

G. Panicle at maturity open and broad, branches long and spreading; first and second florets about 2.5 mm. apart; spikelets usually about 16 mm. long ..... 2. *M. Geyeri*

GG. Panicle narrow or only slightly spreading; first and second florets rarely as much as 2 mm. apart; spikelets usually considerably less than 16 mm. long.

H. Bulb of the culm small, globose, "tailed" at base, i.e., bulb not attached directly to rhizome; first glume less than half as long as the spikelet ...... 7. *M. spectabilis*

HH. Bulb of the culm attached directly to rhizome (if rhizome present); first glume more than half as long as spikelet.

I. Panicle very narrow, the branches and spikelets appressed.

J. Rudiment almost always blunt; not exserted; culms more or less swollen towards the base and usually constricted in one or more places; no woody rhizome present; coast ranges and foothills of the Sierra Nevada of California .... 8. *M. californica*

JJ. Rudiment tapering above, almost invariably slightly exserted; culms more or less bulbous at the bases and attached directly to a woody rhizome, the latter usually present in older plants; higher elevations (usually above 4000 feet), Pacific Coast and as far east as the Rocky Mountains ...... 9. *M. bulbosa*

II. Panicle somewhat spreading, the branches stiffly ascending; spikelets pale; lemmas strongly nerved ...... 9a. *M. bulbosa* var. *inflata*

DD. Culms not bulbous at the bases.

K. Fertile florets 1 or 2.

L. Rudiment 1 mm. long, on a stipe 2.5 mm. long, this usually slightly swollen; lemma pubescent near the tip .. 10. *M. Torreyana*

LL. Rudiment usually 2 mm. or more in length, on a short unswollen stipe 0.5 mm. long, lemma glabrous or scabrous .... 11. *M. imperfecta*

KK. Fertile florets more than 2.

M. Lemmas pilose-ciliate on the lower margins .... 3. *M. Harfordii*

MM. Lemmas glabrous or scabrous.

N. Palea about half the length of the lemma; spikelets often pale and shining, usually about 14 mm. long; plant tall, robust, desert regions .... 12. *M. frutescens*

NN. Palea three-fourths the length of the lemma; spikelets usually about 1 cm. long.

O. Rudiment almost always blunt, not exserted; culms more or less swollen towards the base and usually constricted in one or more places; no woody rhizome present; coast ranges and foothills of the Sierra Nevada of California .... 8. *M. californica*

OO. Rudiment tapering above, almost invariably slightly exserted; culms attached directly to a woody rhizome, the latter usually present in older plants; higher elevations (usually above 4000 feet), Pacific Coast and as far east as the Rocky Mountains ... 9. *M. bulbosa*

Section 2. Eumelica

A. Rudiment blunt, club-shaped or obconic, very rarely tapering above.

B. Spikelets with 1 perfect floret; back of lemma bearing a group of flat, twisted hairs .... 13. *M. montezumae*

BB. Spikelets with more than 1 perfect floret; lemmas glabrous or scabrous.

C. Panicle simple, rarely compound; rudiment almost invariably bent at an angle to the rachilla; interior sterile lemmas extruding; apices of fertile florets very nearly the same height .... 14. *M. mutica*

CC. Panicle usually compound; branches spreading; rudiment never bent at an angle toward rachilla; interior sterile lemmas very rarely extruding; apices of fertile florets not the same height .... 15. *M. nitens*

AA. Rudiment almost invariably tapering above, not blunt, club-shaped or obconic.

D. Spikelets broadly V-shaped when mature, glumes as long or nearly as long as the spikelet .... 16. *M. stricta*

DD. Spikelets narrow, florets appressed; glumes one-half to two-thirds the length of the spikelet .... 17. *M. Porteri*

1. Melica subulata (Griseb.) Scribn. Proc. Acad. Nat. Sci. Phila. 37: 47. 1885. *Bromus subulatus* Griseb. Ledeb. Fl. Ross. 4: 358. 1853. *Melica acuminata* Boland. Proc. Calif. Acad. Sci. 4: 104. 1870. *M. Pammeli* Scribn. Proc. Davenport Acad. Sci. 7: 240. 1899. *Bromelica subulata* Farwell, Rhodora 21: 78. 1919.

Culms up to 125 cm. long, bulbous at the bases and attached to a rhizome; blades 2–10 mm. wide, panicle 8–25 cm. long, averaging 16 cm., usually narrow, occasionally spreading, branches rarely longer than 9 cm.; spikelets 10–28 mm. long, averaging 18 mm., florets 2–5, loosely flowered; glumes acute to sub-acute, first glume 4–7 mm. long, averaging 5 mm., second glume 6–9 mm. long, averaging 7.5 mm., very thin, purple- or brown-tinged; lemmas narrowed above to a long attenuate apex, rarely merely acute, not awned, almost invariably pilose-ciliate on the backs, first lemma 8–15 mm. long, averaging 11 mm.; anthers 2 mm. long; caryopses 4–5 mm. long; rudiment long, tapering above 4–9 mm. long, averaging 6 mm.

Type. Unalaska, *Eschscholtz 4*. The type has not been seen.

Range. Central California northward to Alaska, southeastward in the Rocky Mountains to Sheridan County, Wyoming; also recorded from Chile; distributed chiefly in moist woods, on banks, and on shady slopes.

Representative specimens. California. Butte County: Jonesville, *Copeland 338* (UC, G, M, NY, OW, S). Humboldt County: Humboldt Bay, *Chandler 1174* (UC, G, M, NY, S). Sonoma County: near Occidental, *Boyle 1097*. Oregon. Blue Mountains, *Cusick 3249* (UC, NY, WS, O, US, W, S). Washington. Clallam County: Olympic Mountains, *Elmer 1937* (UC, WS, O, BC, M, NY, S); Island County: Cranberry Lake, *Hitchcock 3468* (UC, NY, WS, W, CA, S).

Melica subulata is related most closely to *M. Geyeri*. Detailed field studies have indicated no evidence of natural crossing.

2. Melica Geyeri Munro ex Boland. Proc. Calif. Acad. Sci. 4: 103. 1870. *M. bromoides* var. *Howellii* Scribn. Proc. Acad. Nat. Sci. Phila. 37: 47. 1885. *Bromelica Geyeri* Farwell, Rhodora 21: 78. 1919. *B. Geyeri* var. *Howellii* Farwell, Rhodora 21: 78. 1919.

Culms up to 200 cm. tall, bulbous at bases and attached to rhizomes; blades 2–8 mm. wide, often short pubescent on upper surfaces; panicle 11–27 cm. long, averaging 18 cm., at maturity loose, spreading, branches distant, spreading to reflexed, up to 14 cm. long; spikelets 8–24 mm. long, averaging 17 mm., florets 2 to 6, loosely flowered; pedicels often flexuous; glumes sub-acute, first glume 3.5–7 mm. long, averaging 5 mm., second glume 5.5–11 mm. long, averaging 7 mm., bronze or purple-tinged; lemmas usually sub-acute, first lemma 8–11 mm. long, averaging 9 mm., often bronze or purple-tinged; anthers 3–4 mm. long; caryopses 4 mm. long; rudiment narrow, tapering above, 3–7 mm. long, averaging 5 mm.

Type. "Russian River Valley [Ukiah, Mendocino County], California," *Bolander*. "No. 40 of my small collection and no. 6119 of the Catalogue, 1867" (UC).

Range. Principally in the coast ranges from Monterey County, California, to northern Oregon; rare in the central Sierra Nevada; chiefly in dry open woods.

Representative specimens. California. Glenn County: Bennet Spring, *Heller 11932* (G, M, NY, CA, S). Mendocino County: Ukiah, *Bolander 40* (UC, type; G, NY, M). Napa County: Calistoga, *Boyle 1072*. Oregon. Josephine County: near Selma, *Henderson 5761* (M, O, W, CA, S).

3. Melica Harfordii Boland. Proc. Calif. Acad. Sci. 4: 102. 1870. *M. Harfordii* var. *minor* Vasey, Bull. Torrey Bot. Club 15: 48. 1888. *M. Harfordii* var. *tenuior* Piper, Contr. U. S. Nat. Herb. 11: 127. 1906. *Bromelica Harfordii* Farwell, Rhodora 21: 78. 1919. *B. Harfordii* var. *minor* Farwell, Rhodora 21: 78. 1919. *Melica Harfordii* var. *tenuis* Suksdorf, Werdenda 1: 17. 1927. *M. Harfordii* var. *viridifolia* Suksdorf, Werdenda 1: 17. 1927.

Culms up to 120 cm. long, densely tufted, blades 2–6 mm. wide, extending widely from culms, as long as 30 cm., averaging 16 cm.; panicle 6–23 cm. long, averaging 15 cm., narrow; spikelets 7–20 mm., averaging 13 mm.; florets 2 to 6; glumes obtuse to sub-acute, first glume 4–10 mm. long, averaging 7 mm., second glume 5–11 mm. long, averaging 8.5 mm., lemmas usually short-awned, awns fragile and usually less than 5 mm. long, pilose ciliate on lower margin, first lemma 6–16 mm. long, averaging 9 mm., apices emarginate, obtuse or narrowly rounded; anthers 3–4 mm. long; caryopses 5 mm. long; rudiment narrow, tapering above, 3–5 mm. long.

Type. "Santa Cruz Mountains near State Road, eastern side

FIG. 1. Distribution of *Melica* in North America.

in Redwoods [near Lexington], California," June, 1865, *Bolander 53* (CA).

Range. Principally in the coast ranges from British Columbia south to Monterey County, occasionally in the central Sierra Nevada below 7000 feet; distributed chiefly on dry slopes or in dry open woods.

Representative specimens. CALIFORNIA. Marin County: Mt. Tamalpais, *Long 189a* (UC, NY, WS, W, CA). Mendocino County: Panther Springs, *Boyle 1081*. OREGON. Ashland Butte, *Cusick 2887* (UC, NY, WS, O, M). Curry County: Port Orford, *Peck 8643* (G, M, NY, O). WASHINGTON. Clallam County: Olympic Mountains, *Elmer 1938* (UC, NY, WS, O, M, BC, S).

Melica Harfordii var. *minor* is here considered simply as applicable to depauperate members of the species. *Melica Harfordii* var. *tenuis* Suksdorf has no valid basis, morphological or geographical. *Melica Harfordii* var. *tenuior* Piper is based on var. *minor* Vasey.

4. Melica aristata Thurb. ex Boland. Proc. Calif. Acad. Sci. 4: 103. 1870. *Bromelica aristata* Farwell, Rhodora 21: 77. 1919.

Culms up to 120 cm. long, densely tufted; sheaths pilose to glabrous; blades short, 6–14 cm. long, averaging 9 cm., 3–6 mm. wide, often pubescent; panicle 10–23 cm. long, averaging 15 cm., usually narrow; spikelets 11–20 mm. long, averaging 14 mm., florets 2 to 3; glumes obtuse to sub-acute, first glume 7–11 mm. long, averaging 9 mm., second glume 7–12 mm. long, averaging 10 mm.; lemmas awned, awns 5–12 mm. long, averaging 9 mm., first lemma 8–13 mm. long, averaging 11 mm., glabrous to slightly ciliate pubescent on lower margins; anthers 2–3 mm. long; caryopses 5–6 mm.; rudiment narrow, tapering above, usually awned, 2.5–6 mm. long.

Type. "Open woods at Clark's" [Wawona], California, June 6 to September, 1866, *Bolander 4861* (UC).

Range. Principally in the Sierra Nevada and Cascade ranges from southern Washington to Tulare County, California; chiefly in dry open woods.

Representative specimens. California. Butte County: Jonesville, *Copeland 337* (UC, G, M, NY, W, O, US, CA, S). Mariposa County: Clark's, *Bolander 4861* (UC, type; M). Tulare County: Bearpaw Meadow, *Long 229a* (UC, NY, W, WS, BC, CA). Oregon. Jackson County: Farewell Bend, *Hitchcock 4963* (NY, WS, S).

Melica aristata is most closely related to *M. Smithii* and *M. Harfordii.* The very short blades are distinctive.

5. Melica Smithii (Porter) Vasey, Bull. Torrey Bot. Club 15: 294. 1888. *Avena Smithii* Porter, A. Gray, Man. ed. 5: 640. 1867. *Melica retrofracta* Suksdorf, Deut. Bot. Monatschr. 19: 92. 1901. *Bromelica Smithii* Farwell, Rhodora 21: 77. 1919.

Culms up to 150 cm. long, loosely tufted, attached to rhizomes, blades lax, 6–15 mm. wide; panicle 13–40 cm. long, averaging 23 cm., open, branches widely spreading to often reflexed, branches rarely in pairs, small brownish swelling in axil of each branch; spikelets 12–20 mm. long, averaging 14 mm., florets 2 to 6, usually 3; glumes acute, first glume 3–6 mm. long, averaging 5 mm., often entirely brown-tinged, second glume 5–9 mm. long, averaging 7 mm.; lemmas awned from bifid apices, awns up to 10 mm. long, averaging 5 mm.; first lemma 9–14 mm. long, averaging 10 mm.; rudiment long, narrow, tapering above, 3.5–6 mm. long, averaging 5 mm.

Type. Woods, Sault Ste. Marie, Michigan, *C. E. Smith.* A photograph of the type which is located in the Academy of Natural Sciences at Philadelphia has been seen.

Range. Southern British Columbia and Alberta, Washington, Oregon, Idaho, Montana and the northern Great Lakes region; specimens have been reported from the Black Hills, South Dakota; cool, moist woods.

Representative specimens. MICHIGAN. Beech-maple forest, *Gleason 18* (G, NY). WYOMING. Teton Mts., *Nelson 6524* (G, NY, M). OREGON. Baker County: Paddys Creek, *Cusick 2239* (UC, G, M, O, WS, US). WASHINGTON. Skamania County: shady places, *Suksdorf 2334* (UC, G, M, O, WS).

6. MELICA FUGAX Boland. Proc. Calif. Acad. Sci. 4: 104. 1870. *M. fugax madophylla* Piper, Contr. U. S. Nat. Herb. 11: 128. 1906. *M. Macbridei* Rowland, Bot. Gaz. 54: 404. 1912. *M. fugax* var. *inexpansa* Suksdorf, Werdenda 1: 1. 1923.

Culms short, occasionally to 65 cm. long, prominently bulbous at bases, usually aggregated together and attached to a light rhizome; blades 2–4 mm. wide; panicle 8–18 cm. long, averaging 10 cm., the short branches widely spreading or appressed; spikelets 4–17 mm. long, averaging 8 mm., florets 2 to 4, loosely flowered, rachilla remarkably swollen, spongy and usually wrinkled in drying; glumes obtuse, first glume 3–5 mm. long, averaging 3.5 mm., second glume 3.5–7 mm. long, averaging 5 mm.; first lemma 4–7 mm. long, averaging 5 mm.; anthers 1–2 mm. long; rudiment narrow, tapering above, 2–3.5 mm. long.

Type. Donner Lake, June, 1869, *Bolander* (G).

Range. Central California to central Oregon east to western Idaho; dry open flats and hillsides or open dry woods, usually on soil of volcanic origin, rarely below 4000 feet.

Representative specimens. CALIFORNIA. Donner Lake, 1869, *Bolander* (G, type; M, NY). Placer County: Yuba River, Cisco, *Heller 12699* (G, M, NY, S). Nevada County: Hobart Mills, *Boyle 1105*. OREGON. Crook County: Summit Prairie, *Cusick 2644* (UC, G, M, NY, O, W, S). IDAHO. Owyhee County: Silver City, *Macbride 948* (UC, G, M, BC, W, S).

The narrow panicled form, while actually common and widespread, has received very little attention in the literature. Suksdorf described the variety *inexpansa* on this character. Specimens possessing this feature have no distinct geographic segregation and intermediate forms are common. It is not here recognized as varietally distinct.

Melica fugax var. *madophylla* Piper is presumably distinguished by the glabrous culms and foliage. Pubescence varies widely in *M. fugax* and there is no geographic segregation of plants possessing this character.

7. MELICA SPECTABILIS Scribn. Proc. Acad. Nat. Sci. Phila. 37: 45. 1885. *M. scabrata* Scribn. in Piper, Fl. Palouse 25. 1901.

Culms up to 100 cm. long, bulbous at bases, the bulbs not attached directly to rhizome but each bulb connected to it by a slender stem; blades 2–5 mm. wide; panicle 5–26 cm. long, averaging 14 cm., narrow to occasionally open, branches often somewhat flexuous; spikelets 7–19 mm. long, averaging 11 mm., florets

3 to 7, turgid; pedicels capillary and often flexuous; glumes obtuse to sub-acute, first glume 3.5–5.5 mm. long, averaging 5 mm., and less than one-half as long as the spikelet, second glume 5–7 mm. long, averaging 6 mm.; lemmas sub-acute or obtuse, first lemma 6–9 mm. long, averaging 7 mm., very broad, lemmas distinctly purple-tinged below the brownish scarious apex, nerves prominent; anthers 2 mm. long; caryopses 3 mm. long; rudiment 1.5–3.5 mm. long, apex narrowed to a small scarious beak, rarely exserted.

Type. Crow Mountains, Montana, 6000 feet, *F. L. Scribner 385,* 1883. The type is presumably in the United States National Herbarium.

Range. Northern California in the coast ranges eastward to Laramie County, Wyoming, south to the La Salle Mountains in southern Utah and northward to British Columbia; chiefly in moist meadows or open woods, rarely below 4000 feet.

Representative specimens. Colorado. Mt. Richthofen, Colo. State College Herb. *3602* (UC, G, NY, US, WS, W, BC). Idaho. Fremont County: Ponds Lodge, *Hitchcock 3855* (UC, WS, W, S). Montana. Bridger Mts., *Rydberg* and *Bessey 3610* (G, NY, W, BC). Oregon. Wallowa Mts., *Cusick 3180* (UC, G, M, NY, WS, O, W). Wyoming. Albany County: Medicine Bow Mts., *Nelson 7747* (G, M, NY, O, W, CA).

Melica spectabilis is most closely related to *M. bulbosa* and is commonly confused with it. The marked contrast of the attachment of the bulb to the rhizome and the comparative length of the glumes and lemmas afford immediate key characters for separation.

8. Melica californica Scribn. Proc. Acad. Nat. Sci. Phila. 37: 46. 1885. *M. poaeoides* Nutt. (misapplied by Torrey) U. S. Rep. Expl. Miss. Pac. 4: 157. 1857. Not *M. poaeoides* Nutt. Jour. Acad. Nat. Sci. Phila. ser. 2, 1: 188. 1848 = *M. imperfecta* Trin. *M. bulbosa* Geyer; Thurb. in S. Wats. Bot. Calif. 2: 304. 1880. Not *M. bulbosa* Geyer; Porter and Coulter, Syn. Flora Colo. 149: 1874 which equals no. 9 of this revision. *M. longiligula* Scribn. and Kearn. U.S.D.A. Bull. Div. Agrost. 17: 225. 1899.

Culms up to 130 cm. long, not definitely bulbous at bases but almost invariably enlarged in the lower portions, usually constricted in one or more places near the bases, densely tufted; blades 2–5 mm. wide; ligule 2–5 mm. long; panicle 4–30 cm. long, averaging 18 cm., very narrow, usually dense, often interrupted below; spikelets 5–15 mm. long, averaging 10 mm., florets 2 to 5, usually 3, chaffy, appearing papery; glumes subequal, first glume 3.5–12 mm. long, averaging 6 mm., second glume 5–13 mm. long, averaging 7.5 mm., occasionally equalling or even exceeding spikelet; lemmas obtuse, emarginate or rarely acute, first lemma 5–9 mm. long, averaging 7.5 mm.; anthers 3 mm. long; caryopses

3 mm. long; rudiment usually blunt or obovoid, rarely tapering above, not exserted, 1–3 mm. long.

Type. Santa Ynez, California, *W. H. Brewer 569* (G).

Range. Coast ranges and lower Sierra Nevada of California; distributed chiefly on dry, rocky, exposed hillsides.

Representative specimens. CALIFORNIA. Mendocino County: South Fork Eel River, *Boyle 1084*. Santa Barbara County: Santa Ynez, *Brewer 569* (G, type). Santa Clara County: Mt. Hamilton, *Elmer 4304* (UC, M, NY, WS, O, CA, S). Sonoma County: *Heller 5351* (M, NY, S). Stanislaus County: Arroyo del Puerto, *Sharsmith 1764* (UC, WS).

The complex synonymy of *Melica californica* was largely clarified by Hitchcock (6, p. 882).

Melica californica may be considered an ecospecies possessing at least two ecotypes and possibly a third. One ecotype occupies the coast ranges of northern, central and south central California; another occupies the foothills of the Sierra Nevada and is here designated as the new variety *nevadensis.* The third entity occupies the southern California coast ranges and is possibly of ecotype status. There is not sufficient geographic segregation as seen from herbarium specimens, to warrant its designation as an ecotype.

8a. MELICA CALIFORNICA var. **nevadensis** var. nov. Spiculae nonnihil sicut V-formatae; glumae acutae, floritumque ultimum saepe excedens; panicula densissima, spiculae specie breviore.

This variety differs from the species in the following characters: (1) spikelet tends to be slightly V-shaped; (2) glumes acute and often exceeding last floret; (3) panicle very dense, especially above; (4) rudiment very blunt, usually truncate; (5) spikelets shorter (average 8 mm.) than in the species.

Type. One-half mile northwest of Central Ferry, Calaveras County, California, April 25, 1935, *J. A. Rutter 163* (VTM).

Range. In the lower Sierra Nevada of California, almost entirely below 4000 feet.

Representative specimens. CALIFORNIA. Amador County: near Jackson, *Hansen 631* (UC, M, S). Butte County: Butte Creek, *Heller 11860* (UC, M, NY, CA, S). Calaveras County: Central Ferry, *Rutter 163* (VTM, type). Tuolumne County: *Keck* and *Clausen 5269* (G, S).

9. MELICA BULBOSA Geyer, Porter and Coulter, Syn. Fl. Colo. 149. 1874. *M. bulbosa* Geyer, ex Hook. Jour. Bot. Kew Misc. 8: 19. 1856. *M. bulbosa* Gray, Proc. Am. Acad. Sci. 8: 409. 1872. *M. bella* Piper, U.S.D.A. Div. Agr. Circ. 27: 10. 1900. *M. bella intonsa* Piper, Contr. U. S. Nat. Herb. 11: 128. 1906. *M. bulbosa* var. *caespitosa* Cronquist, Madroño 7: 77. 1943.

Culms up to 60 cm. tall, usually bulbous at the bases, bulbs attached directly to a woody rhizome, the latter usually present

Fig. 2. Distribution of *Melica* in North America.

in older plants; blade 2–5 mm. wide; panicle usually very narrow, rarely bearing more than twenty-five spikelets; spikelets 6–24 mm. long, averaging 11 mm.; florets 2 to 5, usually 3; glumes obtuse to acute, first glume 5–9 mm. long, averaging 7 mm., second glume 6–10 mm. long, averaging 7.5 mm., glumes two-thirds to three-fourths as long as spikelet, never as long; lemmas usually obtuse, first lemma 6–11 mm. long, averaging 8 mm., distinctly purple-tinged below the scarious apex; anthers 4 mm. long; rudiment narrow, tapering above, exserted, 1.5–5 mm. long, averaging 3 mm.

Type. "Rocky ravine, upper Platte," *Geyer 11* (G).

Range. South central Sierra Nevada in California northward to British Columbia and eastward to Colorado and Jeff Davis County, Texas; chiefly on dry, rocky slopes and in open dry woods; extends to alpine regions.

Representative specimens. CALIFORNIA. Humboldt County: Trinity Summit, *Tracy 14194* (UC, G, S). Tulare County: Aster Lake, *Long 239a* (UC, NY, CA). OREGON. Crook County: Grizzly Butte, *Leiberg 268* (G, W, NY, S). WASHINGTON. Kittitas County: west of Ellensburg, *Hitchcock* and *Martin 3414* (UC, WS, W, CA, S). WYOMING. Sublette County: Piney Mt., *Payson 2715* (UC, G, M, NY, W).

9a. MELICA BULBOSA var. inflata (Boland.) comb. nov. *M. poaeoides* var. *inflata* Boland., Proc. Calif. Acad. Sci. 4: 101. 1870. *M. inflata* (Boland.) Vasey, Contr. U. S. Nat. Herb. 1: 269. 1893.

This variety differs from the species in the wider panicle with longer, stiffly ascending branches, spikelets pale and larger (averaging 16 mm. long) and lemmas acute and strongly nerved.

Range. Central Sierra Nevada northward to central Washington; chiefly in meadows or shady woods, rare.

Type. Yosemite Valley, California, *Bolander 6121* (UC).

Representative specimens. CALIFORNIA. Yosemite Valley, *Bolander 6121* (UC, type; G); Yosemite, Hog Ranch, *Hall* and *Babcock 3334* (UC, NY). Tuolumne County: Mather, *Keck 1109* (G, M, CA, S). WASHINGTON. Chelan County: Blewett Pass, *Thompson 6296* (G, US).

This entity possibly represents a meadow ecotype of the more xeric *M. bulbosa*. Intergrading forms between this variety and the species are common.

10. MELICA TORREYANA Scribn. Proc. Acad. Nat. Sci. Phila. 37: 43. 1885. *M. imperfecta* var. *sesquiflora* Torrey in herb.

Culms weak, slender, up to 100 cm. long, usually in dense clumps; blades lax, 1–4 mm. wide; panicle 8–25 cm. long, averaging 14 cm. long, branches appressed or occasionally spreading; spikelets 4–7 mm. long, averaging 5.5 mm., florets usually 1, occasionally 2; glumes nearly as long or occasionally longer than last floret, usually acute, first glume 3.5–5 mm. long, averaging 4.5 mm., second glume 3.5–7 mm. long, averaging 5 mm.; lemmas sub-acute, pubescent on upper dorsal surfaces, first lemma 4–6 mm. long, averaging 4.5 mm.; palea usually as long as lemma; anthers 2–3 mm. long; caryopses 3 mm. long; rudiment small, blunt-oblong, 0.5–1.5 mm. long, stipe much longer than rudiment, 1.5–4 mm. long.

Type. San Francisco, California, *H. N. Bolander,* Kellogg and Co. 1872. The type is presumably in the U. S. National Herbarium.

Range. Chiefly in the coast ranges of California from San Luis Obispo County northward to Humboldt County, rare in the Sierra Nevada from Mariposa County, to Butte County; distributed principally in thickets, shady woods.

Representative specimens. CALIFORNIA. Alameda County: Berkeley hills, *Long 165a* (UC, NY, WS, W, BC, CA). Butte County: Centerville, Berry Canyon, *Heller 5511* (G, M, W, S). Marin County: Mt. Tamalpais, *Heller 8397* (G, M, NY, CA, S); Tiburon Peninsula, 1926, *Parks* (UC, NY, CA, S). Napa County: Petrified Forest, *Boyle 1076.* Santa Clara County: Los Gatos Canyon, *Heller 742* (UC, G, M, NY, W, S).

11. MELICA IMPERFECTA Trin. Mem. Acad. St. Petersb. VI. Sci. Nat. 2^1: 59. 1836. *M. colpodioides* Nees, Ann. Nat. Hist. 1: 283. 1838. *M. panicoides* Nutt. Jour. Acad. Nat. Sci. Phila. Ser. 2, 1: 188. 1848. *M. poaeoides* Nutt. Jour. Acad. Nat. Sci. Phila. Ser. 2, 1: 188. 1848. *M. imperfecta* var. *flexuosa* Boland. Proc. Calif. Acad. Sci. 4: 101. 1870. *M. imperfecta* var. *refracta* Thurb. in S. Wats. Bot. Calif. 2: 303. 1880. *M. imperfecta* var. *minor* Scribn. Proc. Acad. Nat. Sci. Phila. 37: 42. 1885. *M. Parishii* Vasey; Beal, Grasses N. Am. 2: 500. 1896. *M. imperfecta* var. *pubens* Scribn. U.S.D.A. Div. Agrost. Circ. 30: 8. 1901.

Culms up to 110 cm. tall, densely tufted; blades 1–6 mm. wide, average 3 mm.; ligule 3–6 mm. long, panicle 5–36 cm. long, averaging 19 cm., narrow or spreading, branches often fascicled, closely appressed to widely spreading or reflexed; spikelets 3.5–7 mm. long, averaging 4.5 mm., florets usually 1, occasionally 2; glumes sub-acute to obtuse, usually shorter than last floret, first glume 2–5 mm. long, average 3 mm., second glume 2.5–6 mm. long, average 3.5 mm.; lemmas not pubescent above, apex acute to obtuse, first lemma 3–7 mm. long, averaging 4.5 mm.; palea as long as lemma; rudiment long, obtuse-oblong, 0.5–4 mm. long, averaging 2 mm., stipe shorter than rudiment.

Type. "California." The type, if it now exists at all, is presumably in the Academy of Science at Leningrad.

Range. Lower California to north central California, principally in the coast ranges, rare in the central Sierra Nevada below 4000 feet; chiefly on dry, rocky hillsides or open dry woods.

Representative specimens. CALIFORNIA. Kern County: Kern Canyon, *Heller 7652* (UC, G, M, NY, S). Los Angeles County: Santa Catalina Island, *Fosberg S4430* (UC, NY). Monterey County: Tassajara Hot Springs, *Ferris 8328* (UC, G, CA, S); Pacific Grove, *Heller 6737* (G, M, NY, S). Santa Barbara County: Santa Barbara, *Elmer 3787* (UC, G, M, NY, S). Santa Clara County: near Los Gatos, *Boyle 1064*. San Diego County: Moro Hills, *Abrams* (G, M, NY, S).

The variety *refracta* is reputedly distinguished from the species by the spreading branches and dense pubescence. The variety *flexuosa* is likewise supposedly unique in the possession of widely spreading or reflexed branches. Actually, pubescence and position of the branches varies indiscriminately throughout this group with no geographic segregation of either of these two characters. The variety *minor* is believed simply to be applicable to depauperate specimens.

12. MELICA FRUTESCENS Scribn. Proc. Acad. Nat. Sci. Phila. 37: 45. 1885.

Culms up to 2 m. long, stout, often slightly woody at base, branches often arising near culm base; blades 2–4 mm. wide; panicle 12–40 cm. long, averaging 20 cm., narrow and dense, occasionally interrupted below, pale and shining or rarely purple-tinged; spikelets 12–18 mm. long, averaging 14 mm., florets 3 to 6, usually 4; glumes papery, first glume 7–12 mm. long, averaging 9 mm., second glume 9–15 mm. long, averaging 11 mm.; lemmas usually obtuse, upper third papery-scarious; first lemma 8–11 mm. long, averaging 9.5 mm.; palea usually about half the length of lemma; anthers 2 mm. long; caryopses 2–3 mm. long; rudiment 4.5–6.5 mm. long, consisting of a fairly large sterile lemma enclosing a globose rudiment proper.

Type. Southern California, *Parry* and *Lemmon 401,* 1876. The type is assumed to be in the United States National Herbarium.

Range. From Inyo County in southern California south to Lower California and south-central Arizona; chiefly on dry hills, flats and foothill ranges of the desert country.

Representative specimens. CALIFORNIA. Victorville, 1903, *Jones* (G, W). San Diego County: Bernardo, *Abrams 3361* (G, M, NY, CA, S); Colorado Desert, *Munz* and *Hitchcock 12050* (UC, M). LOWER CALIFORNIA. Socorro Canyon, *Wiggins 5219* (US, S).

The seeds of *M. frutescens* possess, so far as is known, greater viability than those of any other species in the genus. Caryopses from a five-year-old herbarium specimen exhibited seventy-five per cent germination. The marked viability of seeds, rapid vegetative growth, production of branches near the culm base, self-fertility and its marked resistance to drought are features of considerable interest in relation to the development of better forage on our western range lands.

13. Melica montezumae Piper, Proc. Biol. Soc. Wash. 18: 144. 1905. *M. alba* Hitchcock, Contr. U. S. Nat. Herb. 17: 367. 1913.

Culms up to 1 m. long, loosely tufted; blades 1–3 mm. wide, apices indurate, ligules 5–10 mm. long; panicle 5–25 cm. long, averaging 16 cm., open, branches ascending to reflexed, distant; spikelets 6–8 mm. long, pale, shining, fertile floret 1, articulation below the glumes; glumes usually as long as floret, first glume 7–8 mm. long, very broad, somewhat enfolding spikelet, second glume 7–8 mm. long, considerably narrower; lemma 7–8 mm. long, oblong-truncate, very thick, greenish and tuberculate-roughened except for marked scarious apex and bearing a group of flat, twisted, glass-like hairs on back, nerves prominent, many; anthers 2–3 mm. long, rudiment oblong-truncate, 2–3 mm. long.

Type. Santa Eulalia Mts., Chihuahua, Mexico, April 6, 1885, *Pringle 430* (US).

Range. Mountains of northern Mexico and southwestern Texas; apparently in shaded, protected sites.

Representative specimens. Texas. Brewster County: Chisos Mts., *Cory 18657* (G). Pecos County: Sheffield, *Jones 26362* (M, S). Mexico. Chihuahua: Santa Eulalia Mts., *Pringle 430* (G, M, US, type; WS). Coahuila: San Lorenzo Canyon, *Palmer 551* (UC, G, NY).

This species has not previously been reported from the United States. It is probably most closely related to *M. nitens*. A form of the latter species in southwest Texas exists which occasionally has but one floret and a similar rudiment; *M. montezumae* may have arisen from that source.

14. Melica mutica Walt. Fl. Carol. 78. 1788. *M. altissima* Walt. Fl. Carol. 78. 1788 (not *M. altissima* L.). *M. glabra* Michx. Fl. Bor. Am. 1: 62. 1803. *M. rariflora* Schreb. Beschr. Gräs. 2: 157. 1810. *M. diffusa* Pursh, Fl. Am. Sept. 1: 77. 1814. *M. racemosa* Muhl. Descr. Gram. 88. 1817. *M. speciosa* Muhl. Descr. Gram. 87. 1817. *M. Muhlenbergiana* Schultes, Mant. 2: 294. 1824. *M. mutica* var. *glabra* Gray, Man. ed. 5, 626, 1867. *M. mutica* var. *diffusa* Gray, Man. ed. 5, 626. 1867. *M. mutica* f. *diffusa* Fernald, Rhodora, 41: 501. 1939.

Culms up to 100 cm. long, arising from a rhizome; blades 2–6 mm. wide; panicle 4–16 cm. long, averaging 13 cm., simple, rarely compound, open, branches ascending or spreading; spikelets 7–11 mm. long, averaging 9 mm., nodding to pendulous, florets spreading, spikelets V-shaped, flat-topped, apices of first two florets very nearly same height, rachilla somewhat flattened, fertile florets 2, rarely more, articulation below glumes; glumes subequal, margins and apices very scarious, first glume 6–9 mm. long, averaging 7 mm., second glume 6–9 mm. long, averaging 8 mm., as long or nearly as long as spikelet; lemmas very firm, ridged on back, first lemma 6–11 mm. long, averaging 8 mm., nerves prominent; anthers 3 mm. long; caryopses 2–3 mm. long; rudiment very blunt, obconic, 2–4 mm. long, inner sterile lemmas almost invariably extruded, rudiment usually bent at an angle toward rachilla.

Type. "South Carolina." The existence of the type is very uncertain. The following specimen may be considered as representative of this species: *E. B. Harger 7784*, dry woods on Walden Ridge, Pikeville, Bledsoe County, Tennessee (G).

Range. Maryland to Florida and west to eastern Texas and Oklahoma; in moist, rich or dry, open woods and thickets.

Representative specimens. Georgia. De Kalb County: Stone Mt., 1895, *Small* (NY, M, G, CA). North Carolina. Buncombe County: Biltmore Herbarium *645b* (UC, G, M, NY, W, US). Oklahoma. McCurtain County: Shawneetown, *Houghton 3882* (G, M, NY). South Carolina. Horry County: Myrtle Beach, *Griscom 511* (UC, G, M, W, BC, CA, S).

15. Melica nitens (Scribn.) Hitch. Man. Grasses U. S. 201. 1935. *M. scabra* Nutt. Trans. Amer. Phil. Soc. 5: 148. 1837. *M. nitens* Nutt. in herb. *M. diffusa* var. *nitens* Scribn. Proc. Acad. Nat. Sci. Phila. 37: 44. 1885.

Culms up to 120 cm. long, arising from a rhizome; blades lax, 3–15 mm. wide, averaging 7 mm., panicle 6–26 cm. long, averaging 20 cm., wide, compound, branches widely spreading or ascending; spikelets 8–15 mm. long, averaging 11 mm., florets 1 to 4, usually 3, second floret usually exceeding first by 2 mm., nodding to pendulous, articulation below glumes; glumes subacute, first glume very broad, 5–7 mm. long, second glume narrower, 7–9 mm. long, and usually 1 mm. shorter than spikelet; lemmas acute to emarginate, first lemma 8–11 mm. long, averaging 9 mm., very firm but less indurate and ridged than in *M. mutica;* anthers 3 mm. long; rudiment oblong club-shaped, never bent at angle to rachilla, inner sterile lemmas not extruding, 1–4 mm. long, usually 2.5 mm.

Type. Designation of the type is very difficult owing to the confusion of the synonymy. It is presumably the collection first cited by Scribner (9) under var. *nitens* of *M. diffusa: J. Reverchon 3464a,* Texas.

Range. Pennsylvania and Virginia west to Kansas, Nebraska and western Texas. (Specimens have been reported from New Mexico and Arizona.) Habitat variable, rich soil in open woods to rocky woods, bluffs and flats.

Representative specimens. Illinois. Peoria County: Peoria, 1912, *Churchill* (G, M, NY). Iowa. Storey County: Ames, *Ball 33* (NY, M, US). Kansas. Riley County: Woods, *Norton 935* (G, M, NY, W, US). Missouri. Meramec, 1879, *Eggert* (NY, M, W, BC). Oklahoma. Comanche County: Fort Sill, *Clemens 11487* (M, NY, W).

16. Melica stricta Bolander, Proc. Calif. Acad. Sci. 3: 4–5. 1863.

Culms up to 85 cm., densely tufted, anthocyanous near the base (except in var. *albicaulis*), lower portion thickened but not bulbous; blades 2–5 mm. wide; panicle 3–30 cm. long, averaging 14 cm., narrow, simple, branches appressed; spikelets 6–23 mm. long, averaging 16 mm., broadly V-shaped when mature, articulation below the glumes, florets 2 to 5; glumes acute to emarginate, first glume 6–16 mm. long, averaging 13 mm., second glume 6–18 mm. long, averaging 14 mm., as long or nearly as long as the spikelet; lemmas obtuse to acute, first lemma 8–16 mm. long, averaging 12 mm., palea one-half to two-thirds as long as lemma; caryopses 4–5 mm. long; anthers 1–2 mm. long (as long as 3 mm. in var. *albicaulis*); rudiment narrow, tapering above, 2–7 mm. long, averaging 5 mm.

Type. Silver City, Nevada, *G. W. Dunn* (G).

Range. Southern Oregon to southern California eastward to Utah; rocky slopes or open woods; extends to alpine areas.

Representative specimens. California. Humboldt County: Salmon Summit, *Tracy 14377* (UC, G, S). Nevada County: Castle Peak, *Heller 7078* (UC, G, M, NY, W, O, S). Tulare County: Alta Peak, *Long 245a* (UC, NY, BC, W, WS, CA). Oregon. Harney County: Steens Mts., *Cusick 1972* (UC, M, US, BC, O, WS).

16a. Melica stricta var. albicaulis var. nov. Vaginae culmorum inferiorum stramineae pallidae, palea longum dodrans lemmae, antherae 2–3 mm. longae.

The variety *albicaulis* differs from the species in the following characters: (1) sheaths of lower portion of culms pale straw color, (2) palea three-fourths the length of lemma, (3) anthers 2–3 mm. long, (4) glumes more broad, more hyaline and less acute than in the species.

Type. Coldwater and Lytle creeks, San Antonio Mts., California, dry ground under pines, elevation 7000 feet, July 3, 1917, *I. M. Johnston 1516* (UC).

Range. Mountains of southern California.

Representative specimens. California. Ventura County: Frazier Mts., 1934, *Epling* (UC, M). Los Angeles County: San Gabriel Mts., *Abrams 614* (G, NY, S). San Bernardino County: San Antonio Mts., *Johnston 1516* (UC, type; US, W, S); San Bernardino Mts., *Parish 3699* (UC, G, CA).

This variety is based more upon its marked geographic segregation than upon strong morphological divergence from the species.

17. Melica Porteri Scribn. Proc. Acad. Nat. Sci. Phila. 37: 44. 1885. *M. mutica* var. *parviflora* Porter, Porter and Coulter,

Syn. Fl. Colo. 149. 1874. *M. parviflora* Scribn. Mem. Torrey Bot. Club 5: 50. 1894.

Culms up to 100 cm. tall, loosely tufted, arising from a rhizome; blades 2–6 mm. wide; ligule 3–7 mm. long; panicle 13–25 cm. long, averaging 21 cm., narrow to open (in var. *laxa*); spikelets 8–16 mm. long, averaging 12 mm., often secund on the branch; glumes subequal, very short, usually one-half the length of spikelet, occasionally two-thirds; first glume 4–6 mm. long, second glume 5–8 mm. long, averaging 6.5 mm., lemmas tapering to rounded apex, first lemma 6–10 mm. long, averaging 7.5 mm.; anthers 2 mm. long; caryopses 2–3 mm. long; rudiment narrow, tapering upward, 2–5 mm. long.

Type. Glen Eyrie, near Colorado City, Colorado, July, 1872, *T. C. Porter.* The type is assumed to be in the United States National Herbarium.

Range. Northern Colorado south to the Sierra Madre Range in Mexico, westward to Arizona and eastward to central Texas; rocky slopes and open woods.

Representative specimens. COLORADO. Southern Colorado, *Baker 186* (G, M, NY, US, W). El Paso County: 6000 ft., *Shear 726* (G, NY, US). San Miguel County: stream bank, *Maguire 12694* (G, M, WS, W). NEW MEXICO. Socorro County: Mogollon Mts., *Metcalf 283* (UC, G, M, NY, W).

This species was grown easily from seed without stratification despite the fact that this is a species characteristic of high elevations.

17a. MELICA PORTERI var. laxa var. nov. Rami late extensi sive ascensi, spiculae purpureae tinctae, glumae pro portione specie breviore.

Variety *laxa* differs from the species in the following morphological features: (1) branches widely spreading or ascending-spreading, (2) spikelets purple-tinged, (3) glumes proportionately longer, (4) rudiment less acute and shorter in length.

Type. White Mts., New Mexico, 7000 feet, August 13, 1897, *E. O. Wooton 680* (NY).

Range. Mountains of southern New Mexico and Arizona, and the Chisos Mountains of western Texas.

Representative specimens. ARIZONA. Chiracahua Mts., *Blumer 1494* (G, M, W). Rincon Mts., *Blumer 3444* (UC, M, S). Santa Rita Mts., *Pringle 15985* (G, M, NY). NEW MEXICO. Lincoln County: White Mts., *Wooton 680* (NY, type; M); *Wooton 35533* (UC, G, WS, S).

NAMES EXCLUDED

Melica anomala Scribn. in Beal, Grasses N. Am. 2: 311. 1896 = MUHLENBERGIA LONGILIGULA Hitch.

Melica argentea (Howell) Beal, Bull. Torrey Bot. Club 17: 153. 1890 = POA PRINGLEI Scribn.

Melica Hallii Vasey, Bot. Gaz. 6: 296. 1881 = FESTUCA SCABRELLA Torr.

Melica macrantha Beal, Bull. Torrey Bot. Club 17: 153. 1890 = POA MACRANTHA Vasey.

Melica multinervosa Vasey, Bot. Gaz. 16: 235. 1891 = VASEYOCHLOA MULTINERVOSA (Vasey) Hitch.

Melica nana Beal, Grasses N. Am. 2: 504. 1896. Based on MELICA ARGENTEA (Howell) Beal; see above.

Melica purpurascens Hitch. Contr. U. S. Nat. Herb. 12: 156. 1908 = SCHIZACHNE PURPURASCENS (Torr.) Swallen.

Melica striata Hitch. Rhodora 8: 211. 1906 = SCHIZACHNE PURPURASCENS (Torr.) Swallen.

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LITERATURE CITED

1. AVDULOV, N. P. Karyo-systematische untersuchung der familie Gramineen. Bull. App. Bot. of Genetics and Plant-Breeding Suppl. 44: 1–428. 1931.
2. BOYLE, W. S. Cytological evidence for the taxonomic position of Schizachne purpurascens. Madroño 7: 129–130. 1944.
3. BOLANDER, H. N. The genus Melica in California. Proc. Calif. Acad. Sci. 4: 101–104. 1870.
4. DARLINGTON, C. D. and L. F. LA COUR. The handling of chromosomes. 1942.
5. FARWELL, O. A. Bromelica, a new genus of grasses. Rhodora 21: 76–78. 1919.
6. HITCHCOCK, A. S. Manual of the grasses of the United States. U.S.D.A. Misc. Pub. 200. 1935.
7. JORANSON, P. N. The cytogenetics of hybrids, autotetraploids and allotetraploids in the grass genus Melica L. Ph.D. Thesis, Univ. of California Library, Berkeley, California. 1944.
8. RANDOLPH, L. F. A new fixing fluid and a revised schedule for the paraffin method in plant cytology. Stain Tech. 10: 95–96. 1935.
9. SCRIBNER, F. L. A revision of North American Melicae. Proc. Acad. Nat. Sci. Phila. 37: 40–48. 1885.
10. SKORNIAKOV, et al. Schedae ad herbarium florae Asiae Mediae ab Universitate Asiae Mediae editum. Tashkent. Acta Univ. Asiae Mediae, series 8 b, Bot. fasc. 17: 10–13. 1934.
11. STEBBINS, G. L., Jr. and R. M. LOVE. A cytological study of California forage grasses. Am. Jour. Bot. 28: 371–382. 1941.

M. FRENCH GILMAN

Marshall French Gilman, grandson of the first white couple to settle in the San Gorgonio Pass of southern California, died July 18, 1944, after some months of illness. Born November 12, 1871, at Banning, California, French Gilman had a long career of service: as a teacher at Upland, California; postmaster and then horticultural inspector and deputy state quarantine officer at Banning; assitant postmaster and secretary of the Palm Valley Water Company at Palm Springs; teacher and officer in schools in the United States Indian Service at Fort Lewis, Colorado, Shiprock, New Mexico, Sacaton, Arizona, and Fort Bidwell, California; clerk of the high school board at Banning; councilman, member of forestry board of Riverside County, and mayor of Banning.

Fig. 1. French Gilman.

For many years a rancher and fruit-grower, he was always interested in scientific method and cooperated in many ways with the United States Department of Agriculture, particularly with Dr. W. T. Swingle, supervising experimental cotton plantings near Palm Springs, establishing an experimental station of possible food and medicine plants on the Papago Indian Reservation in Arizona, and carrying out on a small plot at Banning experiments on propagation and cultivation of a Chinese species of *Ephedra*, a *Solanum* from Siam, and on budding and grafting cultivated fruits on native plum roots. He was joint author of a paper on *Ammobroma sonorae* Torr. with Frank A. Thackery of the Department of Agriculture (A rare parasitic food plant of the southwest. Ann. Rept. Smithson. Inst. 1930: 409–416. 9 pl. 1931).

In 1899 he married Sarah Morris, a teacher at the Morongo Indian Reservation. Blind in her later years, Mrs. Gilman was unable to accompany her husband to Death Valley when it became financially necessary for him to take employment there with the National Park Service. I remember well on July 8, 1937, when a party of us climbed Telescope Peak in the Panamint Mountains, how Mr. Gilman sat down, pulled out writing materials, and wrote a letter home, saying that he always wrote Mrs. Gilman from the top. The modest Gilman home at Banning was always open to friends. Here was real hospitality and rare charm, and a delight on the part of the owners to tell about their treasures, particularly their large collection of Indian baskets. Mrs. Gilman died in 1941.

Mr. Gilman was an authority on southwestern birds, and on field trips for plants was always observing and identifying birds. The Sahuaro Screech Owl (*Otus asio gilmani*) bears his name. Between the years 1902 and 1937 he published twenty-five articles or notes in Condor and in 1930 he had a paper on "Cacti as nesting sites" in the Journal of the Cactus and Succulent Society of America.

I best knew French Gilman through his interest in plants, collections of which he had made in his various regions of residence and which he had submitted to various herbaria for study. His name will be best and longest known, however, in connection with the flora of Death Valley, to which he began to devote especial study in assisting the late Dr. F. V. Coville in his survey of plants of that area. Then, as acting custodian of Death Valley National Monument for some months in 1933 and 1934, and later in charge of a nursery and small botanical garden there, he devoted several of his last years to the native plants of that region, remaining there even through the hot summers to maintain his nursery. His plantings were visited by thousands of visitors and his evening talks on the plants of Death Valley made him known to many others.

It is a tribute to his energy and industry that he was able during his several years in Death Valley to add so many species to the list known for the region. A few examples that happen to occur to me, some of which were even new to California are: *Betula fontinalis* Sarg., *Stipa arida* Jones, *Oenothera scapoidea* Nutt. var. *seorsa* (Nels.) Munz, *Angelica lineariloba* Gray, *Mimulus montioides* Gray, *Laphamia intricata* Brandg., *L. megacephala* Wats., *Senecio spartioides* T. and G., and *S. uintahensis* (Nels.) Greenman. Then he either collected, or was in the party which collected, many plants new to science; of these the following list is very incomplete: *Eriogonum Gilmanii* Stokes, *E. intrafractum* Cov. and Morton, *E. mensicola* Stokes, *E. panamintense* Morton, *Petalonyx Gilmanii* Munz, *Oenothera dentata* Cav. var. *Gilmanii* Munz, *Cymopterus Gilmanii* Morton, *Gilia Gilmanii* Jepson (a later synonym of *Gilia Ripleyi* Barneby), *Phacelia mustelina* Cov., *Salvia carnosa* Dougl. subsp. *Gilmanii* Epling, *Maurandya petrophila* Cov. and Morton, *Mimulus rupicola* Cov., *Cordylanthus eremicus* (Cov. and Morton) Munz. Dr. Coville (Jour. Wash. Acad. Sci. 26: 209–213. 1936) proposed in his honor the genus *Gilmania* for that rare plant formerly known as *Phyllogonum luteolum* Cov.

Those who knew French Gilman loved him. His kindliness, honesty, sincerity, enthusiasm, ability to face adversity—all these qualities naturally endeared him to many. I count it as one of my great privileges to have had as a friend this man—self-taught and wise. It is good that his name shall live long in the botanical annals of California.—PHILIP A. MUNZ, Bailey Hortorium, Cornell University, Ithaca, New York.

AN ABNORMAL PEPPERGRASS

C. L. HITCHCOCK

During the course of a taxonomic study of the Lepidia of the Western Hemisphere one specimen has been seen which is so unusual that it is felt a brief description of it will be of interest to others. This plant was collected at Charcas, San Luis Potosi, Mexico, in 1934 (*Alfred F. Whiting 914EB,* United States Herbarium number 1688427). It is a teratological specimen, and so greatly modified that it is difficult to make a determination to species, but it is believed that it is *L. Schaffneri* Thellung. The branches of the plant end in one or more racemes at the base of which there remain numerous pedicels supporting all that is left of the ripened silicles—the placentae and repla. Apparently these fruits produced normal seeds.

The flowers of the upper half of each raceme are progressively more and more modified. A practically normal fruit and a normal flower are to be seen in figure one. Two stamens, four sepals, four petals, and four glands are common to all ordinary flowers of the species. Figure two represents one of the little-altered flowers of the specimen. It will be noted that there are two stamens which apparently are fertile, four sepals, four short linear petals (one of which has been removed, the more easily to show the bud beneath it), and rudimentary branches that had started to develop where the "glands" should be. The silicle is enlarged, pubescent, and considerably modified internally, with basal branches developing as shown in figure three. That drawing (plate 2, fig. 3) illustrates an opened fruit bearing a small partially developed branch in the axil of each valve. The two ovules are recognizable as such, although the funiculi are freed from the placentae below their normal point of attachment in the silicle. The replum is lacking entirely.

Figure four shows a flower that is more greatly modified. In place of ovules there are leaf-like structures where ovules might normally be. The branches that originate in the axils of the valves are larger and fastigiate in appearance. The flower drawn in figure five is essentially similar to that of figure four, but all trace of the ovules has disappeared. Figure six represents a case in which a main branch has grown from the center of the fruit, one "axillary bud," only, developing. Figure seven shows a flower

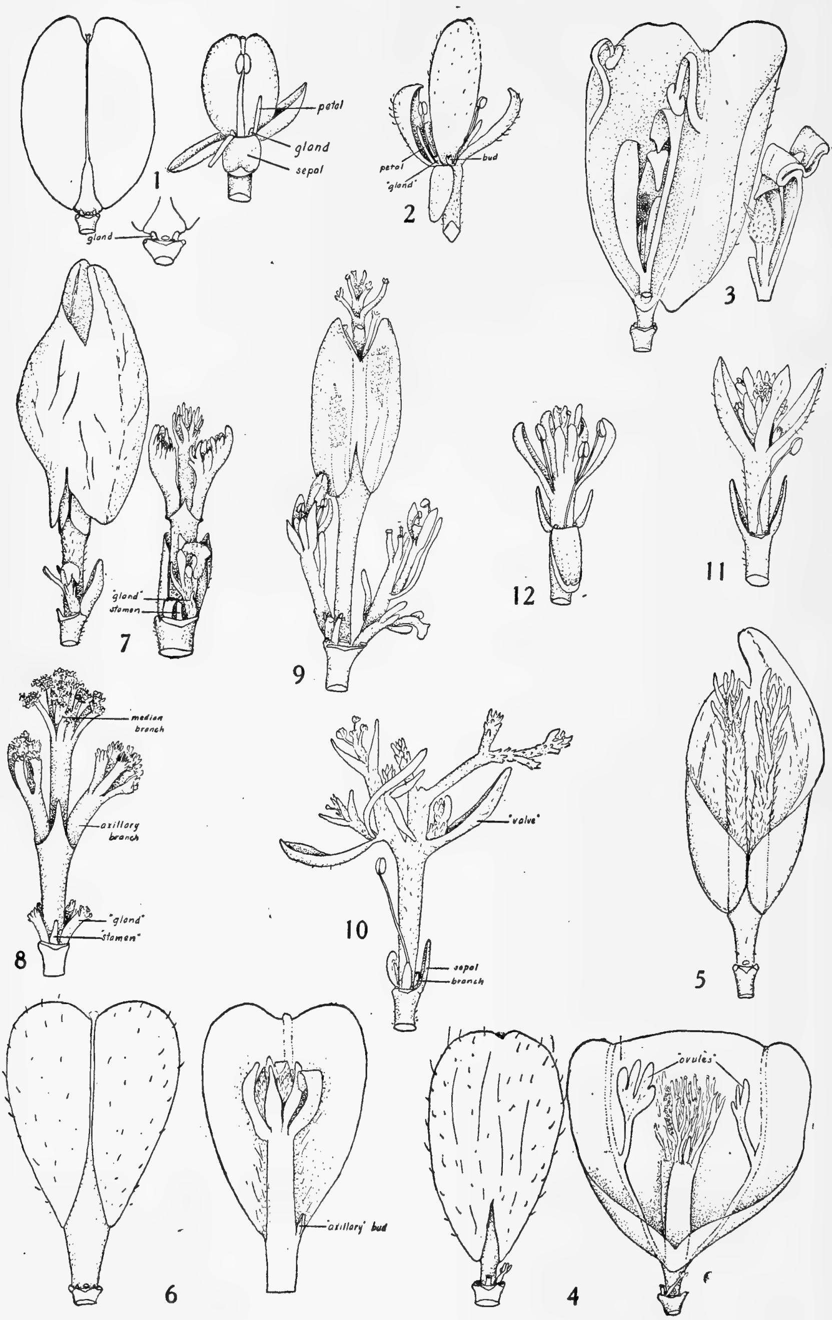

Plate 2. A Teratological Specimen of Lepidium.

in which two branches have developed from the region of the "glands." In the ovary itself, three branches have developed, one from the "axil" of each valve, the third median to these two. Figures eight, nine, and ten are illustrations of flowers that are essentially similar to the previous one; in figure nine the branches from the "glands" are more fully developed. Stamens and ovaries have developed in the axils of a few of the bracts on these branches. The flower of figure ten is so modified that one can but compare, by virtue of their position, the subtending basal bracts of the upper branches to the valves of a silicle. Figures eleven and twelve represent a couple of flowers that have produced central branches in the position normal for the fruit. Sepals, petals, and stamens are not greatly altered in appearance.

Although it is realized that general deductions concerning morphological structures cannot safely be drawn from teratological material, these points are of interest at least: 1. Floral branches from below the ovary apparently have arisen in each case from the position considered "normal" for the glands of the flower. 2. In most cases a branch has developed from the "axil" of each valve of the silicle. 3. Judged from the number of branches that develop in the ovary, there is no indication that there are four carpels in the flower.

University of Washington, Seattle.

REVIEW

Foundations of Plant Geography. By Stanley A. Cain. Pp. xiv + 556 and 63 figures. Harper & Brothers, 1944. $5.00.

This is undoubtedly the most comprehensive and modern book on plant geography written from the historical point of view. Its comprehensiveness is indicated both by its length and the number of titles, 720, in the section on "Literature Cited." Its modernity is evident from the fact that nearly two-thirds of these titles represent works written since 1930. For these reasons alone it is a "must have" for the library of every serious botanist or botanical institution. No where else can one find such a wealth of recent material on this subject carefully and impartially reviewed.

To readers of Madroño Dr. Cain's book is of particular significance for two reasons. In the first place, its basic framework is taken from the principles published by our editor, Dr. Mason, in this journal (vol. 3, pp. 181–190). Secondly, both the history of the flora of the western United States and the work of western botanists receive particular emphasis. The figures include no less than eight outline maps of California and the adjacent states, which illustrate the distribution of such familiar and interesting groups as *Sequoia, Libocedrus, Pinus Jeffreyi, Pentstemon* spp., and *Crepis.* An outline map of the Monterey Peninsula, illustrating the distribution of its interesting conifers, is the only map of a local area which is included.

Although clearly written and well organized, Dr. Cain's book will undoubtedly be of more value to advanced students and mature botanists than to beginners or amateurs. It is a reference book rather than a textbook or popular work. As such, its value is enhanced both by its comprehensiveness and the balanced impartial viewpoint of its author. All material pertinent to the subject, whether obtained from paleontology, population studies, cytogenetics or the more classical approach of the mapping of modern species distributions, is given ample consideration. Such controversial viewpoints as those held by Clements, Willis, and Wegener are treated as objectively as possible, with due consideration given to the arguments on both sides. The author, however, is clearly more interested in patterns of distribution of species and genera in relation to evolution than in plant associations and climate; in other words, the book treats with historical rather than ecological plant geography. The five principal divisions of the book are, in fact, I, Introduction (28 pp.); II, Paleoecology (118 pp.); III, Areography (173 pp.), including such topics as Dispersal and Migration, Center of Area, Center of Origin, and Endemism; IV, Evolution and Plant Geography (77 pp.); and V, Significance of Polyploidy in Plant Geography (30 pp.).

In such an extensive work some minor errors are inevitable. For instance, in the phylogenetic tree of the California closed cone pines on page 113, *Pinus attenuata* is interpreted as a Pleistocene derivative of *P. linguiformis,* whereas on page 83 a reproduction of Axelrod's list of species from the older Mount Eden Pliocene beds includes a counterpart of *P. attenuata,* listed under the synonym, *P. tuberculata.* Also, on page 217 a table showing the endemism in the Galapagos Islands includes figures on the "Maximum Altitude in M.," which range from 210 up to 5000, and agree with published maps only when read as feet, not meters. The discussion of the cytogenetic evidence is accurate and well balanced, although somewhat redundant, as evidenced by the quotation of a paragraph from one of this reviewer's papers, which he does not consider of particular significance, in two different places (pp. 239 and 469). The format, typography, and illustrations are in general clear and attractive, although the number of typographical errors is not inconsiderable.

Dr. Cain has done a great service to all students of plant geography and evolution. His work will continue to be of primary significance for many years to come.—G. LEDYARD STEBBINS, JR., Division of Genetics, University of California, Berkeley.

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MALACOMELES, A GENUS OF MEXICAN AND GUATEMALAN SHRUBS

George Neville Jones

During a study of the American species of the rosaceous genus *Amelanchier* it has become apparent that the shrubs of Guatemala, Mexico, southern Texas, that have been variously treated as a section of *Amelanchier,* or of the gerontogean genus *Cotoneaster,* or as a group separate from both, have certain claims to recognition as a distinct genus. This genus, whose legitimate name for reasons set forth below, is *Malacomeles* Decaisne, is probably most closely related to *Amelanchier* Medic., and to the monotypic *Peraphyllum* Nutt., of the western part of the United States.

I am indebted to Dr. M. L. Fernald, Director of the Gray Herbarium (GH), to Dr. A. C. Smith, Curator of the Herbarium of the Arnold Arboretum (AA), and to Mr. P. C. Standley, Curator of the Herbarium of the Field Museum of Natural History (FM), for the loan of herbarium specimens.

Nomenclatural History

The group of plants under consideration was first recognized as a distinct genus by J. Lindley in 1845. He described it as follows:

"This plant, the *Cotoneaster denticulata* of Mr. Bentham, has all the structure of that genus in its flowers, and much of its habit; but its fruit proves it to be a new genus, which I trust may bear the name of the ingenious Mr. Nägeli, the fellow-worker of Schleiden in botanical investigation. The fruit is a very pale pink colour, about as large as a pistol ball, with a brittle semi-transparent flesh, and the thin putamen of a *Pyrus* instead of the hard bony stone of a *Cotoneaster.* It may be defined as follows—Nagelia. Petala parva, patula. Stamina 10–15. Carpella 2, dorso calyci adnata, ventre libera, ovulis 2 collateralibus ascendentibus. Pomum sphaeroideum, calyce coronatum, carnosum, fragile, endocarpio membranaceo. Semina cuique loculo 2, compressa, castanea, ascendentia. Cotyledones tenues plano-convexae.—Frutex *Cotoneasteris* vultu, canescens; sepalis semimembranaceis; petalis calyce longioribus patentibus."

In 1847, M. J. Roemer had also been in doubt as to the propriety of including the only known New World species, *C. denticulata* Kunth, in the otherwise wholly gerontogean genus *Cotoneaster.* Roemer, however, proposed no taxonomic changes, but merely commented as follows: "Sola species americana hucusque nota; an congener?" It was not until 1874 that the theory of the taxonomic distinctness of this group was again advanced, this time by the French botanist Decaisne, who placed *C. denticulata* "H.B.K.,"

Madroño, Vol. 8, pp. 33–64. May 31, 1945.

and a newly described species, *C. nervosa* Dcne., in his proposed section *Malacomeles* of *Cotoneaster.* This section included Mexican shrubs with denticulate leaves and small white flowers. The brief description is as follows: "Frutices mexicani, foliis insigniter pennatinerviis denticulatis; floribus albis, parvis, axillaribus racemosis v. corymbosis terminalibus; fructibus omnino baccatis." The statement concerning the fruit is evidently an error, because none of the Pomoideae has baccate fruits. Fruits of *Malacomeles* that I have dissected are structurally very similar to those of *Amelanchier.* It should be noted that Decaisne in 1874 actually treated *Malacomeles* as a section of *Cotoneaster,* but in 1881, in reply to criticism by Wenzig of his memoir, he refers to *Malacomeles* as if he had published it as a genus.

The next nomenclatural contribution was made in 1890 by E. Koehne, who described two new species under *Amelanchier.* The first was *A. utahensis,* a true *Amelanchier,* the common and variable xerophytic species of desert and mountainous areas of western United States. The second was described as *A. Pringlei,* and was based upon one of Pringle's collections from Chihuahua, Mexico, (*Pringle 259*) that had been distributed as *Cotoneaster denticulata.* Koehne thus grouped his supposed new species, *A. Pringlei,* which belongs with Decaisne's *Malacomeles* (and is a synonym of *M. denticulata*), with a true *Amelanchier, A. utahensis.* In 1906, Schneider protested against this unnatural arrangement and reinstated *Nagelia* as a genus, citing *N. denticulata,* with two varieties, and *N. Pringlei,* as the component species. Rehder, in 1935, transferred Decaisne's section *Malacomeles* from *Cotoneaster* to *Amelanchier,* and described *A. paniculata,* which he supposed to be different from *A. nervosa* (Dcne.) Standl.

Whether it be maintained as a genus, subgenus, or section, *Malacomeles* Dcne. is the earliest available name for this group, since Lindley's name, *Nagelia* (1845) being a later homonym, is illegitimate. *Nagelia* Lindl. is invalidated by the *Nagelia* of Rabenhorst, described one year earlier. In 1846, Lindley spelled the name *Nägelia,* but this is merely an orthographical variant. Decaisne's name is composed of the Greek *malakos,* "soft," and *meles,* "apple," presumably on account of the soft carpels, as contrasted with the bony carpels of *Cotoneaster.*

Relationships within the Pomoideae

It is at once evident that *Malacomeles* is a bona fide member of the subfamily Pomoideae Focke of the Rosaceae. The cartilaginous or membranous texture of the carpels is a character that at once separates it from *Crataegus, Cotoneaster, Mespilus, Pyracantha, Hesperomeles,* and *Osteomeles,* the latter having pinnate leaves. By the character of the inflorescence, *Malacomeles* is distinguished from *Sorbus, Aronia, Photinia, Stranvaesia,* and *Eriobotrya,* which have the flowers in compound corymbs or panicles. That *Mala-*

comeles does not belong with *Docynia, Chaenomeles,* and *Cydonia* is attested by the fact that those genera have the carpels four- to many-seeded. Evidently the true affinities of *Malacomeles* lie with the genera *Malus, Pyrus, Amelanchier,* and *Peraphyllum. Malus* and *Pyrus* have the ovary and fruit two- to five-loculed, each locule being two-ovuled; but in *Amelanchier, Peraphyllum,* and *Malacomeles* each locule in the fruit is nearly divided by a false partition growing from the back of each carpel, thus forming an incompletely four- to ten-loculed pome containing, if all mature, only one seed in each locule.

Although supposed originally by Lindley, and later by Decaisne to be closely related to *Cotoneaster,* or even to comprise a section of that genus, *Malacomeles* is rather far removed, phylogenetically, in spite of the fact that the habit and appearance of some of the species of *Cotoneaster* suggested a close relationship. The fact that *Malacomeles* is not closely related to *Cotoneaster,* much less is a section of that genus, is clearly shown by the fact that the latter has the carpels bony at maturity, and the fruit has one to five nutlets. *Cotoneaster* is thus more closely related to *Crataegus* than to the *Amelanchier* group. The leaves of *Cotoneaster* are mostly entire, and the species are confined to the Old World, in Europe, Asia, and Northern Africa.

These three genera may be distinguished by the following key:

Mature fruits yellowish, bitter, astringent, inedible; flowers solitary or in umbel-like corymbs, the bracts promptly deciduous; petals pink or rose, obovate; calyx-lobes lanceolate, obscurely glandular-margined; leaves narrow, three to five times as long as wide, entire or nearly so, almost sessile, mostly fascicled at the ends of the branchlets; monotypic genus of western United States .... *Peraphyllum*

Mature fruits purplish black (sometimes drying brownish), or pink at first, sweet or insipid, normally juicy and edible; petals white; leaves distinctly petioled, not fascicled.

 Petals suborbicular or reniform, the width not exceeding the length; calyx-lobes scarcely longer than wide, obtuse or acute, obscurely glandular-margined or entire; carpels free; bracts of the inflorescence more or less persistent; leaves coriaceous, denticulate to entire; shrubs of Guatemala, Mexico, and southern Texas (Brewster County) .... *Malacomeles*

 Petals oblanceolate to oval, three to eight times as long as wide; calyx-lobes entire, linear-lanceolate to deltoid, acuminate or acute, mostly longer than wide; carpels connate below; bracts of the inflorescence promptly deciduous; leaves usually serrate or dentate; shrubs and trees of United States, Canada, Europe, and Eastern Asia .... *Amelanchier*

Malacomeles (Dcne.) stat. nov. *Nagelia* Lindley in Bot. Reg. 31 (Misc.): 40. 1845; Bentham and Hooker, Gen. Pl. 1: 1004. 1865; Schneider in Fedde, Rep. Sp. Nov. 3: 182. 1906. *Nägelia* Lindley, Veg. Kingdom 560. 1846; Wenzig, Linnaea 43: 80. 1880, not Rabenhorst, Kryptog. Fl. 1: 85. 1844, not Regel, Flora 31: 249. 1848. *Cotoneaster* sect. *Malacomeles* Decaisne, Nouv. Arch.

Mus. Hist. Nat. Paris 10: 177. 1874. *Cotoneaster* A. *Naegelia* Wenzig, Jahrb. Bot. Gart. Mus. Berlin 2: 304. 1883. *Amelanchier* sect. *Nagelia* Koehne, Gattung. Pomac. in Wiss. Beil. Progr. Falk-Realgymnas. Berlin 95: 25. 1890; Schneider, Illustr. Handb. Laubh. 1: 742. 1906. *Amelanchier* sect. *Malacomeles* Rehder, Jour. Arnold Arb. 16: 449. 1935. Type species. *Cotoneaster denticulata* Kunth = *Malacomeles denticulata* (Kunth) G. N. Jones.

Shrubs with unarmed branches and simple, coriaceous, alternate, petioled, pinnately veined, denticulate or entire leaves; stipules small, tardily deciduous or somewhat persistent; winter buds solitary, sessile, with several imbricate scales; flowers perfect, actinomorphic, entomophilous, corymbose or paniculate, terminating short leafy branches of the season, appearing after the leaves; pedicels with persistent linear or lanceolate green bracts; hypanthium campanulate or urceolate, more or less adnate to the carpels, becoming ellipsoid in fruit; disk nectariferous; calyx 5-lobed, the lobes broad, entire, imbricate in aestivation, persistent, becoming reflexed on the fruit; petals 5, white, suborbicular, the width equalling or exceeding the length; stamens 20, inserted on the rim of the calyx; styles 3 to 5, free to the base; carpels 3 to 5, cartilaginous or membranous, not bony; ovary inferior, 3- to 5-loculed, each locule 2-ovuled, but in fruit nearly divided by a false partition growing from the back of each carpel, thus forming an incompletely 6- to 10-loculed pome with one seed in each locule if all mature; pome small, berry-like, edible; seeds brown, flattened, smooth; endosperm none.

Key to the Species of Malacomeles

Leaves of the flowering and fruiting branches small, the blades 0.5–1.5 cm. long; lateral veins 4 to 10 pairs, not very conspicuous beneath; sepals suborbicular, ciliate, 2 mm. long; petals 4 mm. long, glabrous; styles three, 2.5–3 mm. long; anthers 1–1.5 mm. long; mature fruits 6–8 mm. in diameter . . . . 1. *M. denticulata*

Leaves larger, usually 1.5–5 cm. long, the lateral veins 10 to 15 pairs, coarse and conspicuous on the lower surfaces; sepals triangular, 3 mm. long, microscopically glandular-denticulate; petals 5–6 mm. long, with a small tuft of hairs on the very short claw; styles five, 3–4 mm. long; anthers 2 mm. long; mature fruits 8–12 mm. in diameter . . 2. *M. nervosa*

1. **Malacomeles denticulata** (Kunth) comb. nov. *Cotoneaster denticulata* Kunth in H.B.K., Nov. Gen. 6: 169, pl. 556. 1823; M. Roem. Syn. Mon. 3: 222. 1847; Decaisne, Nouv. Arch. Mus. Hist. Nat. Paris 10: 177. 1874; Hemsley, Biol. Central Am. 1: 380. 1880; Wenzig, Jahrb. Bot. Gart. Mus. Berlin 2: 304. 1883. *Mespilus denticulata* Sprengel, Syst. Veg. 2: 505. 1825. *Nagelia denticulata* Lindley, Bot. Reg. 31 (Misc.): 40. 1845. *Amelanchier denticulata* (Kunth) K. Koch, Dendrol. 1: 183. 1869; Schneider, Illustr. Handb. Laubh. 1: 743, f. 416. 1906; Standley, Contr. U. S. Nat. Herb. 23: 337. 1922; Standley, Publ. Field Mus. Nat. Hist.

(bot. ser.) 8 : 140. 1930. *Crataegus minor* Sessé and Moc., Pl. Nov. Hisp. 84. 1887; (ed. 2) 79. 1893. *Crataegus inermis* Sessé and Moc., *loc. cit.* *Amelanchier Pringlei* Koehne, Gattung. Pomac. in Wissen. Beil. Progr. Falk.-Real. Berlin 95: 25, pl. 2, f. 20. 1890; Schneider, Illustr. Handb. Laubh. 1: 742, f. 416, 417. 1906. *Nagelia Pringlei* Schneider in Fedde, Rep. Spec. Nov. 3 : 183. 1907.

Shrubs 1–3 m. tall; twigs gray or brown when dry, grayish-tomentose when young, becoming glabrous; winter buds small, tomentose; leaves persistent, coriaceous, numerous, oval or elliptical to obovate or orbicular, conduplicate in the bud; upper surfaces of mature leaves glabrous, glossy, obscurely veined, the midvein impressed; lower surfaces closely grayish tomentose, the midvein prominent; mature blades 5–15 mm. long, 3–10 mm. wide, the apices mucronulate, varying from truncate to rounded or acute, the base shortly cuneate to rounded or truncate; lateral veins 4 to 10 pairs; margins denticulate to entire, the teeth when present 4 to 8 on each margin of average leaves of the flowering and fruiting branches; stipules small; petioles 2–4 mm. long, more or less tomentose; flowers about 1 cm. in diameter; inflorescence short, compact, few-flowered, somewhat corymbose; rachis and pedicels glabrous or pubescent, 3–6 mm. long; bracts persistent, carinate, lanceolate, green, ciliate, otherwise glabrous, about 2 mm. long; petals 5, white, suborbicular or reniform, veiny, 4 mm. long, 5 mm. wide, glabrous on both sides; stamens 20; filaments glabrous, minutely papillose; anthers 1–1.5 mm. long; hypanthium glabrous outside, campanulate, 3–4 mm. long, 3–4 mm. in diameter; sepals suborbicular, 2 mm. long, 2.5 mm. wide, rounded at the apex, ciliate, otherwise glabrous, green, soon reflexed; styles 3, glabrous, free to the base, 2.5–3 mm. long; carpels free; summit of the ovary densely white-tomentose; fruits in clusters of 1 to 4, ellipsoid to subglobose, glabrous, purplish black at maturity, 6–8 mm. in diameter; calyx-lobes on the fruit erect or ascending; seeds reddish-brown, smooth or nearly so, obliquely oval, somewhat compressed, 5–6 mm. long, about 3 mm. wide.

Type locality. Actopan, Hidalgo, Mexico.

Range. Brewster County, Texas, southward to Guatemala.

Specimens examined. UNITED STATES. Texas: El Solitario, *V. L. Cory 1651, 1652* (GH); Glass Mountains, *O. E. Sperry T673* (GH), *B. H. Warnack 540* (GH). MEXICO. Chihuahua: Santa Eulalia Mountains, *C. G. Pringle 259* (AA, GH, FM, isotype of *Amelanchier Pringlei*); vicinity of Santa Eulalia, *Palmer 136* (FM). Coahuila: San Lorenzo Canyon, 6 miles southeast of Saltillo, *Palmer 395* (FM). Nuevo Leon: San Francisco Canyon, about 15 miles southwest of Pueblo Galeana, *C. H.* and *M. T. Mueller 289* (AA, FM); Hacienda Pablillo, Galeana, *Mary Taylor 106* (FM). San Luis Potosi: Charcas, *C. L. Lundell 5458* (FM); without definite locality, *C. C. Parry* and *Edw. Palmer 230* (FM). Hidalgo: hills above El Salto station, *C. G. Pringle 11439* (FM);

Zimapan, *L. A. Kenoyer A388* (FM); Actopan, *Bonpland* (type, Herb. Mus. Paris; phototype, AA, UI). Veracruz: Maltrata, Tlaxialle, *E. Kerber 251* (FM). Oaxaca: Alturas de San Pablo Huitzo, *C. Conzatti 1976* (FM); vicinity of San Luis Tultitlanapa, *C. A. Purpus 3231* (FM). GUATEMALA. Guatemala: near Finca La Aurora, *Ignacio Aguilar 35* (FM); on the road between Guatemala and San Raimundo, *P. C. Standley 62941* (AA, FM). Sacatepequez: Finca El Hato, northeast of Antigua, *P. C. Standley 61154* (FM); near Antigua, *P. C. Standley 61680, 63821* (FM); San Juan, *Jesus Morales Ruano 1375* (FM); Cerro de la Cruz, above Antigua, *P. C. Standley 63330* (AA, FM); Cuesta de las Canas, above Antigua, *P. C. Standley 58913* (AA, FM); near Pastores, *P. C. Standley 59898, 59951* (FM).

2. **Malacomeles nervosa** (Decaisne) comb. nov. *Cotoneaster nervosa* Decaisne, Nouv. Arch. Mus. Paris 10: 177. 1874. *Amelanchier denticulata* var. *psilantha* Schneider, Ill. Handb. Laubh. 1: 743. 1906. *Amelanchier denticulata* var. *nervosa* Schneider, *op. cit.* 744, f. 416, 417, 1906. *Nagelia denticulata* var. *nervosa* Schneider in Fedde, Rep. Nov. Spec. 3: 183. 1907. *Nagelia denticulata* var. *psilantha* Schneider, *op. cit.* *Cotoneaster denticulata* var. *latifolia* Hemsley, Biol. Central Am. 1: 380. 1880, *nom. nud.* *Amelanchier paniculata* Rehder, Jour. Arnold Arb. 16: 449. 1935.

Shrubs 1–3 m. tall; young twigs densely whitish tomentose, tardily glabrate; winter buds densely tomentose; leaves persistent, coriaceous, elliptical to oval, conduplicate in the bud; upper surfaces green, glabrate, glossy, the lower surfaces densely whitish tomentose throughout; mature blades 1.5–5 cm. long, 8–25 mm. wide, the apex acute or obtuse, mucronulate, the base cuneate to rounded; lateral veins 10 to 15 pairs, rather obscure or somewhat impressed on the upper surface, prominent on the lower side; margins remotely and minutely denticulate, the teeth 7–9 per cm., and 6 to 25 on each side of average blades of the flowering and fruiting branches; stipules small, subulate; petioles 5–10 mm. long, densely tomentose; inflorescence terminal or axillary, corymbose, or rarely somewhat paniculate, the pedicels 2–4 mm. long, whitish tomentose; bracts persistent, linear-lanceolate, carinate, green, tomentose on back and margins, 3–4 mm. long; hypanthium loosely floccose, becoming glabrous, somewhat funnelform, 4–5 mm. long, 5–6 mm. in diameter; petals 5, white, broadly oval or suborbicular, abruptly contracted at the base, somewhat concave, veiny, 5–6 mm. long, 4–5 mm. wide, with a small tuft of hairs on the very short (0.5 mm. long) claw; stamens about 20, unequal; anthers cordate-ovate, 2 mm. long; sepals triangular-ovate, acute, dorsally glabrous, tomentose within, acute, mucronulate, 3 mm. long, about 3 mm. wide, microscopically glandular-denticulate, the glands few, dark-colored; styles five, 3–4 mm. long, glabrous, free to the base; summit of the ovary densely white-tomentose; ovary inferior, each locule with 2 ovules separated by a false partition; fruits ellipsoid or subglobose, puberulent at first, glaucous, 8–12 mm. in diameter, edible, 6 or more loculed, 4 or more seeded; calyx-lobes persistent, ascending or reflexed, glabrous on both sides or sparsely pubescent within, the margins ciliate; seeds reddish brown, smooth or minutely striate, 3.5–4 mm. long, obliquely lanceoloid or narrowly ovoid.

Type locality. "Regno Mexicano, Prov. Chiapa—fl. februario (Linden 1840); Karwinski (herb. Imp. Petrop.)."

Range. Nuevo Leon, Mexico, to Huehuetenango, Guatemala.

Citation of specimens. MEXICO. NUEVO LEON: southwest of Puebla Galeana, *C. H.* and *M. T. Mueller 282* (AA, type of *Amelanchier paniculata;* isotype, FM); about 15 miles southwest of Galeana, *C. H.* and *M. T. Mueller 834* (AA); Hacienda Pablillo, Galeana, *Mary Taylor 152* (FM). TAMAULIPAS: Juamave, *H. W. von Rozynski 518* (FM); Tula, *J. Gregg 599* (GH, syntype of *Amelanchier denticulata* var. *psilantha*). SAN LUIS POTOSI: without definite locality, *J. G. Schaffner 460* (AA, FM). CHIAPAS: locality unknown, *Linden* in 1840 (type, Herb. Mus. Paris; phototype, AA, UI). STATE UNKNOWN: *Sessé* and *Mocino 1012, 2128* (FM). GUATEMALA. HUEHUETENANGO: Chiantla, *A. F. Skutch 1125, 1145* (AA, FM), *P. C. Standley 65666* (FM); along Aguacatan Road, east of Huehuetenango, *P. C. Standley 81964* (FM). STATE UNKNOWN: San Martin (?), *J. R. Johnston 1750* (FM).

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DISEASES OF FREMONTIA

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The plants of the genus *Fremontia,* a native of the southwestern United States are highly esteemed by many as ornamental subjects for garden and park and no doubt would be much more widely planted except for certain diseases to which they are susceptible, particularly the first of those treated below.

STEM GIRDLING

This disease, caused by the soil-inhabiting water mold *Phytophthora cactorum* Lib. and Cohn., was first brought to our attention in 1934 because of rather heavy losses in young nursery stock. Since that time it has been seen rather frequently in cultivated specimens of varying size up to fifteen feet or so in height. We have not seen the disease on plants in the wild. The principal effect of this disease is the killing of the bark entirely around the stem commonly at or near the ground line but occasionally higher up. The death of the bark is soon followed by withering of all parts distal to the necrotic portion.

The disease was easily induced artificially by inoculation of pot-grown plants with the fungus taken from pure cultures. If the fungus is introduced through wounds, stems about one-half inch in diameter may be completely girdled in forty-eight hours. Even when the fungus is merely placed in contact with uninjured bark, such small plants are often killed within a few days. Plants of three species of *Fremontia, F. californica* Torr., *F. napensis* Eastw. and *F. mexicana* (Dav.) Macbr., appear to be about equally susceptible.

The prevalence and destructiveness of this disease seem to be clearly related to excess water and inadequate drainage. At least some of the losses could be avoided by planting in exceptionally well-drained sites and by sparing use of water.

Vascular Wilt

Another soil-borne fungus, *Verticillium albo-atrum* R. and B., occasionally infects *Fremontia* plants grown under cultivation. The mycelium of this fungus invades seemingly uninjured roots and eventually pervades most of the xylem elements even those of the petioles and leaf veins. The stele is distinctly discolored (pl. 3, fig. A) while the bark appears unchanged. Infected plants are at first stunted and the leaves wilt and soon drop off (pl. 3, fig. B). Death of small plants ensues in three to five months. The disease was produced by artificial inoculation in plants of the three species named above. It has not been seen in plants in their native habitat. No satisfactory control is known.

Leaf Spot

This disease, caused by the fungus **Hendersonia Fremontiae** (Hark.) comb. nov. (*Ascochyta Fremontiae* Hark.), produces small to large necrotic areas in the leaf blade with typically dark to black margins (pl. 3, fig. D). Harkness (Fungi of the Pacific Coast. Bull. Calif. Acad. Sci. 2: 438–447. 1887.) discovered the disease in 1881 and described the causal organism as follows: "Hypophyllous, scattered, minute, spores pale brown, nearly cylindrical, slightly attenuated at the ends, flexuous, 1-septate, but often appearing 3-septate by division of the endochrome, very unequal in size, 6–12 × 30–40 μ, covering the lower surface of the living leaves of *Fremontia californica*." This description is excellent and enables one to identify the fungus on sight. The three-septate condition of the spores, however, is real and not merely an optical illusion. This becomes clear when the fungus is grown in culture where spores having up to five clearly visible septa are produced. The pale brown color alone would preclude the inclusion of this fungus in the genus *Ascochyta*. The color and multiseptate condition of the conidia and other characteristics place this fungus in the form genus *Hendersonia*. The disease has been found on *Fremontia californica* and *F. napensis* in nature and has

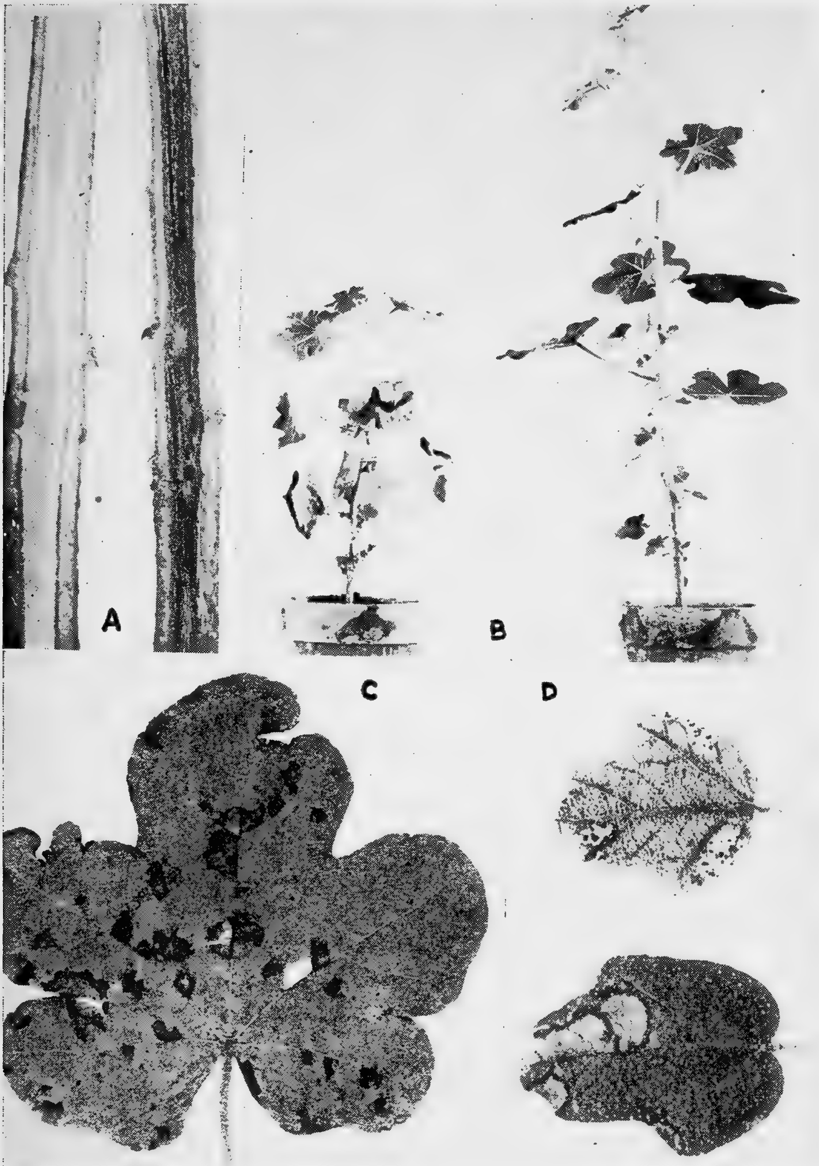

Plate 3. Diseases of Fremontia. Fig. A. Longisections through stems of *Fremontia* showing discolored stele of infected plant (right) and stele of healthy plant (left), ×1. Fig. B. *Verticillium*-infected plant (left), control (right), ×1/5. Fig. C. Leaf of *Fremontia californica* showing angular leaf spot, *Septoria angularis*, ×1. Fig. D. Leaf of *Fremontia napensis* affected by *Hendersonia* leaf spot: ventral view showing pycnidia (upper); dorsal view showing black margins of leaf spots (lower).

been produced on these and on *F. mexicana* by artificial inoculation. The injury is seldom severe.

Angular Leaf Spot

A species of *Septoria* was found to produce small, angular, brown leaf spots (pl. 3, fig. C) which may coalesce to form rather large necrotic areas. Premature defoliation may result where overhead sprinkling is practiced. The small, black pycnidia of the fungus are produced in dense groups beneath the epidermis of the ventral surfaces of the leaves and eventually the ostioles break through to the surface. Conidia from the leaf are one- to three-septate, mostly one-septate, whereas from culture they are one- to many-septate. This fungus does not seem to have been previously described and we therefore submit it as a new species.

Septoria angularis sp. nov. Maculis irregularibus angulatis, fuscis; pycnidiis epiphyllis, subepidermicis, dense gregariis, globosis, 50–70 μ diam., ostiolo minuto perforatis; sporulis oblongis utrinque attenuatis, 1–3-septatis, non constrictis, hyalinis, 10–17 × 1.5–2 μ; sporophoris papilli formibus. Hab. in foliis Fremontiae (Sterculiaceae) Amer. Bor.

Type. On leaves of *Fremontia mexicana* (Davidson) Macbride; nursery in Morgan Hill, Santa Clara County, California, May, 1935, *Harvey E. Thomas* (Herbarium of the University of California no. 688926).

This leaf spot was found also on *Fremontia* growing in a garden of native plants at Santa Barbara. It has been produced by artificial inoculation on the three species of *Fremontia* mentioned above.

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NOTES ON THE GENUS ELYMUS

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Relationships in the *Elymus triticoides*—*E. condensatus*—*E. cinereus* complex of western North America never have been satisfactorily explained, especially in respect to the plants of coastal California. Hitchcock (1) more or less arbitrarily distinguished two species but recognized the possibility of a third entity in the "giant rye grass" of southern California. His discussion of *E. condensatus* is concluded with the statement, "On the coast of California there is a form with robust culms as much as 3 m. tall, compound spikes as much as 30 cm. long and 4 cm. thick, the ascending compound branches sometimes 6 cm. long. This form usually has pronounced rhizomes; possibly distinct." The type of *E. condensatus* from "Monte-Rey, California" has not been examined (it was at Prague at the outbreak of the war) but from the type description and a photograph of the type sheet it may be judged to be the "form" characterized by Hitchcock. There is sufficient evidence to indicate that plants of the Great Basin area which have been referred to *E. condensatus* constitute a distinct species, the correct name for which is *E. cinereus* Scribn. & Merr.

Recent investigation utilizing data from studies of polyploidy in this group have clarified our understanding of species relationships and also have contributed to our knowledge of subspecific differentiation. Tetraploids (2n = 28) are known in all three species; hexaploids are found in *E. triticoides,* and octoploids in *E. condensatus* and *E. cinereus.* Diploids have not been found in these nor any other North American species of *Elymus.* Differences in chromosome number are for the most part accompanied by morphological differences but notable exceptions exist in *E. triticoides* hexaploids, some of which closely resemble the tetraploids. In respect to distribution, *E. condensatus* and *E. cinereus* have separate ranges and different habitat preferences from each other (fig. 1) but the extremely polymorphic *E. triticoides* is widely distributed throughout the ranges of the other two, often growing intermingled with them.

In the following amplified descriptions, notes, and key our understanding of relationships in this group is presented.

Culms 6–10 mm. in diameter at base; leaves 15–35 mm. broad; spikelets 8 to 40 at a node (including those on branchlets) .... 1. *E. condensatus*
Culms 6 mm. or less in diameter; leaves 3–15 mm. broad; spikelets 1 to 6 at a node, rarely more.
  Culm nodes (or vicinity of nodes) with fine, usually dense pubescence; plants non-rhizomatous .... 2. *E. cinereus*
  Culm nodes glabrous; plants rhizomatous.
    Culms 2–3.5 mm. in diameter; leaf blade 3 to 6 mm. broad; spikes with 1 to 2 occasionally 3 spikelets at a node; spikelets 8–15 mm. long with 3 to 6 florets .... 3. *E. triticoides*
    Culms 3.5–5 mm. in diameter; leaf blade 6–15 mm. broad; at least some nodes of spike with 3 to 6 spikelets, or spikelets 17–25 mm. long with 6 to 9 florets .... 4. *E. triticoides* subsp. *multiflorus*

1. Elymus condensatus Presl, Rel. Haenk. 1: 265. 1830.

Perennial; culms stout 1.5–3.5 m. tall, usually in dense clumps; rhizomes short, thick, generally produced along the margins of clumps; leaf blades often more than 2 cm. broad, glabrous or with fine silvery pubescence, exceptionally tough and fibrous; spikes 15–40 cm. long, with numerous, often compound, erect branchlets bearing one to many spikelets; spikelets relatively small, 10–15 mm. long, 3- to 6-flowered; florets frequently sterile, often not maturing; glumes subulate or flat and narrow, equal to or slightly

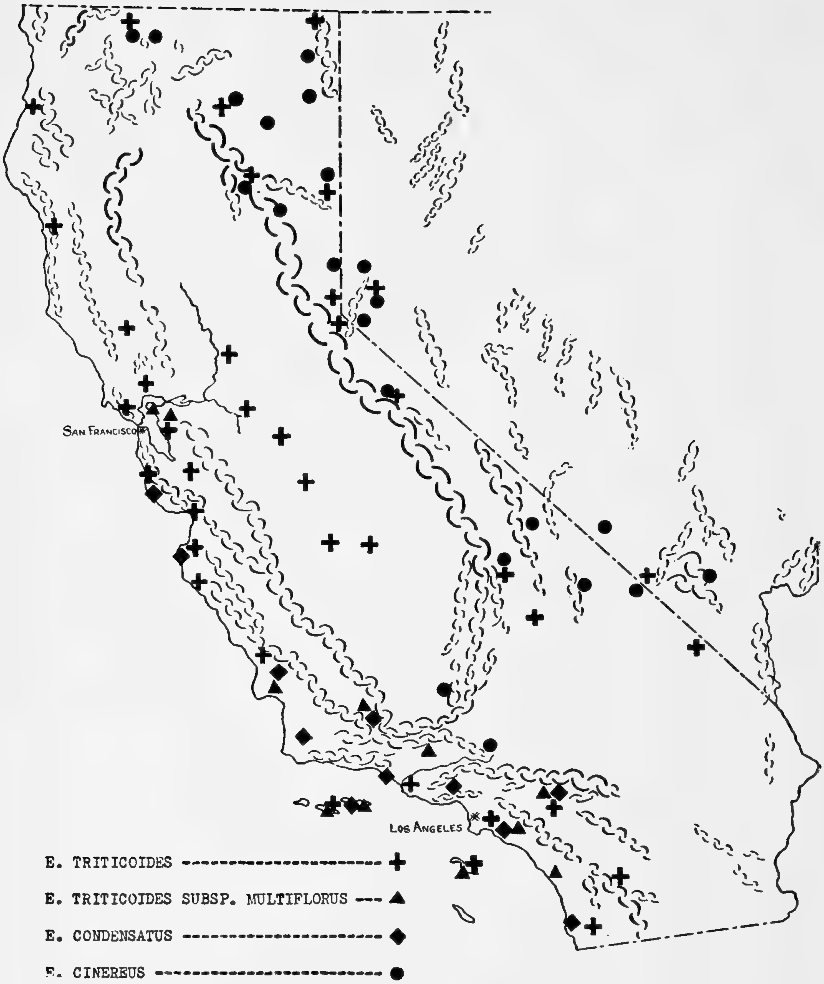

Fig. 1. Distribution of *Elymus condensatus* and *E. triticoides* subsp. *multiflorus*, and the California range of *E. triticoides* and *E. cinereus*.

shorter than the spikelet; lemmas usually with a rather broad hyaline margin, short-awned or acute.

Santa Cruz County, California, south along the coast and on coastal islands to Lower California, inland to southwestern Kern County and the western tip of San Bernardino County.

This giant *Elymus* occurs on dry slopes and open woodlands and characteristically is a bunchgrass with culms in clumps of from ten to fifty. On both the eastern and western slopes of the coastal mountains north of Los Angeles, plants that presumably are seedlings form dense stands on recently burned slopes. Little is known concerning the range or morphological characteristics of the tetraploid and the octoploid segregates of *E. condensatus.* Differences in rhizome production, culm, leaf and spike dimensions, leaf pubescence, and fertility have been observed in the species and some of these may be found to be associated with chromosome number.

2. Elymus cinereus Scribn. & Merr. Bull. Torrey Bot. Club 29: 467. 1902. *E. condensatus* Presl. var. *pubens* Piper, Erythea 7: 101. 1899.

Caespitose perennial; culms usually 0.6–2 m. tall, pubescent or glabrous except for a fine, often microscopic pubescence on or in the vicinity of the nodes; leaf sheaths and blades pubescent or glabrous, frequently glaucous; spikes usually 10–20 cm. long, with 2 to 5 (rarely more) spikelets at a node, the central spikelets occasionally short-pedicelled; rachilla usually hairy, especially at the nodes; florets 3 to 6 in a spikelet; glumes subulate, about as long as the first lemma; lemmas pubescent or hairy at least on the upper portions, the apices bifid or obtuse, awnless or short-awned; palea usually with a dense tuft of hairs near the bifid apex.

Saskatchewan to British Columbia, south to New Mexico and California, in the latter state ranging chiefly east of the Sierra Nevada and not occurring in the Great Valley or immediately along the coast.

Elymus cinereus grows on dry slopes and plains in the desert mountain ranges of California from near sea-level to 7000 feet or higher. It is a plant of the Upper Sonoran zone and is frequent in *Artemisia tridentata* associations. The type collection from Pahrump Valley, Nevada (*C. A. Purpus 6050*) is densely pubescent. The same form occurs in California, Oregon, and Washington and in the latter state has been recognized as *E. condensatus* var. *pubens* Piper. At least some of this extremely pubescent material is known to be octoploid but the extent to which this character is associated with the octoploid genotype has not been determined. A large extremely glabrous form of this species lacking even nodal pubescence in some specimens has been collected in Washington and Oregon. In the opinion of the writer this probably represents the hexaploid genotype although proof is lacking at present.

3. Elymus triticoides Buckl. Proc. Acad. Nat. Sci. Phila. 1862: 99. 1863. *E. Orcuttianus* Vasey, Bot. Gaz. 10: 258. 1885.

Culms single or in small clusters, glabrous or rarely with a fine pubescence on the upper internodes, glaucous especially at the nodes; rhizomes extensive, the internodes long and slender; leaves glabrous or sparsely hairy, rarely pubescent, glaucous or less frequently bright green; spikes 8–20 cm. long; spikelets sessile or rarely on short pedicels; glumes subulate or flat and narrow, as long as or shorter than the first lemma; lemmas smooth or scabrous, short-awned from an acute or minutely bifid apex.

Montana and Washington south to Texas and Lower California and on the coastal islands of southern California.

Elymus triticoides, a plant of exposed slopes and valleys, is the only member of the genus to flourish as a weed of city lots and roadsides in the Western United States. The typical form, with slender culms, narrow leaves, and spikes that have only 1 or 2 spikelets at a node, is composed of both tetraploid and hexaploid populations. This form was at first thought to be entirely tetraploid and probably is predominately so when the entire range of the species is considered. Chromosome counts of several colonies of typical *E. triticoides* in the suburban district between Los Angeles and Long Beach indicate that here the hexaploid is more abundant. Population studies have disclosed a number of differences between the morphologically indistinguishable tetraploids and hexaploids in this region. The former flower two to three weeks earlier, have a pollen maturation of 75 to 98 per cent instead of 5 to 35 per cent, and have an average stomatal length and pollen grain size that is 15 to 20 per cent less than that of the hexaploids.

4. Elymus triticoides Buckl. subsp. **multiflorus** subsp. nov.

Culmi glabri 3.5–5 mm. diametro; laminae luminosae viridae, glabrae, 6–15 mm. latae; spicae magnae, irregulares, aliqui nodi cum 3 ad 6 spiculae, aut spiculae 17–25 mm. longae; spiculae saepe in brevibus ramis, cum 6 ad 9 florae.

Culms stout, frequently in dense clumps; rhizomes thicker and less extensive than in the species; blade usually bright green, glabrous, broad; spikes large, irregular, the spikelets, when crowded, frequently on short pedicels; florets highly sterile; glumes longer than in the species, usually exceeding the first lemma.

Type. Near San Francisco Bay at Albany, Contra Costa County, California, July 4, 1941, *Frank W. Gould 1304* (University of California Herbarium no. 686616).

This large hexaploid occurs in dense stands along the coastal region of central and, to a lesser extent, southern California. Although belonging to the *E. triticoides* complex it has numerous characters in common with the giant *E. condensatus* which occupies a similar range. Dr. G. L. Stebbins, Jr., of the University of California, who has done much of the preliminary cytological work on this group, believes the large hexaploid in general possesses two genomes of *E. triticoides* with one of *E. condensatus.* A logical assumption is that *E. triticoides* subsp. *multiflorus* is comprised of allopolyploids and that hexaploids of the typical form of the species are autopolyploids. Whatever their genetical constitution, it is quite apparent that these hexaploids have had a polyphyletic origin.

It is the intent of the writer to ascribe to subsp. *multiflorus* only those plants which are morphologically characteristic. It is expected, however, that all specimens referable to this group will have a somatic chromosome number of 42.

The following records of chromosome counts have been utilized in this study. These are taken from Stebbins and Love's paper (2) and from previously unpublished data of Dr. Stebbins and the writer. The writer is greatly indebted to Dr. Stebbins for his cooperation and helpful criticism during the course of this study.

Elymus condensatus Presl.

($2n = 28$) CALIFORNIA. Ventura County: *Stebbins 2864*. Los Angeles County: *Stebbins 2859*.

($2n = 56$) CALIFORNIA. Ventura County: *Gould 2357*. Los Angeles County: *Gould 2344*.

Elymus cinereus Scribn. & Merr.

($2n = 28$) OREGON. Grant County: *Soil Conservation Service no. W 5754–40P*. Baker County: *Soil Conservation Service no. W 5754* (counts by Stebbins).

($2n = 56$) WASHINGTON. Whitman County: *Soil Conservation Service no. W 3335* (seed). UTAH. Iron County: Cedar Breaks National Monument, *W. S. Boyle* (counts by Stebbins).

Elymus triticoides Buckl.

($2n = 28$) CALIFORNIA. Plumas County: *Stebbins 2923*. Marin County: *Gould 1299*. Contra Costa County: *Gould 1271, 1284, 1286*. Alameda County: *Stebbins 2702, 2753; Gould 1283*. San Mateo County: *Gould 1292*. San Benito County: *Stebbins 2754, 2755*. Merced County: *Stebbins 2800*. Los Angeles County: *Gould 2173, 2331, 2332, 2340, 2343*.

($2n = 42$) CALIFORNIA. Merced County: *Stebbins 2797*. Los Angeles County: *Gould 2335, 2339, 2341, 2346*.

Elymus triticoides Buckl. subsp. *multiflorus* Gould.

($2n = 42$) CALIFORNIA. Contra Costa County: *Gould 1279, 1288, 1291*. Kern County: *Stebbins 3010*. Los Angeles County: *Stebbins 2858; Gould 2333, 2334*.

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LITERATURE CITED

1. HITCHCOCK, A. S. Manual of Grasses of the United States. U. S. Dept. Agr. Misc. Publ. 200: 246–253. 1935.
2. STEBBINS, G. L., JR., and R. M. LOVE. A cytological study of California forage grasses. Am. Jour. Bot. 28(5): 371–382. 1941.

NOTEWORTHY PLANTS OF TEXAS. IV. PEDIOMELUM RYDBERG

B. C. Tharp and Fred A. Barkley

In considering the Psoraleae in the North American Flora (24: 17–24. 1919), Rydberg segregated a series of species from the genus *Psoralea,* the group being characterized by having deep-seated, tuberous, edible roots, and a long-beaked pod which bursts more or less irregularly around the middle. The series centered about the well known species *Psoralea esculenta* Pursh and was treated as the genus *Pediomelum,* with *P. esculentum* (Pursh) Rydb. as its type.

In reviewing this group as it occurs in Texas, it seems that the segregation of these species into *Pediomelum* is satisfactory. Of the twenty-two species which Rydberg treated, ten are found to occur in the state. In addition to these, three other well-marked species hitherto undescribed were noted.

The general position of these three may be seen from the appended key to the thirteen Texan species:

Rachis not produced beyond the first leaflets; leaves therefore truly digitate; calyx and claw of the banner long.
- Stem usually comparatively tall, 2–10 dm. high, leafy.
  - Plant with comparatively short, mostly appressed pubescence.
    - Leaflets linear; bracts shorter than the calyx .... *P. cyphocalyx*
    - Leaflets oblong, oblanceolate, or obovate; bracts usually as long as the calyx or longer.
      - Bracts broadly ovate, enclosing the calyx .... *P. Reverchonii*
      - Bracts lanceolate or linear-lanceolate, not enclosing the calyx.
        - Bracts ovate-lanceolate, acuminate, rarely as long as the calyx.
          - Bracts 10–15 mm. long; stipules ovate; plant little branched above .... *P. cuspidatum*
          - Bracts 7–10 mm. long; stipules lanceolate; plant much branched above .... *P. Parksii*
        - Bracts linear-lanceolate, caudate-attenuate, 15–20 mm. long, often much exceeding the calyx; stipules lanceolate; plant often much branched above .... *P. caudatum*
  - Plant with long spreading pubescence .... *P. esculentum*
- Stem very low (plant often subacaulescent), usually less than 1 dm. high, sometimes with the lower branches elongate, 1–2 dm. long and prostrate.
  - Plant hirsute; lowest calyx-lobe slightly broader than but scarcely longer than the rest; seeds smooth .... *P. subulatum*
  - Plant appressed-strigose; lowest calyx-lobe much broader and longer than the rest; seeds reticulate.
    - Peduncles much shorter than the petioles, scarcely longer than the spikes; root oblong-fusiform; lowest calyx-lobe ovate-lanceolate; stem short ...... *P. hypogaeum*
    - Peduncles often equaling the petioles, three to four times as long as the spikes; root globose; lowest calyx-lobe narrowly lanceolate; subacaulescent .. *P. scaposum*

Rachis produced beyond the first leaflets, usually bearing one or more terminal leaflets.
  Leaflets 3 or 5.
    Plant caulescent; spikes few-flowered; corolla less than 10 mm. long.
      Stipules lanceolate; bracts lanceolate; plant sparsely strigose .... *P. rhombifolium*
      Stipules deltoid; bracts ovate; plant densely strigose .. *P. Coryi*
    Plant subacaulescent; spikes many-flowered; corolla 15 mm. long or more .... *P. humile*
  Leaflets 5 or more, stem short; flowers many .... *P. Goughae*

A discussion of the previously undescribed species follows.

Pediomelum Parksii[1] sp. nov. Herba perennis; radicibus fusiformibus; caulibus 3–6 dm. altis parce strigosis teretibus; foliis 5-foliolatis; stipulis subulatis, 5–9 mm. longis, submembranacis, glanduloso-punctatis, persistentibus; petiolis 1.5–4 cm. longis, striatis, strigosis; foliolis subsessilibus, 1.5–3.5 cm. longis, 7–18 mm. latis, late rhombeo-obovatis, supra glabris et subter sparse strigosis, glanduloso punctatis supra et subter, apice truncato et mucronato, basi late cuneata, margine strigoso-ciliolatis; pedunculis 3–6 cm. longis, striatis, strigosis; spicis densis, 4–8 cm. longis; bracteis ovato-lanceolatis, caudato-attenuatis, 7–10 mm. longis, calyce subequali; calyce glanduloso-punctato, tubis circa 5 mm. longis, 5 mm. latis, quattuor lobis superioribus lanceolatis, longioribus quam tuba lobo inferiore lato-lanceolato, acuminato, bis longiore quam tuba, marginis dense pilosis; corollis 15 mm. longis; legumine ovoideo, muro tenui, glanduloso-punctato, proboscide subaequalissimo corpori.

Perennial with a tuberous root; stem 3–6 dm. high, sparsely strigose, terete, striate, with spreading branches above; leaves digitately 5-foliolate; stipules subulate, 5–9 mm. long, submembranaceous, sparingly strigose, ciliolate, glandular-punctate, persistent; petioles 1.5–4 cm. long, striate, strigose; leaflets subsessile, 1.5–3.5 cm. long, 7–18 mm. broad, broadly rhombic-obovate, rounded at the apices and mucronate, broadly cuneate

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[1] Harris Braley Parks was born at Carlinville, Illinois, June 10, 1879. B.S. from Blackburn College, 1900. Assistant Superintendent of the Sitka Training School, Alaska, 1905–1911; Professor of Natural Science at Palmer College, 1912–1917; extension entomologist of the Texas Agricultural and Mechanical College, 1918–1920; Secretary of the American Honey Producers League, 1921–1922; apiculturist, Texas Agricultural and Mechanical College, 1922–1926 and Chief of the Division of Apiculture since 1927.

His work in apiculture, together with an intense love for plants, has made him one of the foremost and most admired of modern collectors of Texas plants. Many of his collections in recent years have been made in collaboration with Mr. V. L. Cory. His collection is deposited in the S. M. Tracy Herbarium of the Texas Agricultural and Mechanical College.

It seems most fitting that another species should be named for this outstanding student of the Texas flora.

University of Texas Herbarium Biographical Sketch, V. B. C. Tharp and Fred A. Barkley.

at the bases, glabrous above, very sparingly strigose below, strigose-ciliate margined, minutely glandular-punctate above and below; peduncles 3–6 cm. long, striate, strigose; spikes dense, 4–8 cm. long; bracts ovate-lanceolate, caudate-attenuate, 7–10 mm. long, shorter than the calyx, sparsely pilose, minutely glandular-punctate; calyx glandular-punctate, sparingly hirsute; calyx tube about 5 mm. long, 5 mm. broad; calyx lobes densely pilose on margins, the upper four lanceolate, longer than the tube, the lowest broadly lanceolate, acuminate, twice as long as the tube; corolla 15 mm. long; banner obovate, slightly retuse at the apex; pod ovoid, thin-walled, glandular-punctate, sparsely strigose above, beak half as long as the body.

Type. Childress County, Texas, July, 1929, *Biology Class s.n.*, Herbarium of the University of Texas.

As we interpret the much confused situation in regard to the similar species, *P. cuspidatum* (Pursh) Rydb. and *P. caudatum* Rydb., the former is a little-branched plant with ovate stipules and bracts ovate-lanceolate, acuminate, 10–15 mm. long, rarely as long as the calyx, while the latter inclines toward being much branched above with lanceolate stipules and bracts linear-lanceolate, caudate-attenuate, 15–20 mm. long, often much exceeding the calyx. *P. Parksii* closely resembles *P. caudatum* in general aspect, but has leaflets more broadly obovate (or rarely rhombic-obovate), more obtuse, and with the mucro much less conspicuous. The inflorescence is longer, the calyx is much broader in proportion to its length, and the bract is broadly ovate, short acuminate and much shorter than the calyx.

Pediomelum Goughae[2] Tharp and Barkley sp. nov. Herba perennis; radicibus farinosis, fusiformibus; caulibus cum multis persistentibus cataphyllis subterraneis, aëriis brevissimis cum foliis multis, dense longo-strigosis; foliis palmato-compositis cum 4 ad 7 foliolis, usitate rhachidibus extentis 1–5 cm. longis cum

[2] Lula C. Gough (pronounced "gŏf"), daughter of Wm. Mason and Fannie Faulkner Gough, born at Ft. Worth, Texas, November 26, 1880, educated in the Sherman (Texas) Public Schools. B.A., Denton Teacher's College; M.A., University of Texas. Collections of plants made largely between 1918 and 1925 have been deposited in the Herbarium of John Tarleton Agricultural College and in the Herbarium of the University of Texas. It is a pleasure to dedicate this species to Miss Gough, whose collections in her area of the state, like those of several others of our coworkers, are of inestimable value to our study of the Texas flora.

University of Texas Herbarium Biographical Sketch, VI. B. C. Tharp and Fred A. Barkley.

Explanation of the Figures. Plate 4.

Plate 4. Type Specimens of the Genus Pediomelum. A. *P. trinervatum,* vicinity of Chihuahua, Chihuahua, Mexico, June 5–10, 1908, *Edward Palmer 356,* Herbarium of the New York Botanical Garden. B. *P. Goughae,* Stephenville, Texas, April 12, 1921, *Lula C. Gough s.n.,* Herbarium of the University of Texas. Inserts represent camera lucida sketches of the bracts and calyces, × 4.

PLATE 4. TYPE SPECIMENS OF THE GENUS PEDIOMELUM.

1 ad 3 foliolis palmatis ad apicem; stipulis lanceolatis, acuminatis, 1–2.5 cm. longis, strigosis, persistentibus; petiolis circa 1 dm. longis, strigosis; foliolis ovatis vel rhombo-ovatis, truncatis vel acutis, ad basem cuneatis, strigosis supra et subter; pedunculis 10–13 cm. longis, strigosis; spicis densis, circa 4 cm. longis; bracteis ovatis, obtusis, 7 mm. longis, sparse longo-strigosis; calyce strigoso-canescentes, tubo circa 3 mm. longo; quattuor lobis supra subulatis, attenuatis, circa 6 mm. longis, lobo infra oblanceolato, longo-acuminato, 1 cm. longo, 3-nervato obscuro; corolla caerulea, circa 1.1 cm. longa.

Perennial from a farinaceous root; stem below ground covered with ovate to lanceolate persistent cataphylls, stem above ground very short with many leaves and several short flowering branches, densely long strigose; leaves with 4 to 7 leaflets palmately arranged and usually with an extension of the rachis 1–5 cm. long bearing 1 to 3 additional leaflets palmately arranged; stipules lanceolate, acuminate, 1–2.5 cm. long, strigose, persistent; petioles about 1 dm. long, strigose; leaflets ovate or rhombic-ovate, rounded to acute, cuneate at the bases, strigose on both surfaces; peduncles 10–13 cm. long, strigose; spikes about 4 cm. long, dense; bracts ovate, obtuse, 7 mm. long, sparsely long strigose; calyx long strigose-canescent; tube about 3 mm. long; upper four calyx-lobes subulate, attenuate, about 6 mm. long, the lowest one oblanceolate, long-acuminate, 1 cm. long, obscurely 3-nerved; corolla bluish, about 1.1 cm. long.

Type. Stephenville, Erath County, Texas, April 12, 1921, *Lula C. Gough s.n.*, Herbarium of the University of Texas. (This specimen erroneously bears the date October 12, but checking with a duplicate specimen in John Tarleton Agricultural College Herbarium shows that the date should have been April 12.)

An additional specimen, Post, Garza County, Texas, July 9, 1941, *B. C. Tharp s.n.* in the University of Texas Herbarium, has been examined.

This species in many respects is similar to ***P. trinervatum*** Rydb. of New Mexico and Chihuahua, the type of which upon close examination clearly shows the terminal leaflet is borne upon an extension of the rachis beyond the lowermost leaflets. *P. trinervatum* has a very large lower calyx lobe which is obovate and short acuminate with three very prominent ribs, while in *P. Goughae* the lowermost calyx lobe is oblanceolate and long-acuminate with three rather obscure nerves. The flower of the latter

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Explanation of the Figures. Plate 5.

Plate 5. Type Specimens of the Genus Pediomelum. A. *P. Coryi*, Katherine, Texas, March 22, 1907, *W. L. Bray & H. H. York 5*, Herbarium of the University of Texas. B. *P. Sonorae*, vicinity of Alamos, Sonora, Mexico, March 17, 1910, *J. N. Rose, Paul C. Standley & P. G. Russell 13025*, Herbarium of the New York Botanical Garden.

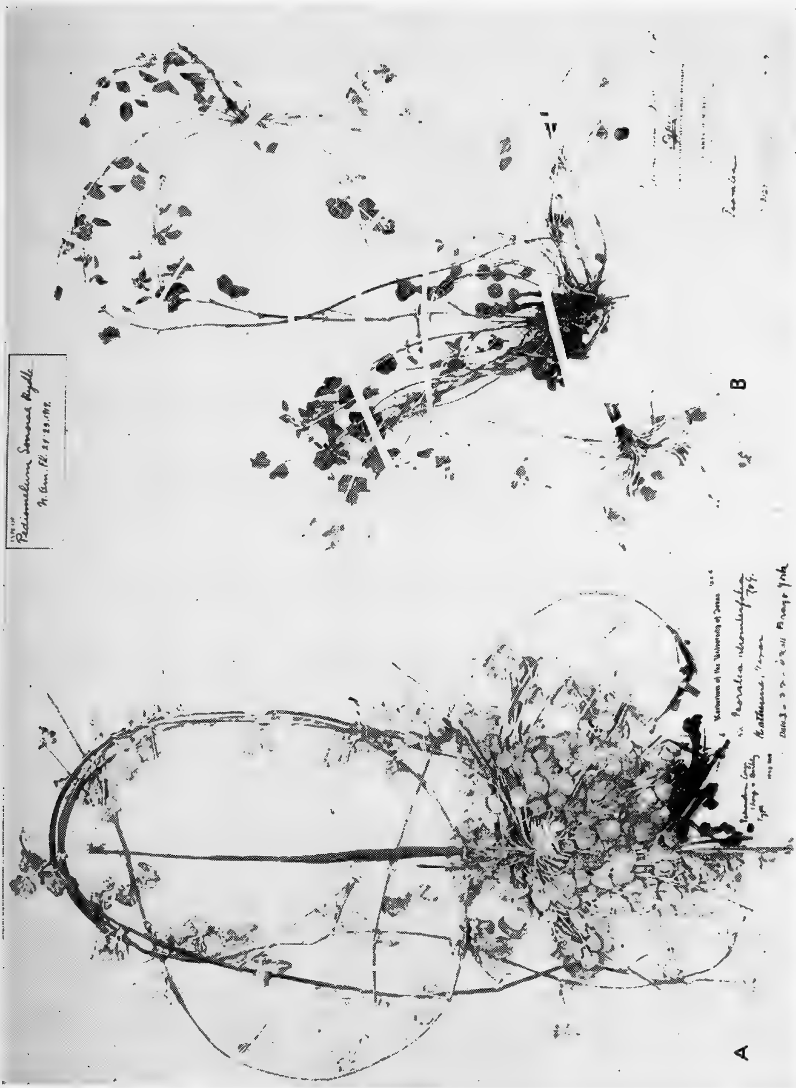

PLATE 5. TYPE SPECIMENS OF THE GENUS PEDIOMELUM.

species is less than half as large and the pubescence much longer than in the former species. The bracts of *P. Goughae* are broadly ovate, subacute or obtuse, while in *P. trinervatum* they are lanceolate, long acuminate.

Pediomelum Coryi[3] Tharp and Barkley sp. nov. Herba perennis; radicibus fusiformibus; caulibus ad basem ramosis, 1–9 dm. longis, decumbentibus, striatis, strigosissimis; foliis pinnate 3-foliolatis; stipulis deltoideis, 3–4 mm. longis, subglabris praeter margine longa-ciliolata; petiolis 1–3 cm. longis, striatis, strigosis; foliolis 5–15 mm. longis, 5–20 mm. latis, rotundis vel orbicularibus, canescentibus, foliolis lateralibus subsessilibus, petiolulis terminalibus 2–8 mm. longis; pedunculis 3–5 cm. longis, strigosis; spicis subcapitatis, floribus paucis; bracteis 1.5 mm. longis, rotundis, truncatis, sparse hirsutis, ciliolatis; calyce canescenti, 5 mm. longis, plus minusve gibberosis supra, lobis subaequalibus, lanceolatis, tubae subaequalibus; corolla purpurea, 6 mm. longa; leguminibus canescentibus, 1 cm. longis, corporibus ovatis, 5 mm. longis, proboscide curvo, circa 5 mm. longo.

Perennial with a deep-seated, farinaceous root; stem branching at base, 1–9 dm. long, decumbent and trailing, striate, densely strigose; leaves pinnately trifoliolate; stipules deltoid, 3–4 mm. long, subglabrous except margin long-ciliolate; petioles 1–3 cm. long, striate, strigose; leaflets 5–15 mm. long, 5–20 mm. broad,

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[3] Victor Louis Cory, Range Botanist, Texas, Substation 14, Sonora, Texas, son of Philip Rose and Rebecca Smith Cory, born September 17, 1880, at Albia, Monroe County, Iowa. B.S., Kansas State College, 1904; M.S., University of Minnesota, 1923. Married Zenobia Frances Brian, January 20, 1917. One daughter, Edith Jean. Farm superintendent for the United States Department of Agriculture 1904–1912 and for the Texas Agricultural Experiment Station 1912–1917 and 1920–1922. Range Botanist for the Texas Agricultural Experiment Station since 1923.

He is widely travelled (Morocco, Sierra Leone, Liberia, Spain, and Mexico). His hobbies are mountain climbing and visiting historic spots in Texas. Outside of Texas he has collected plants in Wisconsin, Minnesota, Kansas, Oklahoma, New Mexico, and Arizona. His collection of Texas plants began in 1923, and since that time he has collected in most parts of the state. Much of his field work has been done in collaboration with H. B. Parks, some with Marcus E. Jones, P. A. Munz, and Simon E. Wolff. His collections are mainly deposited in the Tracy Herbarium of the Texas Agricultural and Mechanical College and in Gray Herbarium of Harvard University. As a result of his extensive field collections he has published many papers dealing with Texas flora.

It is indeed a pleasure to name this species for this student of the Texas flora.

University of Texas Herbarium Biographical Sketch, VII. B. C. Tharp and Fred A. Barkley.

Explanation of the Figures. Plate 6.

Plate 6. Type Specimens of the Genus Pediomelum. A. *P. Parksii,* Childress County, Texas, July, 1929, *Biology Class s.n.,* Herbarium of the University of Texas. B. *P. caudatum,* sandy soil, Dallas County, Texas, *May J. Reverchon* (*Curtiss 563*), Herbarium of Columbia University (at the New York Botanical Garden). Inserts show bracts and calyces, ×4.

PLATE 6. TYPE SPECIMENS OF THE GENUS PEDIOMELUM.

rotund to orbicular, subcordate at the bases, truncate at apices, canescent, lateral leaflets subsessile, terminal petiolule 2–8 mm. long; peduncles 3–5 cm. long, strigose; spikes subcapitate, few-flowered; bracts 1.5 mm. long, rotund, truncate, sparsely hirsute, ciliolate; calyx canescent, 5 mm. long, slightly gibbous on the upper side, calyx lobes subequal, lanceolate, scarcely as long as the tube; corolla purplish, 6 mm. long; pod canescent, 1 cm. long, the body ovoid, 5 mm. long, the beak curved, about 5 mm. long.

Type. Katherine, Texas, March 22, 1907, *W. L. Bray* and *H. H. York 5,* University of Texas Herbarium.

An additional collection, Ottine, Gonzales County, Texas, April 11, 1926, *E. R. Bogusch 1284,* University of Texas Herbarium, has been examined.

This species most closely resembles *P. Sonorae* Rydb. from which it differs markedly in shape of leaf, pubescence, and fruit. Its nearest relative in Texas is *P. rhombifolia* (T. and G.) Rydb., from which is differs in being densely strigose, in having ovate-truncate leaflets and deltoid stipules, in having broadly ovate bracts and fewer flowers more densely arranged in the inflorescence.

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NOTES ON THE FLORA OF THE CHARLESTON MOUNTAINS, CLARK COUNTY, NEVADA. VI[1]

Ira W. Clokey

In the course of preparing the manuscript for the flora of the Charleston Mountains of Nevada, it has been found necessary to describe a new violet from the region and to make adjustments in the nomenclature of some of the species of several other genera. I am indebted to Mr. Milo S. Baker and to Dr. Jens Clausen for their interpretations of the violets of this area.

Ephedra fasciculata A. Nelson var. **Clokeyi** (Cutler) comb. nov. *E. Clokeyi* Cutler, Ann. Mo. Bot. Gard. 26: 402. 1939.

The range of the variety is cocentric with that of the species. Morphologically the variety is too close to *E. fasciculata* to warrant specific distinction, the two differing from each other principally in the size and shape of the fruit.

Echeveria pulverulenta Nutt. subsp. **arizonica** (Rose) comb. nov. *Dudleya arizonica* Rose, Addisonia 8: 35. 1923. *Echeveria arizonica* (Rose) Kearney and Peebles, Jour. Wash. Acad. Sci.

[1] Previous notes in this series have appeared as follows: Madroño 4: 128–130. 1937; Bull. So. Calif. Acad. Sci. 37: 1–11. 1938; *ibid.* 38: 1–7. 1939; Madroño 6: 211–222. 1942; *ibid.* 7: 67–76. 1943.

29: 479. 1939, not *E. arizonica* Hort. ex Berger. 1930. *Dudleya pulverulenta* (Nutt.) Britton and Rose subsp. *arizonica* (Rose) Moran, Desert Pl. Life 15: 72. 1943.

Recent authors—Jepson, Kearney and Peebles, and Munz—do not consider *Dudleya* sufficiently separated from *Echeveria* to be recognized as a distinct genus. This is clearly presented by Jepson (Fl. Calif. 2: 111. 1936) who considers the California species as having close affinities with the Mexican species of *Echeveria.* As stated by Moran (*op. cit.,* p. 74) the subsp. *arizonica* is a reduced desert form of the species.

Representatives of the genus *Amelanchier* are abundant in the Charleston Mountains, in some places being the dominant shrubs. Locally they fall into what are usually considered three species, *A. utahensis, A. oreophila* and *A. Covillei* (*A. nitens*). Owing to the similarity of these three shrubs and the great abundance of intermediates, they are considered here as not worthy of being kept specifically distinct. The three entities can be distinguished as follows:

Shrub symmetrical; leaves acute or rounded at apex, upper surfaces shiny; fruit fleshy.
- Leaves pubescent; fruit purplish .... 1. *A. utahensis*
- Leaves glabrous; fruit somewhat mealy, white or occasionally with a purple cheek .... 2. *A. utahensis* subsp. *Covillei*

Shrub not symmetrical; leaves ovate or obovate, rounded at apex, dull, pubescent; fruit very juicy, purple ... 3. *A. utahensis* subsp. *oreophila*

1. Amelanchier utahensis Koehne, Gatt. Pomac. in Wissen. Beil. Progr. Falk-Real. Berlin 95: 25, pl. 2. 1890. *A. alnifolia* Nutt. var. *utahensis* (Koehne) Jones, Proc. Calif. Acad. Sci., ser. 2, 5: 679. 1895.

Colorado to Oregon, south to New Mexico, Arizona, southern Nevada and southeastern California. Local habitat, Juniper and lower Pinyon belts, at elevations between 1400 and 2100 meters. Widely scattered and locally the dominant shrub. Harris Springs road, *Clokey 7543;* Kyle Canyon, *Alexander 535, Clokey 7541;* 4 to 5 miles below public camp grounds (Kyle Canyon), *Maguire 18086, 18087;* Mountain Springs, *Clokey* and *Anderson 7971;* canyon east of Mountain Springs, *Clokey 8564.* Flowers in April and May; fruits in June.

In some areas, as along the ridge branch of the Harris Springs road, most of the plants are intermediate between the species and the subsp. *Covillei,* while along the old road from Kyle Canyon to Deer Creek, the shrubs are nearly all intermediate between the species and the subsp. *oreophila.*

2. Amelanchier utahensis Koehne subsp. **Covillei** (Standley) comb. nov. *A. Covillei* Standley, Proc. Biol. Soc. Wash. 27: 198.

1914. *A. nitens* Tidestr. *ibid.* 36: 182. 1923. *A. alnifolia* Nutt. var. *Covillei* (Standley) Jepson, Man. Fl. Pl. Calif. 510. 1925.

Eastern Inyo and San Bernardino counties, California, through southern Nevada to northern Arizona. Local habitat, in the Juniper Belt, at elevations of about 1200 meters, in washes and on hillsides. Wilson's Ranch, *Clokey 8236, 8237, McVaugh 5966, Maguire 18045.* Blooms in April; fruits in May and early June.

The type locality of *A. Covillei* is Cottonwood Springs, Panamint Mountains, Inyo County, California; that of *A. nitens* is Wilson's Ranch, Charleston Mountains, Clark County.

3. Amelanchier utahensis Koehne subsp. **oreophila** (A. Nels.) comb. nov. *A. oreophila* A. Nels. Bot. Gaz. 40: 65. 1905.

Montana south to New Mexico, Arizona and southern California. Local habitat, on steep hillsides and canyon bottoms, associated with *Cercocarpus ledifolius, Pinus monophylla* and *P. ponderosa* var. *scopulorum,* at elevations between 2100 and 2300 meters. Kyle Canyon, *Clokey 7141, 7142.* Flowers in May; fruits in August.

Viola charlestonensis Baker and Clausen, sp. nov. Herba geophyta depressa, 10 cm. alta vel minus, rhizomate erecto vel ascendenti cum radice valida altaque; caulibus 1–8, 1/2–2/3 longitudinis subterraneis cum 1 vel 2 nodis subterraneis, supra cum floribus foliisque dense confertis; foliis crassis, cinereis supra cum venis albidis, infra purpurascentibus; caulibus foliis pedunculisque pilis brevibus complanatis adpressis retrorsis subvestitis; foliis radicalibus paucis, rotundatis, late ovatis, obtusis, basi truncatis vel paulum cuneatis, integris, 1.1–2.3 cm. latis, 1–2.5 cm. longis, petiolis 4–6 cm. longis; foliis caulinis angustioribus, ovatis, apice acutioribus, basi cuneatis, 6–20 mm. latis, 8–25 mm. longis; stipulis foliorum radicalium scariosis, adnatis, alas in parte subterranea petioli formantibus; stipulis foliorum caulinorum griseis, lanceolatis, integris, 1–2 mm. longis; bracteolis subulatis, integris, prope medium pedunculi, 1.5–2.5 mm. longis; floribus numerosis, omnino petaliferis, saepe infertilibus; sepalis lineari-lanceolatis, vix auriculatis, 3.5–4 mm. longis, incanis processibus brevibus, albis, adpressis piliformibus; corolla 12–17 mm. diametro, flava supra, manifeste fuscata in dorso petalorum superorum; petalis superioribus et lateralibus late obovatis, lateralibus clavate barbatis; petalo inferiore late spatulato, truncato, breviore quam lateralibus petalis, cum brevi calcare processibus piliformibus vestito per calcarem ad medium petali extendentibus, petalo et calcare 8–11 mm. longo; ovario et basi styli dense muriculata; stylo 2.1 mm. longo; orificio stigmatis terminato tubo in gemma, in aeta terminato labro minuto; capsula per magna, truncata, latitudine et longitudine aequali, dense puberulenta, facie circa 8 mm. diametro; seminibus nigris, circa 2.1 mm. latis, 3.4 mm. longis; caruncula laeve, víx perspicua.

A depressed geophyte, not more than 10 cm. high; rootstock erect or ascending with a strong and deep tap root and branches, supplemented by a few roots springing from the rootstock; stems one to eight, one-half to two-thirds subterranean, one to two nodes below the ground, densely crowded above with leaves and flowers; leaves thick, ashy above with whitish veins, purplish beneath with an almost complete layer of short, appressed and retrorse hairs on both sides of the leaves, as well as on petioles, stems, and peduncles; radical leaves few, rounded, broadly ovate with blunt tip, and a truncate or slightly cuneate base, entire, 1.1–2.3 cm. wide, 1–2.5 cm. long, on petioles 4–6 cm. long; cauline leaves narrower, ovate, mostly with somewhat sharper point and cuneate base, 6–20 mm. wide, 8–25 mm. long; stipules of radical leaves scarious, adnate, forming wings on the subterranean part of petiole, the minute limb near the ground surface; stipules of cauline leaves grayish, lanceolate, entire, 1–2 mm. long; bractlets subulate, entire, above or below the middle of the peduncle, 1.5–2.5 mm. long; flowers abundant, wholly petaliferous, mostly infertile; sepals linear-lanceolate, scarcely auricled, 3.5–4 mm. long, hoary with short, white, appressed, hair-like processes; corolla 12–17 mm. across, yellow on the face, but conspicuously darkened on the backs of upper petals, and faintly on the backs of lower petals; upper and lateral petals broadly obovate, lateral with clavate beards; lower petal broadly spatulate, truncate, shorter than lateral petals, with a short spur covered with hair-like processes extending along the spur to middle of petal, 8–11 mm. including spur; ovary and base of style densely muriculate; style 2.1 mm. long, form and bearding as in group; stigmatic orifice bounded in bud by a tube, in age by minute lip; stamen-sheath as in group; capsule unusually large, truncate, as wide as long, densely puberulent, ca. 8 mm. across each face; seeds black, ca. 2.1 mm. wide, 3.4 mm. long, weight of mature seeds unknown; caruncle smooth, scarcely evident, smallest in *Nuttallianae*.

Type. Forest Service camp no. 1, Charleston Mountains, Clark County, Nevada, *Clokey 7501.* The type specimen is deposited at Pomona College Herbarium, Claremont, California; isotypes are widely distributed.

This species is known to occur only in the Charleston Mountains at elevations from 7500 feet to 9500 feet and in Zion National Park, Utah.

Citation of specimens. Nevada. Charleston Mountains, Clark County: Forest Service camp no. 1, *Clokey 7502, Baker 8690;* Lee Canyon, 9000 feet, *Clokey 7504, Baker 8696;* Charleston Park, 8825 feet, *Clokey 7503;* yellow pine forest, 9500 feet, June 20, 1926, *Jaeger;* ridge, south side of Lee Canyon in limestone, 8600 feet, July 25, 1913, *Heller.* Utah. "Zion National Park near summit, north of Zion Canyon in yellow pine belt, May 13, 1936," *Cottam 6996.* ARIZONA. Jacob's Pool, *Jaeger.* (The fact that in a single season Jaeger collected *flowering plants* of the violet at 7500 feet in June in the Charleston Mountains and at 5000 feet elevation in July at the Arizona station leads one to suspect that the data given on the Arizona label is incorrect.)

This species appears to thrive best in the Charleston Mountains in partial shade in soil containing considerable humus on brushy north or east slopes where it is associated with *Juniperus, Cercocarpus,* scattered Rocky Mountain yellow pine and nut pine. Its poorest development is in the open pine forest in Lee Canyon. The limited distribution of this plant may be accounted for if it proves to be a "lime violet," since the Charleston Mountains seem to be composed largely of limestone. Apparently very few seeds of *V. charlestonensis* are matured; not more than one plant out of ten of those observed in June, 1937, had developed mature capsules. On one unusually vigorous plant there were twenty-three sterile flowers and only two seed pods.

Chromosome counts made from bud fixations of *V. charlestonensis* showed a diploid count of $n = 6$.

On the basis of the scarcity of this species and its limited distribution, it might be assumed that it represents a relic which is dying out because of its low reproduction rate. Also, because it apparently has no very close relatives in the genus, it may be assumed to be very old. Probably its closest living relative is *Viola purpurea* subsp. *integrifolia* Baker and Clausen, yet in the size of its seeds and in its subterranean stems it resembles *V. pedunculata* Torr. and Gray. *Viola charlestonensis* differs from the above-mentioned species in the following particulars:

(a) It is covered with very short, retrorse, appressed, white hairs; on the leaf veins these hairs are so dense that the veins appear as white lines on the upper surfaces of the leaves.

(b) It is the only species in the *Nuttallianae* with wholly entire leaf margins; in *V. purpurea* subsp. *integrifolia* most of the later leaves are entire.

(c) It is the only species in the *Nuttallianae* with the spur pubescent on the exterior.

(d) The capsules and seeds are larger than those of *V. purpurea,* but they are comparable in size to those of *V. pedunculata,* which, however, is a much larger plant.

(e) The caruncle is very small and smooth; in all other species of the *Nuttallianae* it is rough and even wrinkled and it spreads out from the base of the funiculus in all directions.

PEDICULARIS SEMIBARBATA Gray subsp. **charlestonensis** (Pennell and Clokey) comb. nov. *P. semibarbata* Gray var. *charlestonensis* Pennell and Clokey in Clokey, Bull. So. Calif. Acad. Sci. 38: 6. 1939.

Typical *P. semibarbata* is a variable species of the high mountains of southern California. The subsp. *charlestonensis* is confined to the Charleston Mountains and the Sheep Range, both of Clark County, Nevada. Owing to the distinct geographical range as well as to the morphological differences, this entity should be considered a subspecies rather than a variety.

Castilleja linariaefolia Benth. var. **omnipubescens** (Pennell) comb. nov. *C. linariaefolia* Benth. forma *omnipubescens* Pennell, Proc. Acad. Nat. Sci. Phila. 89: 424. 1938.

As var. *omnipubescens* is confined to the southern part of the range of *C. linariaefolia* and in some areas is the only form found, it is considered worthy of varietal rank.

South Pasadena, California.

A NEW PINE FROM MOUNT ROSE, NEVADA

Herbert L. Mason and W. Palmer Stockwell

In September of 1938 an unusual pine was observed growing on the east slopes of Mount Rose in Washoe County, Nevada. In general aspect this pine appears to be like its forest associate, *Pinus Jeffreyi* Murray, its most obvious difference being its diminutive cones. Closer examination, careful analyses, and preliminary breeding experiments, however, disclose a number of very important differences in structure, biochemistry and behavior that may serve to separate these two pines. A discussion of these differences and of the interrelationships of the new pine with other members of the genus must await further developments of a program of study now seven years under way at the Institute of Forest Genetics of the United States Forest Service in cooperation with the University of California. Some of this work, however, has reached a point where publication is desirable, hence it is necessary that the pine be named. It will suffice here to report that several successful field crosses have been made and many of the F_1 hybrids are now growing in the nursery; the resin has been analyzed chemically and will be reported upon in due time. Precise statement of range must await the investigation of several recent reports of additional occurrences before it can be completely formulated. Hence the present paper will deal with the pine in the stand encompassing the type locality, which to date is the only stand positively known to exist by virtue of specimens in hand. As now understood the new pine is essentially confined to the lateral moraines about seven miles long and less than a mile wide flanking the upper reaches of Galena Creek and ranging in altitude from 7000 to 8500 feet. This precise habitat did not exist prior to the Pleistocene. Only a very few individuals occur off the moraines and these not more than a few hundred feet away. It is unfortunate that the stand today probably represents only second growth timber, the area having been logged to supply mine timber and building materials for the development of the Comstock Lode at Virginia City in the middle of the last century. The original extent of the stand at this locality is probably lost to us unless some detail of wood anatomy can be discovered for the identification of the stumps of the original forest that eighty-five years of Nevada's climate have failed to erase from the scene. From these brief statements of the circumstances surrounding the occurrence of this species the reader will sense the fascination of the challenge to investigation offered by this problem. Whence came this pine? If it is of recent origin, what has been the nature of the isolating mechanism that set it apart in the genus? What of its history and parentage? It seems especially fitting to commemorate in the name of these trees the Washoe Indians who hunted in this forest.

Pinus washoensis sp. nov. Arbor pyramidatus, alta usque ad 60 m.; truncus valde fastigatus, diametros 1 m.; cortex tenue, maturans cum fissuris asperis vel aliquando laminatum; gemmae terminales ovoideae-acutae, 15–20 mm. longae, rufulae, margines squamarum gemmarum fimbriati; fasciculi ternati vel aliquando binati, vaginae persistantes, rugosae, summae squamarum persistante approximatae; acies virides-griseae, longae 10–15 cm., crassae, subtiliter aequaliterque serrulatae, ordinaes 12 stomata dorsales, ordines sex super supericiebus dorsualibus utrimque, hypodermis biformis, inter ordines stomatum intrusus, ductus resinae medii, 7 ad 10, cellulis parvulis muris crassis marginatae, inaequaliter multiseriatae, endodermis cum muris externis crassis, fasciae distinctae, nec pressae, iuli staminati breve cylindrati, 10–20 mm. longi, rubri-purpurei, eorum squamae gemmarum rubrae-ochraceae, marginis inaequaliter laceratae; iuli ovulati ellipsoidei, 15–20 mm. longi, 10–12 mm. lati, caerulei-purpurei obscuri; conus ovoideus, 5–8 mm. longus, badius, squamae in numero circa 160 ad 190, dehiscentes non reflexae, apophysis dorsualis, demisse pyramidatus; umbo rubrus-ochraceus, cum aculeo levis reflecto; semen 8 mm. longum, 3 mm. crassum, pars liberum alae rhomboideum-cuneatum, 1.5 ad 2 longitudines seminis.

Pyramidal tree up to 60 meters high; trunk strongly tapered, diameter 1 meter; bark maturing late, thin, becoming rough fissured or occasionally plated; terminal buds ovoid-acute, 15–20 mm. long, reddish, bud scale margins fimbriate; fascicles ternate or occasionally binate, sheaths persistent, rugose, scale tips remaining approximate; needles gray-green, 10–15 cm. long, stout, finely and regularly serrulate, dorsal stomata in 12 rows, ventral in 6 rows on each face, hypoderm biform, intrusive between the rows of stomata, resin ducts 7 to 10, median, bordered by small thick-walled cells, irregularly multiseriate, endodermis with heavy outer walls, bundles distinct, not crowded; staminate catkins short cylindric, 10–20 mm. long, red-purple, their bud scales tan, with irregularly lacerate margins; ovulate catkins ellipsoid, 15–20 mm. long, 10–12 mm. wide, dark blue-purple; cone ovoid, 5–8 cm. long, nut brown, scales about 160 to 190 in number, not reflexed on dehiscence, apophysis dorsal, low pyramidal, umbo tan, with a slender slightly recurved prickle; seed 8 mm. long, 5 mm. wide, 3 mm. thick, free portion of wing rhombic-cuneate, 1.5 to 2 times the seed.

Specimens examined. Sierra Nevada, east side of Mount Rose, Washoe County, Nevada: altitude 7500 feet, Sept. 9, 1938, *Mason 12078;* altitude 7000 feet, Aug. 8, 1939, *Mason 12228;* altitude 8100 feet, Aug. 6, 1940, *Mason 12370* (type, Herbarium of the University of California, nos. 692993, ovulate, and 692994, staminate); altitude 8500 feet, July 18, 1939, *Stockwell* and *Cumming, 1455; Cumming,* Nov., 1941 (cones only).

Department of Botany, University of California, Berkeley.

California Forest and Range Experiment Station, Berkeley, conducted at and in cooperation with the University of California at Berkeley.

REVIEW

The Botanical Collections of Wilhelm N. Suksdorf, 1850–1932. By William A. Weber. Research Studies of the State College of Washington, Vol. XII, No. 2. Pp. 51–121. Pl. 1, 2. June, 1944.

"And this," said my guide, pausing for emphasis, "is the Suksdorf collection!" Dozens of bundles of specimens (wrapped and unwrapped, labeled and unlabeled) were piled on top of old wooden herbarium cases, on chairs, on and under tables, and on the floor. A thick coating of black dust covered them and the dingy basement room. This was the Suksdorf collection in 1934. Inside the packages, however, the specimens were still in the beautiful condition they had been left by their meticulous collector. That insects had not played havoc with them was partially due to the foresight of Dr. Harry F. Clements, then plant physiologist at the State College, who had put them all through a drying oven the previous year. The bundles were arranged in accordance with a variety of systems or with no system at all, and most of the external labels had become misplaced or lost. In the absence of field books, diaries, and correspondence, the collector's symbols (in German script) defied translation.

However, the requests of specialists for certain materials were importunate, and were met as fully and promptly as possible. Preparing a loan of any group necessitated going through every bundle. In the absence of herbarium assistants, the "curator" and his graduate fellows (Dr. Reed C. Rollins and Mr. Louis O. Dillon) and a few willing undergraduate students spent long hours in tiresome searching. Despite these difficulties, a number of small groups and a few large ones (*Carex, Plectritis, Castilleja,* *Arnica,* the Cruciferae, the Saxifragaceae) were made available for general use. By 1937 the entire collection had been arranged systematically, fumigated repeatedly, and stored in as safe a place as could be found.

With this background in mind, it is easier to appreciate properly the excellent work Mr. Weber has done with the collection, culminating in this paper devoted to Wilhelm N. Suksdorf and his herbarium. No other western collector, to my knowledge, has had his travels, activities, and accomplishments so carefully and appreciatively documented. The study consists of six parts: an introduction, a biographical sketch, an itinerary, a list of described entities based upon the Suksdorf collection, a gazetteer, and a list of Suksdorf's few scientific writings. Two portraits are reproduced, that of the collector in middle age being a particularly fine addition to our record of him.

Born near Kiel in Germany and defeated by ill health in his efforts to obtain an education in the United States, Suksdorf was handicapped by a reluctance to use the English language, which largely cut him off from communication with his contemporaries. He is remembered chiefly for the materials which he provided for Asa Gray and Sereno Watson, and for many overseas botanists. The biographer appears to share Suksdorf's conviction that he was not fully appreciated by the botanical world. That he was among the best of botanical collectors cannot be questioned, but that he was a potentially great botanist can. His longest publication, dealing with *Amsinckia* (in which he described 201 "new species") does credit to his powers of observation but not to his taxonomic judgment. The species described by others from Suksdorf's collections have fared much better than those named by himself.

Mr. Weber's study properly concentrates on Suksdorf's itinerary of sixty years, and on a careful gazetteer of the places he visited in Washington, Oregon, California, and Montana. This is particularly useful in the case of Suksdorf because of his fondness of unusual (often Indian) geographical names, and his practice of freely coining German place names when no others were available. Suksdorf's specimens, collected in this area, were prepared in large sets and were widely distributed; they contributed much to Asa Gray's and Sereno Watson's knowledge of the western floras and are still useful tools to systematists.

The present paper is a model of its kind. It is to be hoped that its publication will stimulate the preparation of accounts of the activities and movements of other distinguished collectors in the Pacific Northwest. The collecting localities of others, from Douglas and Nuttall to the Howell brothers and Cusick, need similar careful study and documentation. The floras of the area are so diverse that a precise determination of past collecting sites would greatly facilitate our understanding of the distribution of many groups of plants.—LINCOLN CONSTANCE, Department of Botany, University of California, Berkeley.

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THE GENUS ERIASTRUM AND THE INFLUENCE OF BENTHAM AND GRAY UPON THE PROBLEM OF GENERIC CONFUSION IN POLEMONIACEAE

Herbert L. Mason

In the course of preparing the manuscript of the Polemoniaceae for Abrams' Flora of the Pacific Coast States, certain taxonomic problems were encountered whose solution called for discussion and the presentation of facts and evidence to an extent beyond the scope and format of that work. Since the present paper is the first in a series, it is deemed desirable here to discuss the problem of generic concepts in Polemoniaceae as influenced by Bentham and Gray, because this influence has made itself felt on the thinking and action of subsequent botanists in their treatment of the species and genera of this family. This discussion will be incorporated in the treatment of the problem surrounding the nomenclature and generic concept of *Eriastrum* Wooton and Standley.

The name *Eriastrum* was proposed by Wooton and Standley to take the place of *Huegelia*[1] Bentham which is a later homonym of *Huegelia* Reichenbach, a group of plants in the family Umbelliferae, and in lieu of *Welwitschia* Reichenbach, whose later homonym, *Welwitschia* Hooker, is conserved as a genus in Gnetaceae. Since, up until the present paper, only the combination *Eriastrum filifolium* (Nutt.) Woot. and Standl. has been made, it might seem to the point to propose the name *Huegelia* Benth. to the International Committee on Botanical Nomenclature with the recommendation that it be conserved. However, in view of the expressed objectives of *nomina conservanda* and the restrictions governing their recommendation, it seems more fitting that the name *Eriastrum* Woot. and Standl. be adopted. *Huegelia* Benth. was rejected by its author in his later treatment (2, p. 310) of the group. It has never since been generally accepted by authors. In 1848 Lindley (15) described *Huegelia lanata,* an entity herein discussed under *Eriastrum pluriflorum.* Seventy years after Bentham's proposal of *Huegelia,* Howell (10) transferred *Gilia floccosa* Gray to that epithet. Nothing further occurred involving the name *Huegelia* until 1925, when, ninety-two years after its proposal by Bentham, Jepson (11) took it up and made the necessary transfers to meet his interpretations of that date; in 1943 he (12) made additional changes. Meanwhile, three important monographic treatments of the genus had appeared, none of which used the epithet *Huegelia* in the rank of genus. In 1907 Brand (4) included

[1] The spelling *"Hugelia,"* first employed by Bentham (1), was later (3) corrected to read *"Huegelia"* since the genus was named in honor of Baron Charles de Hügel.

Corrected date line: Madroño, Vol. 8, pp. 33–64. June 6, 1945.
Madroño, Vol. 8, pp. 65–104. July 31, 1945.

the group as a subgenus under *Navarretia* and Macbride (16) in 1917 and Craig (5) in 1934 treated it monographically as a subgenus of *Gilia.* Thus *Huegelia* Benth. as a genus did not come into general use within fifty years following its proposal nor had any monographic treatment prior to 1890 used that generic name—two points required by botanical law for names to be conserved. *Huegelia* is, therefore, according to the rules, ineligible for conservation.

Eriastrum is fraught with many vexatious problems that are reflected unhappily in its tangled nomenclature. Originally proposed as distinct by Bentham, *Huegelia* was later rescinded by him to be merged with *Gilia,* then merged with *Navarretia* by Brand, reassigned to *Gilia* by Macbride (16) and returned to its original status as a genus by Jepson. This diversity of treatment does not reflect any particular difficulty inherent in *Eriastrum* but rather the state of confusion in the genera in Polemoniaceae as a whole. The problem is of long standing and results partly from a difficult taxonomic subject but more especially from the respect for eminent authority among contemporary botanists. More specifically, it reflects the influence of George Bentham and Asa Gray on subsequent botanical thought.

In summarizing the predominantly annual species of Polemoniaceae, Bentham (1) aggregated them into seven genera—three of which are now included in *Linanthus;* a fourth, *Huegelia,* now *Eriastrum,* with the exception of one species of *Gilia* which was included; a fifth, *Aegochloa,* now *Navarretia,* in which he included *Leptodactylon pungens;* a sixth, *Gilia,* including three species now in *Linanthus;* and the seventh, *Collomia,* including also two species of *Gilia* and one of *Phlox.* Subsequent collections tended to break down these unnatural generic boundaries of Bentham so in DeCandolle's Prodromus he (2) retained only *Gilia, Navarretia* and *Collomia.* His *Navarretia* replaced *Aegochloa* and he eliminated *Leptodactylon pungens* from it but added *Collomia heterophylla. Collomia,* however, still including only annuals with unequal stamens and solitary ovules, did not include all of the members of the genus as we now know it, but it did still include species now belonging to *Gilia* and to *Phlox.* In Genera Plantarum, Bentham (3) again changed his concepts and merged *Navarretia* with *Gilia,* but he was preceded in this move by Gray as indicated below. His concept of *Collomia* changed only to the extent of allowing more ovules in the locule and of indicating the possibility that some plants might be biennial. Thus this last step accomplished little save giving us two genera involving fourteen more or less unnatural sections where we had had seven more or less unnatural genera to begin with.

Gray's (7) early work was influenced very largely by Bentham and in his first major work on Polemoniaceae he accepted only two genera in the annual group, namely *Gilia* and *Collomia.* In so doing, Gray may have anticipated Bentham or even suggested the move to him. His comment (7, p. 248) is of interest. "The genera at first sight would appear to be more obviously and strictly limited than they actually prove to be; and, except for certain connecting forms, their number might be properly increased by the severance of one polymorphous genus into several, which, for the want of a little extinction, just fail to establish their characters." It was the connecting forms that disturbed him.

Gray did not approve of Bentham's concept of *Collomia* because the uniovulate character caused Bentham to remove *C. heterophylla* to *Navarretia* and yet retain some uniovulate species in *Gilia.* Gray, therefore, relied solely on the unequally inserted stamens with the result that *Collomia,* according to Gray, included in addition to the annual species properly belonging there, four species of *Gilia* and one of *Phlox.* Gray's treatment of subgenera under *Gilia* was at first not nearly as confused as was that of Bentham. This state of affairs did not remain so for long. Gray's first four subgenera are all now *Linanthus* except *Leptosiphon* in which he included *Gymnosteris;* then came *Leptodactylon* as we recognize it today and *Navarretia* in which he included *Langloisia.* His *Huegelia* is our *Eriastrum.* His remaining four subgenera are all *Gilia* but they indicate a very unnatural grouping of the species. Later, however, he added the perennial species of *Collomia* and a *Polemonium* to his subgenus *Eugilia.* It is not surprising to find also in the supplement to the second edition of the Synoptical Flora of North America that Gray had had enough of *Collomia.* He transferred all of the species to *Gilia* and inserted *Collomia* as a subgenus along with *Courtoisia* to care for the multiovulate collomias. At the same time he transferred some species of *Loeselia* to *Gilia,* in the subgenus *Ipomopsis,* and erected the subgenus *Chaetogilia* to care for *Langloisia.*

From a study of the genera and subgenera of this group of Polemoniaceae as they were developed under Bentham and Gray, it is obvious that at no time did these two men really have a true picture of the inter-relationships of the species with which they were dealing. Certainly we cannot differentiate *Linanthus* from *Gilia* if we do as Bentham did and include part of *Linanthus* in *Gilia.* Likewise, *Collomia* cannot be differentiated from either *Gilia* or *Phlox* or *Navarretia* so long as species of these genera are included in it and so long as some of its species are included in them. The chief difficulty with this shifting of genera to subgenera or sections by Bentham and Gray was that they left the groups constituted much as they had been as genera and little progress resulted. An unnatural genus makes just as poor a subgenus. Their treatment is akin to an ostrich burying his head in the sand. By submerging the genera as subgenera the necessity of differentiating between them was eliminated and, like the ostrich, they did not have to look at the object that annoyed them.

No present-day botanist who would either lump the genera of Polemoniaceae or differentiate them will find any real supporting evidence, on either side, in the work of Bentham or of Gray. These two never did face the real problem. They described species, placed them in unnatural higher categories and, when their categories did not hold up, they hid them away—species and all.

Many subsequent writers have made no attempt to rationalize the diversity in the genus *Gilia* as handed down to us by Bentham and Gray, nor have they attempted to analyze the problems that confronted these two men. Theirs has been a blind faith in eminent authority. To them only one important fact stands out, namely, that the eminent botanists Bentham and Gray overthrew the genera involving the dominantly annual species of Polemoniaceae, therefore these genera have no basis in fact or are so vague as not to warrant separate considerations. These writers are wholly oblivious to the fact that the courses of both Bentham and Gray in this group of plants were dictated by complete and absolute frustration, brought about not by any breach of eminence but rather by an incomplete representation of the family as a whole in their collections. In other words, considering the state of information, botanists were in no position, during the lifetime of Bentham and Gray, to circumscribe genera in Polemoniaceae with any degree of assurance or completeness. Therefore the actions of Bentham and Gray in the matter should not weigh too seriously in our consideration of the problem today.

The predominantly annual species of Polemoniaceae can be divided into natural genera and *Eriastrum* is one of them. In the past, great weight has been placed upon certain key characters in the differentiation of the genera of this group of plants. Use of a particular character has often been inherited from the keys of our predecessors and may date back to early beginnings when only a few species were known or in some cases even from times when the subgenera and genera were very unnatural. Such key characters are often erroneous, as is the stamen character most frequently used to separate *Eriastrum* from *Navarretia*. This has been recently pointed out by Mrs. Sharsmith (18) who adds that thereby the major character separating *Eriastrum* from *Navarretia* is eliminated. Long, sagittate or cordate anthers are frequent in *Eriastrum*, but there are also several species in the genus which have short anthers, a character historically attributed to *Navarretia*. Despite the invalidity of this "key" character, these two genera are none the less distinct from one another. Genera do not stand or fall solely on good or bad key characters. After all, it is the sum total of attributes that characterizes any object, whether it be a hat, a stone, a species, or a genus. It is the sum total of the attributes of the species of *Eriastrum* that gives the genus its character. These attributes may be expressed in terms of form and behavior. We are indeed fortunate when differences can be stated in precise terms of single characters but differences are none the less important when they must be grouped to give character to the whole.

In general, the less complex, usually simple or simple-pinnate leaves and bracts, the heavy arachnoid lanate pubescence, the less harsh spininess, the simple calyx lobes and the usually large sagittate or cordate anthers clearly characterize *Eriastrum.* None of these characters separately apply to all species of the genus. On the other hand, elaborate and irregularly dissected leaves and bracts, a general spininess, the absence of lanate pubescence and in its place a conspicuous glandulosity, very small, round or elliptic anthers, and often toothed or lobed sepals characterize *Navarretia.* Here again, except for the absence of lanate pubescence, none of these characters alone applies to all the species. By the intangibles, however, that are contributed by the sum total of characters and are included under the general term, "aspect," *Eriastrum* and *Navarretia* are easily and positively distinguishable, so much so, in fact, that one rarely finds them confused in herbaria. There are no intermediate or intergrading species.

Eriastrum Wooton and Standley

Huegelia Bentham, Bot. Reg. 19: *sub* t. 1622. 1833, not *Huegelia* Reichenbach, Consp. 144. 1828. *Welwitschia* Reichenbach, Handb. 194. 1837, not *Welwitschia* Hooker, Gard. Chron. 71: 1862, *nom. cons.* *Eriastrum* Wooton and Standley, Contr. U. S. Nat. Herb. 16: 160. 1913. *Gilia* and *Navarretia* of authors, in part.

Erect annuals or perennials, simple or virgately to paniculately or corymbosely branched. Herbage puberulent to densely arachnoid floccose or lanate. Leaves linear and entire to pinnately toothed or dissected. Flowers sessile in bracteate heads, rarely solitary on slender pedicels. Heads usually enveloped in a dense mat of arachnoid wool, less commonly glandular-puberulent. Calyx deeply cleft into linear, unequal to subequal simple lobes, the sinuses usually over half filled with a hyaline membrane, lobes and membrane often densely arachnoid woolly. Corolla blue or white to yellow, rarely pink, sometimes bicolored, funnelform to subsalverform. Stamens inserted on the base of the corolla throat, or occasionally in or just below sinuses of the corolla lobes, included or exserted. Anthers versatile, often sagittate, sometimes cordate or elliptic. Capsule ellipsoid or obovoid, sometimes conspicuously three-sided, often with the base of the style persistent on the capsule and splitting with the valves. Seeds one to several in each locule, usually mucilaginous when wetted. Greek: *erion,* wool, *aster,* star, in allusion to the woolly plants with star-like flowers.

As herein treated, the genus includes fourteen species confined to Western North America. Type species: *E. filifolium* (Nutt.) Woot. and Standl.

In the treatment of the species comprising this genus, Brand (4) found it difficult to arrive at an absolute separation from *Navarretia,* but he presented a successful key to the subgenera, of which *Huegelia* is one. Except for *Eriastrum luteum* and *E. Wilcoxii,* the rest of the annual species are badly confused by Brand. Craig (5, p. 385), whose generic concepts stemmed from Gray, remonstrated with Brand for " . . . his inclusion of *Hugelia* in *Navarretia,* while at the same time separating both from *Gilia.* . . ." Craig's concept of entities within the genus is excellent and we owe the first real characterization and organization of the problems of the genus to him. Craig's work, with slight modification, is largely followed by Jepson (12) in his treatment of 1943. The treatment of *Eriastrum* herein is a further modification of Craig's concepts. In general, the same entities are recognized, but for reasons outlined herewith several of these entities are placed in a different status.

The general simplicity of the plant in *Eriastrum,* together with its concealing mantle of arachnoid lanate pubescence and small flowers makes the detection of characters difficult. Habit of branching is often useful in differentiating species, but foliage characters are at best trends in a series and not too definite. Flower size and the proportion between the tube, throat and lobes are very good as are also the size of stamens and the relative length of stamen and anther (plate 7). They are small and require careful dissection and measuring. Intergradation through hybridization seems rampant in some groups and wholly lacking in others. Hence observations on this feature are useful in formulating concepts of relationship. It is here felt that there is little to be gained by indiscriminate aggregation into subspecies where clear-cut geographic breaks appear or where there is little or no natural hybridization. The use of the term "intergrade" has been somewhat overworked in *Eriastrum.*

Use of Key

In using the key to the species, care should be taken in determining the position of stamen insertion. Because of conspicuous vascular strands, the filament often appears decurrent on the corolla tube or throat; in some cases this portion may be torn free from the throat thus giving the impression of the filament being longer than it is. This may result in a major error in interpretation. Likewise, in dried specimens, the filaments sometimes adhere to the corolla giving the impression of being adnate. Such

Plate 7. Ideographs of Flowers of Species of Eriastrum. Triangles from bottom to top represent corolla tube, throat and limb respectively; left hand arm represents filament and anther; right hand bar, the sepals. When a given whorl of a flower is irregular, the longest element is represented. The ideographs depict the subspecific entity involving the type of the species. Drawn to scale for length only.

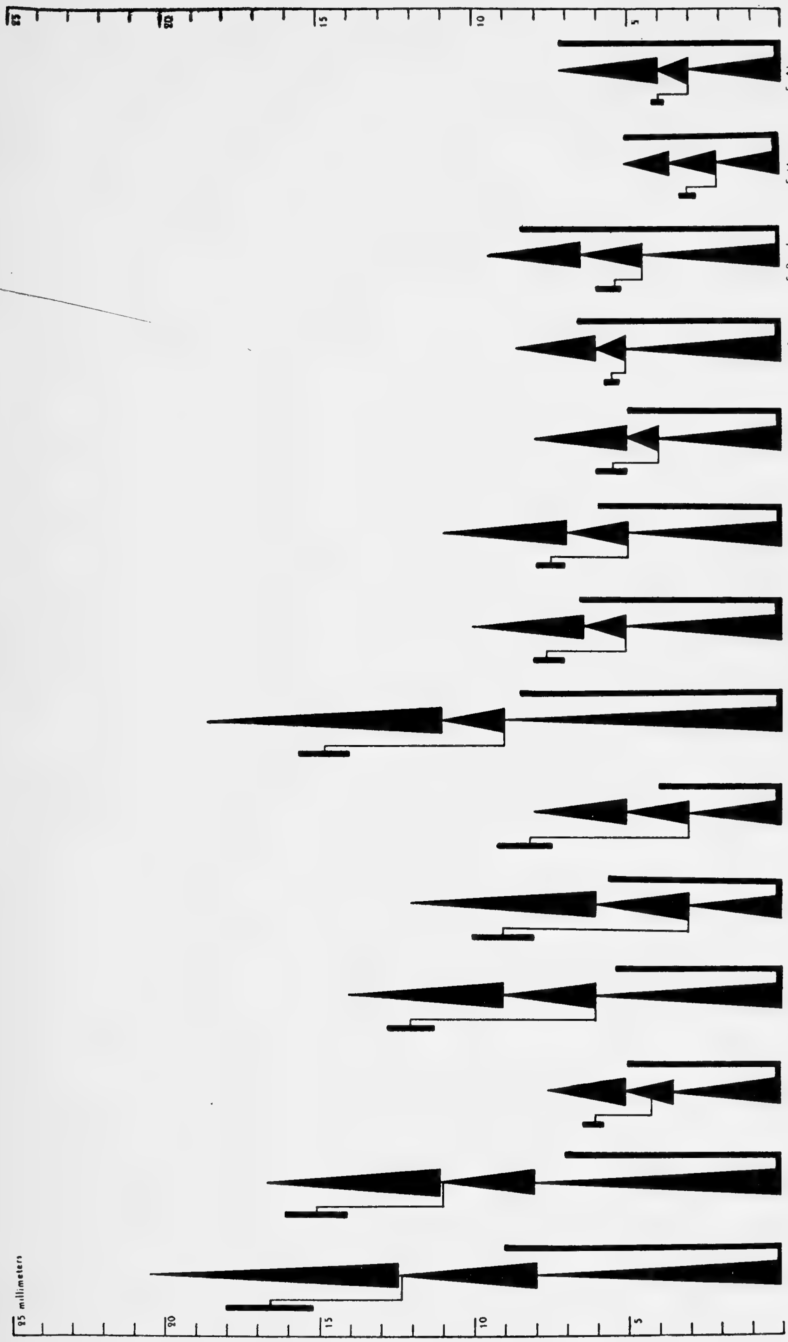

PLATE 7. IDEOGRAPHS OF FLOWERS OF SPECIES OF ERIASTRUM.

difficulties can be eliminated by thoroughly soaking the corolla before attempting dissection. In most Polemoniaceae the corolla is readily divisible into three regions: the tube, which is usually parallel-sided or expands gradually toward the top; the throat, which expands much more abruptly or in some cases may appear to be obsolete; the lobes, which may be regular or irregular. In most species of *Eriastrum* the point of stamen insertion marks the base of the throat and measurements of the throat involve the distance from the stamen insertion to the sinus of the corolla lobes. When the word "tube" is used, it refers to the tube only and does not refer to the combined throat and tube.

In interpreting the mode of branching, it is essential that only larger specimens be used. This is especially true where corymbose branching is indicated. Small specimens are almost always racemosely branched or simple.

Key to the Species of Eriastrum

Plants perennial, woody throughout, or at least from a persistent woody crown; anthers often 3–5 mm. long ..... 1. *E. densifolium*
Plants annual, herbaceous throughout.
  Stamens inserted in the sinuses of the petals, corolla 10–20 mm. long, anthers 2–2.5 mm. long .... 2. *E. pluriflorum*
  Stamens inserted at the base of throat or at least well below sinuses.

A. Corolla 8–20 mm. long, the lobes equal or longer than tube, filaments 2 to 4 times throat

Stamens subequal to equal in length, corolla tube 1 to 1½ times calyx; leaves usually simple and entire, lateral pinnae if present, long and filiform.
  Corolla 15–20 mm. long, its tube 4 to 6 times throat; bracts all equal or exceeding calyx and sometimes the corolla; corolla regular; hills of Monterey Bay region .... 7. *E. virgatum*
  Corolla 8–15 mm. long, the tube not over 3 times throat, tube shorter than calyx; bracts subequal or shorter than calyx, or 1 or 2 exceeding calyx; corolla slightly irregular, chiefly southern California .... 5. *E. sapphirinum*
Stamens very unequal in length; corolla irregular, tube 1½ to 2 times calyx; leaves pinnately parted, pinnae rigid .... 4. *E. eremicum*

AA. Corolla 6–12 mm. long, the lobes conspicuously shorter than tube, regular to slightly irregular

Stems low, diffuse, divaricately branched, glabrous; stamens inserted midway on throat; corolla 6–8 mm. long; deserts .... 3. *E. diffusum*
Stems virgately, corymbosely or racemosely branched or simple; stamens inserted on base of throat.
  Filaments of stamens long exserted.
    Stamens 6–8 mm. long, exceeding corolla lobes; corolla golden yellow; seeds solitary in locules .... 6. *E. luteum*
    Stamens 3–4 mm. long, not exceeding the corolla lobes; corolla blue or white, seeds 2 to 4 in a locule ..... 8. *E. filifolium*

Filaments included, sometimes the anther exserted.
  Corolla 9–12 mm. long; throat 2 mm. long; anthers exserted; chiefly Great Basin .... 9. *E. Wilcoxii*
  Corolla 4–9 mm. long (if over 9 mm. long the anthers wholly included).
    Stamens longer than throat (anther tips exserted).
      Branching racemose; corolla longer than calyx; ovules 2 to 4 to a locule; plants 6–30 cm. high; east base of Cascades and Sierra Nevada, Tehachapi Mountains, north to Kings River .. 10. *E. sparsiflorum*
      Branching corymbose; corolla shorter than calyx; ovules solitary in locules; plant 3–10 cm. high; anthers very short; central California coast ranges .... 14. *E. Abramsii*
    Stamens shorter than throat.
      Corolla 7–10 mm. long, longer than longest sepal; ovules 1 to 2 in a locule.
        Branching racemose, stamens 0.75 mm. long; corolla throat 1 mm. long .... 11. *E. Tracyi*
        Branching virgate corymbose; stamens 1.5 mm. long; corolla throat 2 mm. long .... 12. *E. Brandegeae*
      Corolla 4–5 mm. long, subequal longest sepal; ovules several to each locule .... 13. *E. Hooveri*

1. **Eriastrum densifolium** (Benth.) comb. nov. *Huegelia densifolia* Benth. Bot. Reg. 19: *sub* t, 1622. 1833. *Gilia Huegelia* Steud. Nomen. ed. 2, 1: 683. 1840. *G. densifolia* Benth. in DC. Prodromus 9: 311. 1845. *Navarretia densifolia* Kuntze, Rev. Gen. 2: 433. 1891. *N. densifolia* Brand in Engler, Pflanzenreich 4^{250}: 165. 1907. *Welwitschia densifolia* Tidest. Contr. U. S. Nat. Herb. 25: 429. 1925. *Gilia densifolia* var. *typica* Craig, Bull. Torrey Bot. Club 61: 390. 1934.

Eriastrum densifolium is based upon a Douglas specimen from California that is distinctly shrubby, has thickly set simple linear to occasionally irregularly pinnatifid but not rigid leaves, and corollas 20–25 mm. long. Such plants are known from south of Pismo, San Luis Obispo County.

The variation existing within this species has been adequately reviewed by Jepson (12).

Range. The entity involving the type is confined to the coastal region of California from Morro Bay south to Point Conception where it grows in coastal sand hills.

Representative specimens. "California," *Douglas.* San Luis Obispo County: sand hills 2 miles south of Pismo, *Peirson 2224;* Oso Flaco Lake, *Mason 12474,* Nipomo Mesa, *Mason 12466;* 1 to 3 miles south of Pismo Beach, *Craig 1875.* Santa Barbara County: 3 miles north of Guadalupe, July 3, 1933, *Craig;* Purissima hills, *Mason 412.*

1a. **E. densifolium** subsp. **elongatum** (Benth.) comb. nov. *Huegelia elongata* Benth. Bot. Reg. 19: *sub* t. 1622. 1833. *Gilia elongata* Steud. Nomen. ed. 2, 1: 683. 1840. *Navarretia densifolia* subsp. *elongata* Brand in Engler, Pflanzenreich 4^{250}: 165. 1907. *Gilia densifolia* var. *elongata* Gray ex Brand, *loc. cit.*

This subspecies is based on a Douglas specimen from California not unlike plants growing on the east slopes of the Santa Lucia Mountains in southern Monterey County and in San Benito County. It is less woody than typical *E. densifolium,* the leaves are more rigid and are usually white canescent. It has a very complex genetic and geographic pattern and careful field and genetic study will undoubtedly yield a basis for subdividing it. As at present known, it is not too well differentiated from *E. densifolium* subsp. *austromontanum.*

Range. Monterey and San Benito counties to southern California and Baja California, north in the Sierra Nevada to Inyo County.

Representative specimens. "California," *Douglas* (presumably southern Monterey County). Monterey County: near China Camp, 4200 feet, *Baker 7843;* Tassajara road, 5000 feet (?), *Hall 10077.* San Benito County: 6 miles north of Pinnacles, *Howell 11524.* San Luis Obispo County: coast range north of San Luis Obispo, *Palmer 413.* Los Angeles County: Mint Canyon, *Alexander 850;* Pacoima Wash, *Wolf 1998.*

1b. **E. densifolium** subsp. **austromontanum** (Craig) comb. nov. *Gilia densifolia* var. *austromontana* Craig, Bull. Torrey Bot. Club 61: 391. 1934. *Huegelia densifolia* subsp. *austromontana* Ewan, Bull. Torrey Bot. Club 64: 520. 1937. *H. densifolia* var. *austromontana* Jepson, Fl. Calif. 3: 162. 1943.

This subspecies differs from the above in its more elaborate bracts and more complex leaf pattern, in its lower stature and in being less woolly. It occurs regularly at higher altitudes. Morphological intergradation with subsp. *elongatum* is almost complete and I retain it as separate only with hesitancy.

Range. Higher mountains of southern California and northern Baja California north to Santa Barbara and Inyo counties, California.

Representative specimens. Santa Barbara County: Zaca Peak, 3900 feet, *Axelrod 531.* Inyo County: Onion Valley, *Sharsmith 3259;* Big Pine Creek, 7000 feet, *Alexander* & *Kellogg 2602.* San Bernardino County: San Bernardino Mountains, Seven Oaks, *Peirson 4127.* Los Angeles County: Rock Creek, San Gabriel Mountains, *Peirson 482.* Riverside County: Santa Rosa Mountains, *Munz 15105;* San Jacinto Mountains, *Munz 5820.* San Diego County: Palomar Mountain, *Pennell* & *Grant 25927, Chandler 5372;* near Nellie, Palomar Mountains, *Munz 8341* (type).

1c. **E. densifolium** subsp. **mohavensis** (Craig) comb. nov. *Gilia densifolia* var. *mohavensis* Craig, Bull. Torrey Bot. Club 61: 392. 1934. *Huegelia densifolia* var. *mohavensis* Jepson, Fl. Calif. 3: 162. 1943.

The leaves have a broad rachis and short spinescent teeth, the bracts are lanceolate-dentate.

Range. Mohave Desert, San Bernardino to Inyo counties.

Representative specimens. Inyo County: along Bishop Creek, Bishop Park, *Ferris 8970;* Independence, Owens Valley, *Peirson 933.* Kern County: between Rosamond and Mohave, Mohave Desert, *Craig 1360* (type).

1d. **E. densifolium** subsp. **sanctorum** (Milliken) comb. nov. *Gilia densifolia* var. *sanctora* Milkn. Univ. Calif. Publ. Bot. 2: 39. 1904. *Huegelia densifolia* var. *sanctora* Jepson, Man. Fl. Pl. Calif. 792. 1925.

Perhaps one of the most distinct subspecies in *Eriastrum densifolium,* this entity is characterized by its extraordinarily long corolla tube, which is three times the calyx.

Range. Locally developed along the washes and the bordering plains of the Santa Ana River and its tributaries.

Representative specimens. Santa Ana River bottoms, Riverside County: Spanishtown crossing above Riverside, *Hall 173, 683* (type); between Redlands and Highland, *Reed 3107.* San Bernardino County: banks of Santa Ana River, *S. B. & W. F. Parish 1590.*

2. **Eriastrum pluriflorum** (Heller) comb. nov. *Gilia virgata* var. *floribunda* Gray, Proc. Am. Acad. Sci. 8: 272. 1870, not *G. floribunda* Gray. *G. pluriflora* Heller, Muhlenbergia 2: 113. 1906. *Navarretia virgata* var. *floribunda* Brand in Engler, Pflanzenreich 4^{250}: 168. 1907. *Gilia Brauntonii* Jepson and Mason in Jepson, Fl. Econ. Pl. Calif. 130. 1924. *Huegelia Brauntonii* Jepson, Man. Fl. Pl. Calif. 793. 1925. *H. pluriflora* Ewan, Bull. Torrey Bot. Club 64: 520. 1937.

Range. Hills bordering the San Joaquin Valley, California.

Representative specimens. Contra Costa County: near Brentwood, *Mason 7252.* Alameda County: Corral Hollow, *Brewer 1212.* Stanislaus County: Del Puerto Canyon, *Hoover 3535.* Fresno County: Waltham Creek Canyon, *Eastwood & Howell 5835;* 9 miles south of Kerman, *Hoover 2326.* Kings County: Kettleman Hills, *Hoover 2647.* San Luis Obispo County: 4 miles south of Cholame, *Keck 2800;* 8 miles west of Simmler, *Keck 2808.* Santa Barbara County: 14 miles west of Maricopa, *Mason 12489;* Upper Cuyama Valley, *Munz 11416.* Madera County: 2 miles south of Southfork, *Mason 11956;* Kelshaw Corners, *Constance 234.* Tulare County: South Fork of Kaweah River, *Eastwood 4518;* Middle Tule River, *Purpus 5573.* Kern County: Sunset, *Heller 7734* (type collection of *Gilia pluriflora* Heller); near Oil City, *Heller 7742;* southwest of Woody, *Keck & Stockwell 3318.*

2a. **E. pluriflorum** subsp. **Sherman-Hoytae** (Craig) comb. nov.

Gilia Sherman-Hoytae Craig, Bull. Torrey Bot. Club 61: 415. 1934.

A desert annual, shorter and more tufted than the species; leaf lobes very short, sometimes reduced to teeth; corolla lobes over half as long as broad; stamens 3–4 mm. long.

Range. Centering in the western Mohave Desert.

Representative specimens. Los Angeles County: Lancaster, 1909, *K. Brandegee, Davy 2278;* 10 miles south of Muroc, *Munz & Craig 12925* (type).

HUEGELIA LANATA Lindley (Jour. Hort. Soc. 3: 74. 1848). This is a doubtful species. It is not clear from the literature why no one has been able to ascertain its identity, but since the time of Bentham, *H. lanata* has been questioned by all who have mentioned it. Since in time of war one cannot obtain further evidence, it is necessary to leave it in doubt. A consideration of the description suggests it to be identical with either *Eriastrum pluriflorum* or *E. eremicum.* It is an annual 9 inches tall, leaves 2 inches long with 2 to 3 short segments on either side, bracts recurved, calyx much shorter than corolla tube, anthers long exserted, linear, sagittate, white; plant white lanate throughout. It is reputed to have come originally from Mexico. The relative length of corolla tube and calyx and the number of lateral leaflets I think place it rather definitely in one of the above two species. The recurved bracts suggest *E. eremicum* while the size of plant and leaf would suggest *E. pluriflorum.* The herbage is too white woolly throughout and the leaves too complex for *E. virgatum* as herein interpreted. Should its identity become established its name must probably replace one now in use.

3. **Eriastrum diffusum** (Gray) comb. nov. *Gilia filifolia* var. *diffusa* Gray, Proc. Am. Acad. Sci. 8: 272. 1870. *Navarretia filifolia* var. *diffusa* Brand in Engler, Pflanzenreich 4^{250}: 167. 1907. *Welwitschia diffusa* Rydb. Fl. Rocky Mountains 688. 1917. *W. filifolia diffusa* Tidestrom, Proc. Biol. Soc. Wash. 48: 42. 1935. *Huegelia diffusa* Jepson, Fl. Calif. 3: 167. 1943.

This is a well-defined species related to *E. eremicum* but differing in the smaller, more regular corollas, the stamens inserted above the base of the throat and the very small anthers. The stamens vary in length from equal to unequal but the former condition is most common.

Range. Throughout the desert regions of the southwest from Utah to Texas, southern California and southern Nevada to Sonora, Mexico and Baja California.

Representative specimens. CALIFORNIA. Providence Mountains, May, 1902, *T. S. Brandegee;* New York Mountains, *Alexander & Kellogg 1426;* Little San Bernardino Mountains, *Munz & Johnston 5169;* McCoy Wash, Colorado Desert, *Hall 5965;* Lancaster, May, 1909, *K. Brandegee.* UTAH. Milford, *Jones 1788.* ARIZONA.

Beaver Dam River, *Maguire 4927;* west of Baboquivari Mountains, *Harrison & Kearney 8551.* New Mexico. Mesa west of Organ Mountains, April 23, 1900, *Wooton.* Mexico. Sonora: 10 miles north of Quitovac, *Keck 4138.* Baja California: San Julio, April 19, 1889, *T. S. Brandegee.*

3a. **E. diffusum** subsp. **Jonesii** nom. nov. *Gilia eremica* var. *Yageri* Craig, Bull. Torrey Bot. Club 61: 420. 1934, as to lectotype only, not *G. virgata* var. *Yageri* Jones.

Planta 3–15 cm. alta, diffuse ramulosa, omnino floccosa-lanata; folia simplicia linearia usque ad 3–5 partita; flores in capita compacta, corolla leviter inaequalis, 10–12 mm. longa, lobae coeruleae, tubae albae vel flavae; stamina 2–3 mm. longa, aequa vel inaequalia, circa media faucium inserta; antherae cordatae usque ad ovales, 0.7–1 mm. longae.

Plant 3–15 cm. high, diffusely branched, floccose-lanate throughout; leaves simple linear to 3 to 5 parted; flowers in compact heads, corolla slightly irregular, 10–12 mm. long, lobes blue, tube white or yellow; stamens 2–3 mm. long, equal or unequal, inserted about midway on throat; anthers cordate to oval, 0.7–1 mm. long.

This entity was first diagnosed by Craig (5) under circumstances that led him to believe that he was dealing with the plant diagnosed by Jones and named *G. virgata* var. *Yageri,* an entity herein assigned to subspecific status under *E. eremicum.* It therefore has never had a Latin diagnosis. It differs from the type in the larger corollas and slightly larger anthers and longer filaments. Craig's assignment of this entity to *Gilia eremica* was not without doubt and he pointed out its obvious relationships to *Eriastrum diffusum.* The position of the stamens about halfway on the throat, the small anthers and the nearly regular corollas seem conclusive evidence that it belongs with *E. diffusum* rather than with *E. eremicum.*

Range. Throughout the desert area of Arizona south to Sonora, Mexico.

Representative specimens. Arizona. Pima County: Yager, *Jones 9935* (type); Tucson, *Lemmon 170, 173,* April 3, 1894, *Toumey;* plains west of Santa Catalina Mountains, *Lemmon 241.* Gila County: Pinal Mountains, *Eastwood 17318.*

3b. **E. diffusum** subsp. **Harwoodii** (Craig) comb. nov. *Gilia filifolia* var. *Harwoodii* Craig, Bull. Torrey Bot. Club 61: 424. 1934. *Huegelia diffusa* var. *Harwoodii* Jepson, Fl. Calif. 3: 167. 1943.

It differs from the type in its densely lanate floccose heads and apiculate corolla lobes. The stamens are about midway on the throat.

Range. Eastern Mohave Desert.

Representative specimens. Kern County: Kelso, June, 1915, *K. Brandegee.* Riverside County: Blythe Junction, *Munz & Harwood 3589* (type).

4. **Eriastrum eremicum** (Jepson) comb. nov. *Navarretia densifolia* var. *jacumbana* Brand, Ann. Conserv. and Jard. Bot. Genève 15 and 16: 340. 1913. *Huegelia eremica* Jepson, Man. Fl. Pl. Calif. 793. 1925. *Gilia eremica* Craig, Bull. Torrey Bot. Club 61: 416. 1934. *G. eremica* var. *zionis* Craig, *op. cit.* 418. *G. eremica* var. *typica* Craig, *op. cit.* 417.

This is the common bilabiate-flowered type of the desert area of the Southwestern United States. It is exceedingly variable as to degree of zygomorphy of the corolla and leaf complexity. In general there is greater simplicity of the leaf and flower in the eastern portion of its range. *Gilia eremica* var. *zionis* Craig is a form approaching the subspecies below but scarcely warrants subspecific recognition.

Range. Desert area from southeastern California to southern Nevada, Utah and northern Arizona.

Representative specimens. CALIFORNIA. Los Angeles County: Mint Canyon, *Peirson 2829;* 12 miles south of Muroc, *Peirson 7268.* San Bernardino County: near Victorville, *Mason 3070;* Daggett, *Hall 6142;* Morongo Valley, *Alexander & Kellogg 2291;* Box "S" Ranch, *Munz & Hitchcock 12772;* Barstow, 1909, *K. Brandegee;* Goffs, *Alexander & Kellogg 1378;* New York Mountains, *Alexander & Kellogg 407.* Riverside County: Van Deventer's, *Hall 1892;* Santa Rosa Mountains, *Munz 15148;* Eagle Mountains, *Alexander & Kellogg 2219;* pass south of Palm Springs, *Munz & Harwood 3526.* San Diego County: Jacumba, *Abrams 3640* (type coll. of *Navarretia densifolia* var. *jacumbana* Brand). Inyo County: Panamint Valley, *Parish 10162.* NEVADA. Clark County: Valley of Fire, *Maguire 4929;* 10 miles east of Glendale, *Maguire 4452.* UTAH. La Sal Mountains, *Purpus 6521;* La Verkin, *Jones 5194;* Zion National Park, *Boyle 308;* between St. George and Las Vegas, *Goodman & Hitchcock 1665;* Springdale, *Mason 12453.* ARIZONA. Rim above Quartermaster Canyon, *Grater 15;* Gila River, *A. & R. Nelson 1671;* McDowell Mountain, *Gillespie 5644.*

4a. **E. eremicum** subsp. **Yageri** (Jones) comb. nov. *Gilia virgata* var. *Yageri* Jones, Contr. West. Bot. 13: 2. 1910. *G. eremica* var. *arizonica* Craig, Bull. Torrey Bot. Club 61: 419. 1934. *G. eremica* var. *Yageri* (Jones) Craig, *op. cit.* 420, as to name, not as to lectotype.

It differs from the type in its larger, more nearly regular corollas and its simpler leaves.

Jones, in describing *Gilia virgata* var. *Yageri,* listed several collections belonging to three or four different entities within what is now *Eriastrum eremicum.* Of these he designated *Jones 10279* and *10253* as type, which is not an uncommon practice. Katherine

Brandegee in an unpublished note appended to a scrap of *Jones 10253* in her "study collection" now deposited at the Herbarium of the University of California pointed out, among other things, that *Jones 10279* was so fragmentary as not to be recognizable. Craig (5, p. 421) likewise noted that *Jones 10279* was " . . . so imperfect a specimen as to be impossible of exact reference. . . ." *Jones 10253,* however, was an adequate specimen which Craig designated as the type of his *Gilia eremica* var. *arizonica.* He then discarded *Jones 10279* as the type of his *G. eremica* var. *Yageri,* a name based on *G. virgata* var. *Yageri* Jones. Because the epithet "Yageri" was presumably drawn from the town Yager, in Arizona, Craig next designated *Jones 9935,* collected at Yager, as a lectotype of *G. eremica* var. *Yageri* (Jones) Craig. Had Jones designated no type or had he only designated the inadequate *Jones 10279* as type, this might have been a justifiable and logical procedure. It would seem, however, that in view of the adequacy of *Jones 10253,* it must stand for Jones' concept of *G. virgata* var. *Yageri.* Therefore it seems necessary to place *G. eremica* var. *arizonica* Craig in synonomy under *Eriastrum eremicum* subsp. *Yageri* (Jones) Mason and retain this epithet for the entity typified by *Jones 10253,* as Jones designated it.

Range. Desert region and its borders in Arizona.

Representative specimens. ARIZONA. Wickenberg, *Jones 10253;* Prescott-Phoenix highway, *Nelson 10263;* Apache trail, *Nelson 10103;* Apache Junction, *Gillespie 5545;* Arizona Strip, *Maguire & Blood 4453;* Peach Springs, *Wilson 145;* Mazatzal Mountains, *A. & R. Nelson 1945;* Welton, *Harrison & Kearney 9141.*

5. **Eriastrum sapphirinum** (Eastwood) comb. nov. *Gilia sapphirina* Eastwood, Bot. Gaz. 38: 71. 1904. *Navarretia virgata* var. *sapphirina* Brand in Engler, Pflanzenreich 4^{250}: 168. 1907. *Gilia virgata* var. *sapphirina* Macbride, Contr. Gray Herb. 49: 58. 1917. *Huegelia virgata* var. *sapphirina* Jepson, Man. Fl. Pl. Calif. 793. 1925.

Having restricted the epithet, *Eriastrum virgatum,* to those northern plants isolated in the vicinity of Monterey Bay which have long corolla tubes and long bracts, the southern California plants formerly referred to that name must now be known as *E. sapphirinum* (Eastwood) Mason. Corolla tube from subequal to two and one-half times the throat, the bracts are subequal the calyx, rarely with one or two slightly longer, the heads are few-flowered, the calyx and bracts are glandular pubescent, rarely slightly floccose. Variation within the species seems to center around the pubescence of the inflorescence, the length of the bracts, the extent of its hyaline membrane, and the size of the corolla. Variations centering around these characters seem to be aggregated geographically and are treated below. They appear to interbreed completely.

Range. Usually at higher elevations of the mountains of southern California south to Baja California.

Representative specimens. CALIFORNIA. Riverside County: Strawberry Valley, San Jacinto Mountains, *Hall 329;* Hemet Valley, *Wilder 959.* San Bernardino County: north base of Sugarloaf Mountain, *Munz 10760;* Bear Valley, *Peirson 8585.* San Diego County: Laguna Mountains, *Wiggins 2821;* Palomar Mountain, *Meyer 489;* Oak Grove, *Peirson 2299.* Los Angeles County: Swartout Canyon, *Hall 298.* BAJA CALIFORNIA. Fourteen miles southeast of Tecate, *Peirson 5840.*

5a. **E. sapphirinum** subsp. **gymnocephalum** (Brand) comb. nov. *Gilia virgata* subsp. *gymnocephala* Brand in Engler, Pflanzenreich 4^{250}: 168. 1907. *G. virgata* var. *oligantha* Brand, *loc. cit.*

The flowers are solitary and pedicelled, rarely in pairs. This represents a type of variation that recurs in many members of the Polemoniaceae. *Gilia multicaulis* and *G. peduncularis,* and *G. tricolor* and its variety, *longipedicellata,* are similar pairs of variants in the same direction.

Range. San Diego County and northern Baja California.

Representative specimens. CALIFORNIA. San Diego County: Granite, *Spencer 68;* near Viejas, June 16, 1906, *K. Brandegee.* BAJA CALIFORNIA. Santa Catalina Mountains, July 29, 1883, *Orcutt.*

5b. **E. sapphirinum** subsp. **dasyanthum** (Brand) comb. nov. *Navarretia virgata* var. *dasyantha* Brand in Engler, Pflanzenreich 4^{250}: 168. 1907. *Huegelia virgata* var. *dasyantha* Jepson, Man. Fl. Pl. Calif. 793. 1925. *Gilia virgata* var. *dasyantha* Craig, Bull. Torrey Bot. Club 61: 395. 1934.

Range. Lower and moderate altitudes of southern California and Baja California and perhaps ranging into the hills bordering the San Joaquin Valley where it is represented by two collections with doubtful data, one by Lemmon and the other by Mrs. Brandegee.

Representative specimens. CALIFORNIA. Los Angeles County: Verdugo Canyon, *Ewan 3641;* Mandeville Canyon, *Clokey & Templeton 4549;* Monrovia Canyon, *Howell 3879;* Little Tujunga Wash, *Wolf 2262;* San Dimas Wash, *Wheeler 860;* Claremont, *Baker 3345.* San Bernardino County: San Bernardino Valley, *Parish 11282;* plains north of San Bernardino, *Parish 11888;* San Gorgonio Wash, June, 1933, *Epling & Robison.* Riverside County: Riverside, July, 1897, *Hall;* Rubidoux, *Condit;* Wilder's near Riverside, *Wilder 45.* San Diego County: grade above Rincon, *Wiggins 3087.* BAJA CALIFORNIA. Five miles south of San Tomas, *Pennell & Epling 25231;* Hanson's Ranch, July, 1884, *Orcutt.*

5c. **E. sapphirinum** subsp. **ambiguum** (Jones) comb. nov. *Gilia* *floccosa* var. *ambigua* Jones, Contr. West. Bot. 13: 2. 1910. *G. virgata* var. *ambigua* Craig, Bull. Torrey Bot. Club 61: 412. 1934. *Huegelia virgata* var. *ambigua* Jepson, Fl. Calif. 3: 165. 1943.

This is a desert and desert border race with broad, short three- to seven-lobed bracts often destitute of any membrane on the margins; flowers in closely compacted small heads. It merges with the species in mountains bordering the deserts. Included here are the southern California plants formerly interpreted as *Huegelia lutea* Benth. or *Gilia lutescens* Steud. These plants are amply distinct from *Eriastrum luteum* of the Santa Lucia Mountains to the north in their numerous small heads and in their consistently short bracts and shorter stamens. The flower color is white or pale yellow or blue rather than the golden yellow of the northern plant. The corolla lobes are longer and the throat shorter. The branching is more open paniculate.

It is a matter of interest to note that Jones cited two collections under his *Gilia floccosa* var. *ambigua,* one of them, the type, being characterized by short bracts; the other specimen, from Bear Valley, has several of the bracts exceeding the calyces and is more properly referred to subsp. *dasyantha.* Jones' type was immature but it compares favorably with the Keck and Stockwell, and Alexander and Kellogg collections cited below.

Range. Desert slopes of the mountains of southern California.

Representative specimens. San Bernardino County: near Victor (now Victorville), *Jones 10011* (type); 7 miles west of Victorville, *Keck & Stockwell 3300;* south of Victorville, *Alexander & Kellogg 2302;* Mojave River district, *Palmer 405.* Los Angeles County: Lancaster, June, 1888, *K. Brandegee;* Ravenna, June, 1910, *K. Brandegee.* Riverside County: Santiago Peak, *Munz 7103;* Temescal Canyon, *Peirson 4708;* San Jacinto Canyon, June, 1910, *Condit.*

6. **Eriastrum luteum** (Bentham) comb. nov. *Huegelia lutea* Benth. Bot. Reg. 19: *sub* t. 1622. 1833, not *Gilia lutea* Steud. *Gilia lutescens* Steud. Nomen. ed. 2, 1: 684. 1840. *Navarretia floccosa* Kuntze, Rev. Gen. 2: 433. 1891, in part. *N. lutescens* Kuntze, *loc. cit. N. lutea* Brand in Engler, Pflanzenreich 4^{250}: 168. 1907. *Gilia floccosa* Gray, Proc. Am. Acad. Sci. 8: 272. 1873 (in part). *Navarretia floccosa* Kuntze, Rev. Gen. 2: 433. 1891.

The following only as to type, not as to text.

Huegelia floccosa (Gray) Howell, Fl. N.W. Am. 458. 1903. *Gilia virgata* var. *floccosa* (Gray) Milkn. Univ. Calif. Publ. Bot. 2: 40. 1904. *Navarretia virgata* subsp. *floccosa* (Gray) Brand in Engler, Pflanzenreich 4^{250}: 168. 1907. *Welwitschia floccosa* (Gray) Rydb. Fl. Rocky Mountains 688. 1917. *Huegelia virgata* var. *floccosa* (Gray) Jepson, Man. Fl. Pl. Calif. 793. 1925. *H. filifolia* var. *floccosa* (Gray) Jepson, Fl. Calif. 3: 166. 1943 (excluding lectotype).

The southern California references to *Eriastrum luteum* by previous authors are here included in *E. sapphirinum* subsp. *ambiguum* (Jones) Mason and reasons are given in the account of that subspecies. *Eriastrum luteum,* being based upon *Huegelia lutea* Benth., has as its type a Douglas specimen from "California." A remarkably close match for the Douglas plants is a collection by Brandegee from near Jolon, a town very close to Mission San Antonio, and along the route of Douglas on his southward overland journey from Monterey.

Range. Santa Lucia Mountains of Monterey and San Luis Obispo counties, California.

Representative specimens. "California," *Douglas.* Monterey County: Jolon, June, 1909, July, 1910, *K. Brandegee, T. S. Brandegee,* Herb. Univ. Calif. no. 84336. San Luis Obispo County: mountains north of San Luis Obispo, June, 1878, *Lemmon;* ¾ mile west southwest of Highland School (Poso Quadrangle), *Hendrix 232;* 2 miles west of Lime Mountain (Adelaida Quadrangle), *Nordstrom 1353.*

In the above synonymy, the names listed in the second part are all based on *Gilia floccosa* Gray as to type. Most of the authors of combinations, however, were discussing *Eriastrum Wilcoxii* in the text, having been misled by Gray's misuse of the epithet, *Gilia floccosa,* in his later publications. When Gray originally named *G. floccosa,* he was obviously intending only to apply a new name to *G. lutescens* Steud., a name based on *Huegelia lutea* Benth. Gray (7, p. 272) believed that Bentham had erred in assuming the color of *H. lutea* to be yellow and expressed himself as follows, "Flowers blue or pale purple, becoming white only in age, and though appearing yellowish in original dried specimens of Douglas, probably never yellow. Hence a new specific name is required." This quotation clearly indicates Gray's purpose and intent. Although the only specimens mentioned by Gray in his description of *Gilia floccosa* are " . . . the original dried specimens of Douglas . . . " which are coast range plants, it is probable that his concepts of flower color were based largely upon transmontane plants. But if one would argue that *G. floccosa* Gray constituted an original name with a validly published description, as has been recently suggested by Jepson (12), the Douglas specimen must then be regarded as its type. Some time prior to the publication of the Synoptical Flora of North America, Gray received a specimen which he cited in that work (8, p. 143) under *Gilia lutescens* as follows, "Back of San Simeon, *Palmer,* confirming the yellow color of the corolla." Through this collection, Gray became aware that Bentham's name, *Huegelia lutea,* was after all appropriate, and that in changing it to *Gilia lutescens* upon finding *G. lutea* preoccupied, Steudel (19) was justified in selecting a name descriptive of the yellow color. Gray, however, persisted in retaining the name, *G. floccosa,* for the transmontane plants, excluding from it *Huegelia lutea* Benth. and its synonym, *Gilia lutescens* Steud. Thus, in effect, Gray redescribed *G. floccosa* to embrace the blue-flowered plants and excluded from it "the original dried specimens of Douglas" or, if you will, the type specimen upon which it was originally based.

Gray preempted for this species an epithet from a specimen in Nuttall's herbarium named *Huegelia floccosa* Nutt., which to Gray was a *nomen dubium* since the specimen was unidentifiable. The combination *H. floccosa* Nutt., published by Gray, is both a *nomen dubium* and a *nomen nudum* but not a true synonym of *Gilia floccosa* Gray.

When he first published *Gilia floccosa,* Gray (7, p. 272) cited the range as "California to Arizona, interior of Oregon, and Utah," without any differentiation between transmontane and cismontane California. In publishing the reconstituted species, however, he (8, p. 143) clearly differentiated between the southern and eastern part of the state and the remainder of California as follows: "Dry plains and desert, southern and eastern portions of California and S.E. Oregon to Utah and Arizona." Thus with the original description he had included the range of *Gilia lutescens* and it is clear that he intended, by qualifying the habitat, to exclude it in his later treatment.

It seems necessary to go into this detail because of an argument raised by Jepson (12, p. 166) in behalf of *G. floccosa* Gray. Jepson maintains that since Gray's original description and citation of range applies mainly if not wholly to transmontane plants, and since Gray continued to so apply the name *G. floccosa* in subsequent publications, therefore he was not dealing with the same entity named *Huegelia lutea* by Bentham; that because of Gray's "wrongly citing the name of a different and valid species as a synonym" (*H. lutea* Benth.) this cannot invalidate a name with a properly published description; and finally, that Gray used " . . . slightly qualifying phrases which indicate shadows of doubt" in citing *H. lutea* Benth. as a synonym.

That Gray was referring not only to transmontane plants in his original description of *Gilia floccosa* will be clear from the above outline of the case. It should be obvious also that the original *G. floccosa* Gray is inseparably attached to "the original dried specimens of Douglas" from which it cannot legally be detached. It, therefore, should also be clear that Gray was not wrong in citing *Huegelia lutea* Benth. and *Gilia lutescens* Steud. as synonyms, but rather in bestowing the name *G. floccosa* upon a detached entity not involving the type of *G. floccosa.* Gray's action may have been good taxonomic practice at that time, but today our rules do not permit it and demand correction of such errors. And finally, a reading of Gray's original description and attendant discussion will make it amply clear that Gray used no qualifying words or phrases of any kind in citing *Huegelia lutea* Benth. in synonymy. His doubts concerned only the color of the flower of the Douglas specimen, and the identity of the herbarium name, *Huegelia floccosa* Nutt.

7. **Eriastrum virgatum** (Benth.) comb. nov. *Huegelia virgata* Benth. Bot. Reg. 19: *sub* t. 1622. 1833. *Gilia virgata* Steud. Nomen. ed. 2, 1: 684. 1840. *Navarretia virgata* Kuntze, Rev. Gen. 2: 433. 1891. *N. virgata* Brand in Engler, Pflanzenreich 4^{250}: 167. 1907. *N. densifolia* var. *lanata* Brand, *op. cit.* 165. *Gilia virgata* var. *typica* Craig, Bull. Torrey Bot. Club 61: 394. 1934.

Its very long corolla tube, strictly regular corolla, very long bracts and its geographic isolation are distinctive.

Range. Sand hills and mesas, in the vicinity of Monterey Bay, from Pajaro hills to Carmel River Canyon.

Representative specimens. "California" (Monterey), *Douglas;* Monterey, *Brewer 642;* Carmel River Canyon, *Mason 541;* Seaside, *Heller 6753* (type of *Navarretia densifolia* var. *lanata* Brand); Pajaro hills, *Chandler 454.*

8. Eriastrum filifolium (Nutt.) Wooton and Standley, Contr. U. S. Nat. Herb. 16: 160. 1913. *Gilia filifolia* Nutt. Jour. Acad. Nat. Sci. Phila. n.s. 1: 156. 1848. *Navarretia filifolia* Kuntze, Rev. Gen. 2: 433. 1891. *Gilia virgata* var. *filifolia* Milkn. Univ. Calif. Publ. Bot. 2: 39. 1904. *Navarretia filifolia* subsp. *eufilifolia* Brand in Engler, Pflanzenreich 4^{250}: 167. 1907. *Gilia floccosa* var. *filifolia* Nels. and Macbr. Bot. Gaz. 61: 35. 1916. *Welwitschia filifolia* Rydb. Fl. Rocky Mountains 688. 1917. *Huegelia filifolia* Jepson, Man. Fl. Pl. Calif. 792. 1925. *Gilia filifolia* var. *typica* Craig, Bull. Torrey Bot. Club 61: 422. 1934.

Eriastrum filifolium is herein confined to plants of coastal southern California and Baja California, that is, plants of the hills, valleys and mesas on the coastal side of the main mountain crests. The exclusion of *E. sparsiflorum* (Eastw.) Mason and *E. Wilcoxii* (Nels.) Mason treated under various epithets in minor categories under this species by authors, is here based upon the slender filiform leaves, the very long, exserted filaments, the nature of the pubescence, the corolla proportions, the very long and narrow capsule, and the geographic isolation. The type of *E. filifolium* was collected near Santa Barbara by Nuttall. This is close to the northern point in its range since the northernmost collection reported is from Santa Maria in Santa Barbara County.

Range. Coastal southern California and Baja California.

Representative specimens. California. Riverside County: Temecula Valley, *Mason 3200.* San Diego County: 2 miles south of Pala, *Mason 3133;* San Diego, May, 1906, *K. Brandegee;* Cuyamaca, July, 1894, *T. S. Brandegee;* Mt. Helix, *Rose 35260;* Granite, *Spencer 66.* Baja California. Ryersons Ranch, June, 1893, *T. S. Brandegee;* Llano de Satana, May, 1889, *T. S. Brandegee;* Tiajuana, May, 1883, *Orcutt.*

9. **Eriastrum Wilcoxii** (Nelson) comb. nov. *Gilia floccosa* Gray, emend. Syn. Fl. N. A. 2: 143. 1878, not type of *G. floccosa* Gray, Proc. Am. Acad. Sci. 8: 272. 1873 (see discussion under *Eriastrum luteum*). *Gilia Wilcoxii* Nelson, Bot. Gaz. 34: 27. 1902. *Welwitschia Wilcoxii* Rydb. Fl. Rocky Mountains 688. 1917. *Huegelia filifolia* var. *floccosa* Jepson, Fl. Calif. 3: 166. 1943, as to lectotype, not as to type.

Eriastrum Wilcoxii is the species most often under consideration under the various combinations of *Gilia floccosa* Gray of authors. The following are to be referred to it as to text but not as to type. All are here regarded as type synonyms of *Eriastrum luteum* (Benth.) Mason; hence they are not complete synonyms of *E. Wilcoxii* (Nels.) Mason.

Gilia floccosa Gray, Proc. Am. Acad. Sci. 8: 272. 1873, in part as to text, not as to type. *Huegelia floccosa* (Gray) Howell, Fl. N.W. Am. 458. 1903. *Gilia virgata* var. *floccosa* (Gray) Milkn. Univ. Calif. Publ. Bot. 2: 40. 1904. *Navarretia floccosa* (Gray) Kuntze, Rev. Gen. 2: 433. 1891, in part (since it was based on original *Gilia floccosa* Gray). *Navarretia virgata* subsp. *floccosa* (Gray) Brand in Engler, Pflanzenreich 4^{250}: 168. 1907. *Welwitschia floccosa* (Gray) Rydb. Fl. Rocky Mountains 688. 1917. *Huegelia virgata* var. *floccosa* (Gray) Jepson, Man. Fl. Pl. Calif. 793. 1925. For a discussion of the nomenclatural problem involved here see under *Eriastrum luteum*, pp. 81–83.

Eriastrum Wilcoxii is the common member of this genus in the Great Basin area. The type came from St. Anthony, Idaho.

The occurrence of this species in the La Panza Range, San Luis Obispo County, California (*Gifford 830*), is not an inconsistent distribution for a Great Basin species. The La Panza Range is just to the west of the Temblor Range with the Cholame Valley intervening. The McKittrick flora (17) of Pleistocene age gives positive evidence of a pinyon-juniper association in the Temblor Range at that time. This is a typical Great Basin association and relics of it still persist in Santa Barbara Canyon just to the south. The chief difference between this and the Great Basin plants rests in the fact that this specimen seems to have the seeds solitary in the locules. The Duran collection from the White Mountains has in many of the locules only one ovule, but I have found none in which all the locules were uniovulate. It is of interest to note in such cases that the single ovule fills the locule and hence is of a very different shape and size from those developing in multiovulate locules.

Range. Eastern Washington to Idaho and Utah, south through Oregon to the Panamint Mountains of California; known west of the Sierra-Cascade ranges only in the La Panza Range of San Luis Obispo County, California.

Representative specimens. WASHINGTON. Washington Territory, *Canby 966*. Douglas County: junction of Crab and Wilson creeks, *Sandberg & Leiberg 246*. IDAHO. Canyon County: Nampa, *Macbride 1069.* Elmore County: King Hill, *Nelson* & *Macbride 1093.* Custer County: Challis, *Macbride* & *Payson 3213.* Blaine County: *Macbride* & *Payson 2984.* OREGON. Devine Ranch, *Leiberg 2408.* Harney County: Steens Peak, *Peck 19004.* UTAH. Juab County: 2 miles east of Troutcreek, *Maguire* & *Becraft 2746.* NEVADA. Washoe County: north of Wadsworth, *Archer 6202.* Douglas County: west side Carson Valley, *Mason 12361;* Kingsbury Grade, *Mason 12169.* Ormsby County: Empire City, *Jones 3969;* Kings Canyon, *Baker 1234.* Esmeralda County: *Shockley, U. C. 134018.* Elko County: northwest of Halleck, *Pennell* & *Schaeffer 23391;* Deeth, *Pennell* & *Schaeffer 23420.* Nye County: 1 mile from Dieringer, *Goodner* & *Henning 695.* Mineral County: Wassuk Range, *Archer 6997;* 2 miles south of Hawthorne, *Archer 6801.* CALIFORNIA. Nevada County: near Boca, July, 1888, *Sonne.* Mono County: Casa Diablo Mountains, *Alexander 1820;* Paoha Island, Mono Lake, *Gifford 867;* Sherwin Hill, *Peirson 10717;* Mono Mills, *Abrams* & *Keck 2883.* Inyo County: White Mountains, *Duran 1690, 2531, 2681;* Sierra Nevada southwest of Olancha, *Alexander* & *Kellogg 2951;* Westgard Pass, *Keck 537;* Panamint Mountains, July 7, 1937, *Epling.* San Luis Obispo County: Black Mountain, La Panza Range, *Gifford 830.*

10. **Eriastrum sparsiflorum** (Eastwood) comb. nov. *Gilia sparsiflora* Eastw. Proc. Calif. Acad. Sci., ser. 3, 2: 291. 1902. *Navarretia filifolia* subsp. *sparsiflora* Brand in Engler, Pflanzenreich 4^{250}: 167. 1907. *Gilia filifolia* var. *sparsiflora* Macbr. Contr. Gray Herb. 49: 57. 1917. *Huegelia filifolia* var. *sparsiflora* Jepson, Man. Fl. Pl. Calif. 792. 1925.

The present treatment of *Eriastrum sparsiflorum* and *E. Wilcoxii* represents somewhat of a departure from the usual in that they are here regarded as distinct from one another as well as from *E. filifolium.* Examination of *E. filifolium* from coastal southern California will, I think, clearly demonstrate that it is amply distinct from these entities in its delicate filiform leaves, the long exserted stamens, the very long filaments, the proportion of the corolla parts, as well as in its complete geographical isolation.

Superficially some specimens of *E. sparsiflorum* and *E. Wilcoxii* resemble one another, but if one takes the pains to dissect flowers and measure minute details and add these findings to observations of a grosser nature, a combination of characters will be found that will enable them always to be distinguished. The proportion of the tube, throat, and lobes of the corolla, stamen length (see ideographs, pl. 7), number of flowers to a head, the aggregation of heads, pattern of branching and leaf elaboration will provide a basis for differentiation. *E. sparsiflorum* and *E. Wilcoxii* are, however, much more closely related to one another than to any other species.

Several collectors have found these species growing together and have made a point of reporting no intergradation. This lack of hybridization would seem important evidence for retaining them separate. Such a colony is represented by Mason 12361 and 12362. No significant intergradation or hybridization was noted.

Craig (5), who regarded these two entities as distinct from one another, nevertheless cites a list of specimens which he believes intergrade. Careful study of the specimens cited in this list shows that Craig's conclusions resulted from predominant use of leaf characters to differentiate the two. On the basis of stamen character and the relative length of the corolla throat every one of these "intermediate" specimens, save the Brandegee collection from Lake County, can be placed in *E. sparsiflorum* or in *E. Wilcoxii.* The Brandegee collection does not belong with either of these entities. Collections from Idaho cited by Craig as intergrading are not unlike typical *E. Wilcoxii* from St. Anthony, Idaho, the type locality. All are small specimens, hence do not exhibit the characteristic corymbose branching of *E. Wilcoxii.* However, there is a suggestion of it on the larger individuals. I have as yet seen no material from either Washington or Idaho that I would include in *E. sparsiflorum.*

Range. East base of Cascades and Sierra Nevada, Tehachapi Mountains, and north on the west slope of the Sierra Nevada to Fresno County, California.

Representative specimens. OREGON. Bend, *E. Nelson 861;* Crooked River, 1925, *Gorman;* Desert Well, *Leiberg 387;* Anderson Valley, *Leiberg 2385.* NEVADA. Douglas County: Glenbrook, *Rose 35509;* Zephyr Cove, 1936, *Miller;* Mottsville, *Mason 12362.* CALIFORNIA. Ventura County: Mt. Pinos, *Hall 6580, Dudley & Lamb 4685.*

11. **Eriastrum Tracyi** sp. nov. Annua erecta et tenuia, 1–2 dm. alta; stipites simplices vel racemose ramosi; omnino arachnoide flocculentes; folia inferiora simplicia, superiora 3-scissa super basim, segmenta linearia-filiformia; flores in capitibus terminalibus congesti, saepe capites plures ad extremitates ramorum aggregata, dense sed laxe arachnoide lanata; bracteae 3- usque ad 5-scissae ex basi lata, saepe cum membrana brevi in sinibus, infra arachnoide lanatae, super glabrescentes; calyx profunde in segmentis inaequalibus subaequalibusve 6–8 mm. longis scissus, dense arachnoide floccosis-lanatis, sinus cum membrana hyalina circa semicompleti; corolla 8–9 mm. longa, subhypocrateriformis, coerulea clara usque ad alba, tubus 5 mm. longus, fauces 1 mm. longae, lobae 2–3 mm. longae; stamina faucium ad basim affixa, circa 0.75 mm. longa, filamentae 0.5 mm. longae, antherae 0.5 mm. longae, ovales, versatiles; pistillum longitudine circa longitudinis tubi corollae dimidium; capsula 5 mm. longa, 2–2.5 mm. lata, oblonge ellipsoidea; semina 1 usque ad 2 in loculo.

Erect slender annuals 1–2 dm. high; stems simple or racemosely branched; lightly arachnoid flocculent throughout; lower leaves simple, upper 3-cleft above base, segments linear filiform; flowers congested in terminal heads, often several heads aggregated at ends of branches, densely but loosely arachnoid lanate; bracts 3 to 5 cleft from a broad base, often with a short membrane in the sinuses, arachnoid lanate below, becoming glabrate above; calyx deeply cleft into unequal or subequal segments 6–8 mm. long, densely arachnoid floccose lanate, sinuses about half-filled with a hyaline membrane; corolla 8–9 mm. long, subsalverform, light blue to white, tube 5 mm. long, throat 1 mm. long, lobes 2–3 mm. long; stamens inserted at base of throat, about 0.75 mm. long, filaments 0.5 mm. long, anthers 0.5 mm. long oval, versatile; pistil about one-half the corolla tube in length; capsule 5 mm. long, 2–2.5 mm. wide, oblong ellipsoid; seeds 1 to 2 to a locule.

Type. Hayfork Valley, Trinity County, California, altitude 2600 feet, June 30, 1923, *J. P. Tracy 6463* (type, Herb. Univ. Calif. no. 690662).

Range. Known only from Trinity County, California.

This species superficially resembles both *E. Brandegeae* and *E. filifolium,* from which it can be distinguished by its racemose rather than virgate or corymbose branching, its very small anthers, and the proportions of the parts of the corolla. Its capsule is much broader in proportion to length than is that of *E. filifolium.* The fact that these three entities have hitherto remained undifferentiated despite the corolla and stamen characters is an excellent example of the dangers of allowing superficial characters to influence judgment and points to the need of close examination of flower parts when dealing with *Eriastrum.* It is possible that future experimental study may produce evidence to warrant subspecific grouping of these species but at present due to their geographic isolation, no such evidence exists.

12. **Eriastrum Brandegeae** sp. nov. Annuum erectum, caulis ramosus, corymbosus, virgatusque, 5–30 cm. altum, folia tripartita in divisionibus linearibus filiformibus super basi, leviter flocculosum; flores sessiles in capitibus obovatis floccosis arachnoideis; bracteae 3 ad 5 lobatae, capita excedentes; calyx 7–10 mm. longus, profunde in divisionis inequalibus linearibus tenuibusque fissus, dense arachnoideus, sinus cum membrana angusta et rugata semiimpletus vel amplius; corolla hypocrateriformis, circa 10 mm. longa, alba usque ad coerulea pallida; tubus 4–5 mm. longus, fauces 2 mm. longi, lobi 3 mm. longi, tubus et fauces simul quam calyx brevior; stamina faucium ad basim affixa, 1–2 mm. longa, inequales, inclusa, filamentes quam antherae bis longa, antherae cordate sagitattae; pistillum 4–5 mm. longum, inclusum; capsula cum laeteribus tribus, elliptica in lineamento 4 mm. longa et 2 mm. latus, quam calyx brevior; semina solitaria in loculis, loculi raro 2-ovulati, sub aqua mucilaginosa.

Erect annual 5–30 cm. high, branching virgately corymbose paniculate; leaves 3-parted into linear filiform divisions from above the base, lightly flocculent; flowers sessile in densely arachnoid floccose obovoid heads; bracts 3- to 5-lobed, exceeding heads; heads 1 to 3 at ends of branches; calyx deeply cleft into unequal linear acerose divisions, 7–10 mm. long, densely arachnoid, sinuses over half-filled with a narrow plaited membrane; corolla subsalverform, about 10 mm. long, white to pale blue, tube 4–5 mm. long, throat 2 mm. long, lobes 3 mm. long, tube and throat together shorter than calyx; stamens inserted at base of throat, 1–2 mm. long, unequal to subequal, filaments two times anthers, anthers cordate sagittate, 0.5 mm. long; pistil 4–5 mm. long, included, capsule 3-sided, elliptic in outline, 4 mm. long by 2 mm. wide, shorter than the calyx; seed solitary in locules, only rarely locules 2-ovuled, mucilaginous when wetted.

Type. Ridge southeast of Borax Lake, Lake County, California, June 28, 1945, *Mason 12604* (Herb. Univ. Calif. no. 693854). Other collections. Lake County: between Burns Valley and Borax Lake, *Hoover 3553;* Snow Mountain, August, 1892, *K. Brandegee;* 1½ miles south of Kelseyville, *Schulthess.*

Range. Known only from the mountains of Lake County, California, and isolated geographically from both of the above.

The plant superficially resembles *E. filifolium* (Nutt.) Mason but can be readily distinguished by its more abundant but less compact flocculence in the inflorescence, its normally five-lobed instead of three-lobed bracts, its shorter and unequal wholly included stamens, its shorter and broader ovary and its one-seeded locules.

It has been identified by some with *E. sparsifolium* (Eastw.) Mason, but may be readily distinguished by its more virgate corymbose branching, unequal to subequal stamens with anthers included, cordate rather than sagittate anthers, subsalverform and shorter corolla, shorter corolla lobes and one-seeded locules of the capsule.

13. **Eriastrum Hooveri** (Jepson) comb. nov. *Huegelia Hooveri* Jepson, Fl. Calif. 3: 167. 1943.

Eriastrum Hooveri superficially resembles both *E. filifolium* and *E. Brandegeae* but differs markedly from these two in flower and seed characters.

Range. Rolling plains bordering the southern San Joaquin Valley.

Representative specimens. Fresno County: Raisin City, *Hoover 2231;* 9 miles south of Kerman, *Hoover 2329;* Little Panoche Creek, *Lyon 948.* Kern County: 4 miles east of Shafter, *Stebbins 2105;* 7 miles south of Shafter, *Hoover 1846* (type collection); Oildale, *Hoover 4081.*

14. **Eriastrum Abramsii** (Elmer) comb. nov. *Navarretia Abramsii* Elmer, Bot. Gaz. 41: 314. 1906. *Huegelia Abramsii* Jepson and Bailey in Jepson, Fl. Calif. 3: 167. 1943.

Considerable concern has been expressed as to Elmer's (6) inclusion of *Eriastrum Abramsii* in *Navarretia.* Elmer may have been impressed by the small anthers or he may have agreed with Kuntze (14) in the page priority of *Navarretia* over *Gilia.* It is, however, in no sense a *Navarretia.* Its relationships are wholly within *Eriastrum* as is testified by its simple pinnate leaves and bracts, and densely arachnoid lanate heads.

Range. This species is most abundant in the Mount Hamilton Range, but it ranges from the east face of the Santa Cruz Mountains in Santa Clara County north to Lake County, and south to San Benito County. It is always found in chaparral and often on serpentine or ferro-magnesium rock of Jurassic Age.

Representative specimens. San Benito County. Call Mountains, *Lyon 1561.* Santa Clara County. Santa Cruz Mountains: Black Mountain, *Elmer 4586, Pendleton 1473, Dudley* in 1903; Emerald Lake, *Rose 37658.* Mt. Hamilton Range: chaparral above Arroyo Bayo Creek, *Mason 8302, Sharsmith 1982;* between Arroyo Mocho and Colorado Canyon, *Mason 8313;* Santa Isabella Creek, *Sharsmith 1160;* Seeboy Ridge, *Sharsmith 3738;* Arroyo Bayo and San Antonio Valley, *Sharsmith 3307;* Arroyo Mocho, *Sharsmith 951;* head of Colorado Creek, *Sharsmith 3184.* Stanislaus County. Mt. Hamilton Range: Arroyo del Puerto, *Sharsmith 1816.* Lake County. Between Lower Lake and Knoxville, 1935, *Mason;* Coldstream, 1884, *K. Brandegee;* between Burns Valley and Borax Lake, *Hoover 3554;* 2½ miles south of Kelseyville, *Mason 12606.*

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Literature Cited

1. Bentham, G. In Lindley, Bot. Reg. 19: *sub* t. 1622. 1833.
2. ———. Polemoniaceae in DeCandolle, Prodromus 9: 302–322. 1845.
3. ———. Polemoniaceae in Bentham and Hooker, Genera plantarum 2: 820–824. 1876.
4. Brand, A. Polemoniaceae in Engler, Das Pflanzenreich 4^{250}: 1–203. 1907.
5. Craig, T. A revision of the subgenus Hugelia of the genus Gilia (Polemoniaceae). Bull. Torrey Bot. Club 61: 385–396. 1934.
6. Elmer, A. D. E. New and noteworthy western plants. III. Bot. Gaz. 41: 309–326. 1906.
7. Gray, A. Revision of North American Polemoniaceae. Proc. Am. Acad. Sci. 8: 247–282. 1870.
8. ———. Synoptical flora of North America. 1878.
9. ———. Synoptical flora of North America, ed. 2. 1886.
10. Howell, T. A flora of Northwest America. 1903.
11. Jepson, W. L. Manual of the flowering plants of California. 1925.
12. ———. Flora of California 3(2): 160–168. 1943.
13. Kellogg, A. Description of two new species of Collomia from Nevada Territory. Proc. Calif. Acad. Sci. 3: 17–19. 1863.
14. Kuntze, O. Polemoniaceae in Revisio generum plantarum 2: 432–434. 1891.

15. LINDLEY, J. New plants, etc., from the Society's garden. Jour. Hort. Soc. 3: 73–80. 1848.
16. MACBRIDE, J. F. Notes on the Hydrophyllaceae and a few other North American spermatophytes. Contr. Gray Herb. 49: 23–59. 1917.
17. MASON, H. L. A Pleistocene flora from the McKittrick asphalt deposits of California. Proc. Calif. Acad. Sci., ser. 4, 25: 221–234. 1944.
18. SHARSMITH, H. K. Notes on Navarretia Abramsii of the Polemoniaceae. Am. Midland Nat. 32: 510–512. 1944.
19. STEUDEL, E. Nomenclator botanicus, ed. 2, pt. 1. 1840.

A NEW ARGYTHAMNIA FROM TEXAS

VICTOR L. CORY

I recall with pleasure a field trip made in June of 1935 with Dr. P. A. Munz, then of Pomona College, Claremont, California. Dr. Munz and his family were traveling overland from California en route to the Gray Herbarium, and we planned a field trip to San Antonio from my headquarters at the Ranch Experiment Station situated midway between the towns of Sonora and Rocksprings in the central portion of the Edwards Plateau. At San Antonio we would visit my co-worker, Mr. H. B. Parks of the State Apicultural Laboratory, and have him join us and lead us on a field trip to the Carrizo Sands and to Sutherland Springs in Wilson County. On this trip, we took occasion, also, to visit for the first time the Mustang Desert, which covers much of Atascosa, Frio, La Salle, McMullen, Dimmit and Zavala counties. It is a great rolling plain covered with cacti, low brush and large areas of salt plant (*Varilla texana*), the latter plant having attracted, in the past, hundreds of wild horses, mustangs, to this desert-like country. The animals were said to be the wild descendants of Spanish horses augmented by strays from Fort Ewell. A writer in 1850 tells of the young men of the country having an annual spring hunt to capture good colts for riding animals, and, as late as 1880, settlers along the edge of the desert reported small herds of wild horses. The Spanish Trail came into the Mustang Desert from the west and about the middle turned north to San Antonio. In 1935 the road between Cotulla and Fowlerton, La Salle County, passed three or four miles south of Los Angeles, a village situated outside the Mustang Desert and directly north of its western edge. This old road was closed a few years later, when a new state highway was made which passes through Los Angeles and skirts the northern side of the Mustang Desert. Going east and at three miles inside this area, which is carpeted with curly mesquite grass (*Hilaria Belangeri*), some interesting plants were collected. Two of them we were unfamiliar with: *Varilla texana* A. Gray and *Jatropha cathartica* (Berl.) Jtn., the latter having a large, fleshy, almost globose rootstock and attractive pink flowers. In digging out the rootstocks, the pick would almost bounce back when struck into the hard, dry, adobe soil, much as if struck against concrete.

The following plant, new to us, was also new to science.

Argythamnia argyraea sp. nov. Caulibus pluribus e radice perenni, gracilibus, teretibus, 25–35 cm. altis, plerumque 1–2 mm. crassis, indumento brevi argenteo; foliis alternis, integris, basis 3-nervis, ellipticis ovatibusve, utrinque indumento brevi argenteis, ad 4 cm. longis, plerumque 5–8 mm. latis; floribus dioecis; floribus pistillatis axillaribus, solitariis, pedunculatis; pedunculis quam folio brevioribus, 2-bracteolis ca. 1–2 mm. ad calycem impositis, pro ratione crassis, 5–8 mm. longis; petalis 5, ca. 0.5 mm. latis, 2 mm. longis, acutis, costis prominente; sepalis 5, ovato-lanceolatis, ad 4 mm. longis, 2 mm. latis, intus minus dense, extus dense argenteo-pubescentibus, basi saepe viridibus glabratisve; ovario stylisque conferte brevi-villosis; capsulis profunde 3-lobis, conferte argenteo-tomentosis, ca. 5 mm. latis, 3 mm. longis; seminibus immaturis.

Stems many from a root crown, terete, slender, 25–35 cm. tall, mostly 1–2 mm. in diameter, silvery with short appressed hairs; leaves alternate, entire, 3-nerved at the bases, elliptic to ovate, silvery on both surfaces with short appressed hairs, up to 4 cm. long and mostly 5–8 mm. broad; flowers dioecious, but only fruiting specimens collected; pistillate flowers axillary, solitary, pedunculate; peduncle shorter than subtending leaf, with two bracteoles 1–2 mm. below the calyx, relatively stout, 5–8 mm. long; pistillate flowers with 5 petals, these about 0.5 mm. broad and 2 mm. long, acute, midvein prominent; sepals 5, ovate-lanceolate, up to 4 mm. long and less than half as broad, outer surface densely silvery-pubescent, the inner surface less densely so, with the basal portion frequently green and glabrate; ovary and styles densely short-villous; capsules deeply 3-lobed, densely silvery-pubescent, about 5 mm. broad and 3 mm. long; seeds immature.

Type. Near western and northern edges of Mustang Desert, nineteen miles east of Cotulla, La Salle County, Texas, June 23, 1935, *Cory 14972* (Gray Herbarium).

This species resembles *Argythamnia aphoroides* in being dioecious, but it differs from that species in its silvery pubescence, its narrower leaves, and in its smaller fruits and seeds.

I am indebted to Dr. I. M. Johnston of the Arnold Arboretum for calling to my attention the fact that this plant was undescribed, and also for suggesting the very appropriate specific name; and to Dr. Leon Croizat for checking my material as well as for valuable assistance in preparation of the Latin description. I am grateful to Mr. H. B. Parks for visiting the type locality on June 30, 1937, to collect ample material for further study, and for information concerning the Mustang Desert. The plant is still to be collected when the seeds are mature.

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NOTES ON PACIFIC COAST MARINE ALGAE. III.

E. Yale Dawson

The following notes on various Rhodophyceae are intended mainly to clarify certain problems of nomenclature and distribution in connection with the preparation by the author of "A Guide to the Literature and Distribution of the Marine Algae of the Pacific Coast of North America."

Acrochaetium Thuretii (Bornet) Collins and Hervey var. **agama** (Rosenvinge) comb. nov. *Chantransia Thuretii* (Bornet) Kylin var. *agama* Rosenvinge, Mar. Alg. Denmark 1: 102. 1909. *Rhodochorton Thuretii* (Bornet) Drew var. *agama* Drew, Univ. Calif. Publ. Bot. 14: 171. 1928.

Papenfuss (6, p. 311) in his revision of the *Acrochaetium-Rhodochorton* complex has retained the name *Acrochaetium Thuretii* (Bornet) Collins and Hervey. The variety *agama* deserves, therefore, the present new combination.

Liagora californica Zeh. This species has been recorded only from the type locality, Santa Catalina Island, California. The following specimens deposited in the Herbarium of the University of California indicate a more extensive range: Point Loma, San Diego County, California, 1875, *Edward Palmer;* Guadalupe Island, Baja California, March 18, 1932, *H. W. Clark.*

Pterocladia pyramidale (Gardner) comb. nov. *Gelidium pyramidale* Gardner, Univ. Calif. Publ. Bot. 13: 273. 1927.

Some time after Gardner described this plant from tetrasporic material he discovered specimens bearing cystocarps. In an unpublished note he made the following observations, which have since been independently confirmed by the author and by Dr. C. K. Tseng. "The cystocarps are abundant, usually single and near the outer ends of ultimate pinnules. They are unilateral and open by a single ostiole at the distal end. This necessitates placing the species in the genus *Pterocladia.*"

Pikea pinnata Setchell. Specimens found in beach drift at Coronado, San Diego County, California (*Fork 317* in Herb. Univ. Calif.) extend the known range of this species southward from San Luis Obispo County, California.

De Toni (2) pointed out that the genus *Prionitis* J. Agardh (1851) is invalidated by *Prionitis* Adanson (1763) and proposed the name *Zanardinula* for the algal genus. Both De Toni and Papenfuss (5, p. 342) have made new combinations in this genus. The following are also in order:

Zanardinula mexicana (Dawson) comb. nov. *Prionitis mexicana* Dawson, A. Hancock Pac. Exped. 3: 283. 1944.

Zanardinula guaymasensis (Dawson) comb. nov. *Prionitis guaymasensis* Dawson, A. Hancock Pac. Exped. 3: 283. 1944.

Zanardinula kinoensis (Dawson) comb. nov. *Prionitis kinoensis* Dawson, A. Hancock Pac. Exped. 3: 284. 1944.

Zanardinula filiformis (Kylin) Papenfuss var. **delicatula** (Taylor) comb. nov. *Prionitis filiformis* var. *delicatula* Taylor, A. Hancock Pac. Exped. 12: 210. 1945.

Callocolax globulosis sp. nov. Frondibus parasiticus, hyalinis, 2 mm. altis, 2–3 mm. latis, irregulariter hemisphaericus, lobatis tuberculaeformibus; cystocarpiis internis, per thallis lobatis sparsis; carposporiis 7–10 μ diam.; tetrasporangiis ignotis.

Parasitic on *Callophyllis* sp.; external parts from a relatively small, central attachment to the host, colorless, irregularly hemispherical, 2–3 mm. broad, up to 2 mm. high, with crowded, rounded lobes; cystocarps internal, without ostioles, of irregular shape, scattered through the lobed plant body; carpospores 7–10 μ diam.; tetrasporangia unknown (pl. 8, figs. 3–5).

Type. Growing on a sterile, undescribed species of *Callophyllis* dredged from a depth of twelve meters off Point Loma, San Diego County, California, April 5, 1944, *Martin W. Johnson* (Herbarium of the University of California no. 690149).

The cystocarps of the present species show conclusively that it belongs to the genus *Callocolax* which was first designed to embrace the species *C. neglectus* Schmitz, parasitic on *Callophyllis laciniata* (Hudson) Kützing from the south coast of England. The only other species of this genus known from the Pacific Coast of North America is *Callocolax fungiformis* Kylin (3, p. 35) found growing on *Callophyllis edentata* Kylin near Friday Harbor, Washington. It was described from sterile material, but vegetatively is a much larger plant than *Callocolax globulosis*. Smith (7, p. 153) mentions a *Callocolax* collected in the Monterey region and refers it with reservations to *C. neglectus*. Recently he has written to me: "My material seems to be more or less like your new species."

Iridophycus californicum (J. Agardh) comb. nov. *Collinsia californica* J. Agardh, Analecta Algol., Cont. V., 79. 1899. *Iridaea californica* (J. Agardh) Kylin, Lunds Univ. Årsskr., N.F., 37(1): 23. 1941.

Kylin reexamined the two fragments in Agardh's herbarium under the name *Collinsia californica* and states (4, p. 23) that it is not unlikely that they may be the same as the plant described by Setchell and Gardner under the name *Iridophycus sanguineum*.

Plate 8. Pacific Coast Rhodophyceae. Figs. 1–2, *Rhodymeniocolax botryoidea: 1,* cystocarpic plant from type collection growing on stipe of *Rhodymenia rhizoides.* ×8. *2,* transverse sectional diagram of small cystocarpic plant from type collection. ×16. Figs. 3–5, *Callocolax globulosis: 3,* mature, cystocarpic plant from type collection growing on blade of *Callophyllis* sp. ×8. *4,* transverse sectional diagram of cystocarpic plant in fig. 3. ×16. *5,* transverse sectional view of lobe "A" of fig. 4, showing several cystocarpic cavities filled with carpospores. ×65. Figs. 6–7, *Rhodymenia pacifica: 6,* terminal portion of blade bearing tetrasporic lobules. ×3. *7,* transverse sectional view of tetrasporic lobule. ×250.

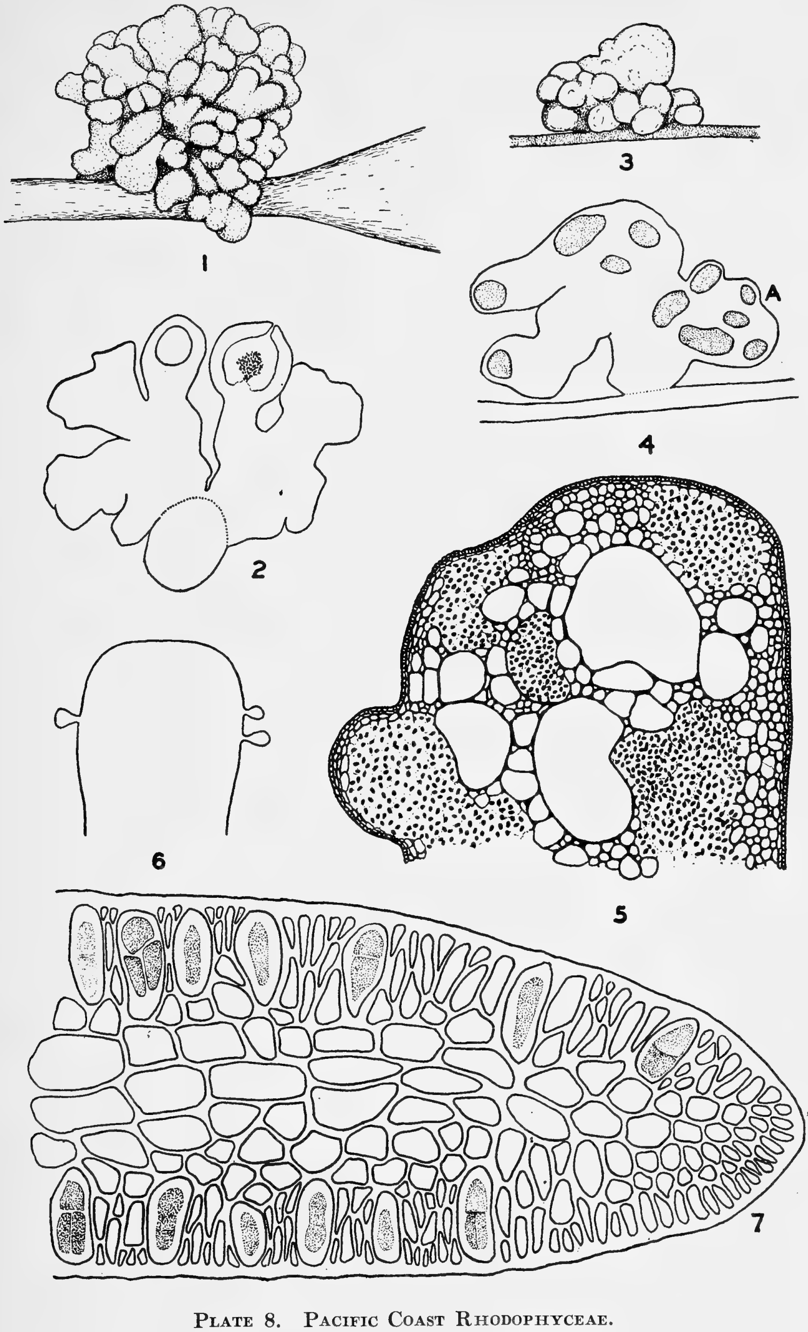

PLATE 8. PACIFIC COAST RHODOPHYCEAE.

Since he was not sufficiently certain, however, to place *I. sanguineum* in synonymy, the older name must be carried on in this new combination until the point can be settled by careful comparison of specimens. The name *Collinsia* is disposed of in any event, as De Toni has pointed out (2) that *Collinsia* J. Agardh (1899) is invalidated by *Collinsia* Nuttall (1817).

Rhodymenia pacifica Kylin, Lunds Univ. Årsskr., N.F., Avd. 2, 21(19): 21. 1925.

This species was described from sterile material collected in the lower littoral at Pacific Grove, California. Reproductive material has not been described. Although the species is not known to occur in the tidal zone in the San Diego region, specimens have been dredged from depths of ten to twelve meters off Point Loma, San Diego County, and have been found in beach drift at La Jolla. In several specimens tetrasporic lobules have been detected occurring marginally; on some, very near the apex of the broadly rounded segment (pl. 8, fig. 6) and on others, from 1 to 3 cm. below the apex. Tetraspores occur over the entire lobule on both sides and cause a nemathecial modification of the outer cell layers (pl. 8, fig. 7). According to this character of the tetrasporic sori, this species should be arranged in the section *Clinophora* of the subgenus *Eurhodymenia* (1, p. 127).

Rhodymeniocolax botryoidea Setchell, Univ. Calif. Publ. Bot. 10: 394. 1923.

This parasitic red alga has recently come to my attention in connection with its host, *Rhodymenia rhizoides* Dawson (1, p. 146). The host was originally given as *Rhodymenia palmetta* ?, and the parasite was only sketchily described in Latin without illustrations. It seems well to present here some illustrations (pl. 8, figs. 1–2) of the type material collected by N. L. Gardner at White's Point, San Pedro, California, in June, 1908. Additional material has been collected in abundance on old specimens of the host found in beach drift at La Jolla, California, throughout the winter and spring of 1944–45.

Pleonosporium squarrosum Kylin var. obovatum Gardner, Univ. Calif. Publ. Bot. 13: 414. 1927.

The type locality was not given by Gardner with the description of this plant. An examination of the type sheet (*Macoun 168*) in the Herbarium of the University of California reveals that the specimens came from Sidney, Vancouver Island, British Columbia. No date is given.

Holmesia californica (Dawson) comb. nov. *Loranthophycus californicus* Dawson, Bull. Torrey Bot. Club 71: 655–657. 1944.

Re-examination of the type specimen of *Loranthophycus californicus* Dawson and comparison with material of *Holmesia capensis* J. Agardh from South Africa in which the tetrasporangia are borne in tiny leaf-like structures on the thallus surface, have prompted the author to abandon his earlier conclusion that the plant was a parasitic species of the Delesseriaceae. It now seems that what was thought to be a parasitic plant similar in form to *Gonimophyllum* is really the tetrasporic branchlet of the membranous "host," a species of *Holmesia.* Its original assignment to the Membranoptera group, although not as a parasitic member, is maintained. The description given of the "host" may now be considered that of the vegetative characters of *Holmesia californica.*

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LITERATURE CITED

1. DAWSON, E. Y. A review of the genus Rhodymenia with descriptions of new species. Allan Hancock Pac. Exped. 3: 115–181. 1941.
2. DE TONI, J. Noterelle di nomenclature algologica VII. Primo elenco di Floridee omonime. Published by the author. Brescia. 1936.
3. KYLIN, H. The marine red algae in the vicinity of the Biological Station at Friday Harbor, Washington. Lunds Univ. Årsskr., N.F., Avd. 2, 21(9): 1–87. 1925.
4. ———. Californische Rhodophyceen. *Ibid.* 37(2): 1–51. 1941.
5. PAPENFUSS, G. F. Notes on algal nomenclature. III. Miscellaneous species of Chlorophyceae, Phaeophyceae and Rhodophyceae. Farlowia 1: 337–346. 1944.
6. ———. Review of the Acrochaetium-Rhodochorton complex of the red algae. Univ. Calif. Publ. Bot. 18: 299–334. 1945.
7. SMITH, G. M. Marine algae of the Monterey Peninsula, California. Stanford University. 1944.

A NEW ASTER FROM YUKON

ARTHUR CRONQUIST

Among some specimens from Yukon recently sent to me for determination by Mr. J. P. Anderson is an *Aster* which seems unlike anything described previously from North America. With the exception of the well-known *Aster alpinus* L. and *A. sibiricus* L., the genus shows little tendency toward circumpolar distribution. There are in fact very few species of *Aster* in the far north. A survey of the more pertinent treatments of Siberian asters, such as those in Ledebour's Flora Rossica, Hultén's flora of Kamtchatka, Komarov's key to the plants of the far eastern region of the U.S.S.R., and Onno's revision of certain species supposedly related to *Aster alpinus* (Bibl. Bot. 106: 1–83. 1932), reveals nothing that might be considered allied to the plant in question. It seems proper, then, to look to the southward for its relatives. In Rydberg's flora of the Rocky Mountains it would key to *A. campestris* Nutt. Although superficially not unlike smaller forms of that species, it differs strikingly in its lax, herbaceous, equal phyllaries, as contrasted to the firm, chartaceous-based, more or less imbricate phyllaries of *A. campestris.* It also differs in its short simple caudex, instead of creeping rhizomes, as well as in several other features. Its true affinities, as suggested by the involucre, and by the auriculate-clasping bases of the upper leaves, are with *A. modestus* Lindl. and *A. novae-angliae* L. In addition to the major differences among these three shown in the following table, *A. yukonensis* has smaller heads with fewer and shorter rays.

TABLE 1. COMPARISON OF THREE SPECIES OF ASTER

A. yukonensis	*A. novae-angliae*	*A. modestus*
Perennial from a very short simple caudex, with some fibrous roots.	Perennial from a thickened rhizomatous caudex, with very numerous fibrous roots.	Perennial from a creeping rhizome; fibrous roots not excessively numerous.
Stems several, decumbent, 6–18 cm. tall.	Stems several, erect, 3–20 dm. tall.	Stems solitary, erect, 3–10 dm. tall.
Leaves linear or nearly so, 2–4 cm. long, 1.5–3.5 mm. wide, entire.	Leaves lanceolate, 3–10 cm. long, 6–20 mm. wide, entire.	Leaves lanceolate, 4.5–13 cm. long, 8–40 mm. wide, usually toothed.
Heads 1 or 2.	Heads several or usually numerous.	Heads several or sometimes numerous.
Involucre villous with flattened hairs, as well as glandular.	Involucre glandular, scarcely or not at all hairy.	Involucre glandular, scarcely or not at all hairy.
Outer phyllaries essentially herbaceous to the base, not chartaceous.	Phyllaries evidently chartaceous toward the base.	Outer phyllaries essentially herbaceous to the base, not chartaceous.
Known only from southwestern Yukon.	Ontario to Alabama, west to North Dakota, Wyoming, and New Mexico.	Southern Alberta and British Columbia to Oregon, Idaho, and Minnesota.

Aster yukonensis sp. nov. Herba perennis e caudice brevissimo, caulibus pluribus decumbentibus glanduloso-villosis 6–18 cm. altis, foliis linearibus sessilibus 2–4 cm. longis, 1.5–3.5 mm. latis, superioribus auriculatis subamplexicaulibus, capitulis solitariis vel 2, disco 8–13 mm. lato, involucro 7–10 mm. alto, glanduloso et villoso, bracteis linearibus herbaceis 2–3 seriatis equalibus, achaeniis obscure pauci-nervis, pappo paenissime simplici.

Perennial with a very short simple caudex and fibrous roots; stems several, decumbent, slender, purple, 6–18 dm. long, sparsely to moderately spreading-villous and more or less glandular, especially upwards; leaves linear or nearly so, about 2–4 cm. long and 1.5–3.5 mm. wide, all sessile, or the lower subpetiolate, the upper becoming auriculate-clasping, fairly numerous and equably distributed (the internodes only about 6–18 mm. long), most of them nearly or quite glabrous, the upper becoming glandular, all acute or acuminate except for some rounded-obtuse and mucronate lower ones; heads solitary or 2, the disk when pressed 9–13 mm.

wide; involucre 7–10 mm. high, glandular, sparsely to moderately villous with flattened hairs; phyllaries green, purplish above, especially on the margins, or the inner purplish throughout, acute to attenuate-acuminate, in 2 to 3 equal series; ligules about 20, blue, 10 mm. long, 2 mm. wide; disk-corollas about 5.9–6.5 mm. long, the tube 1.8–2.3 mm., the lobes 0.6–0.8 mm.; style-appendages lanceolate or lance-subulate, acute to acuminate, 0.4–0.5 mm. long; achenes obscurely several-nerved, pubescent with stiff appressed brown-based hairs; pappus of about 35–40 slightly sordid or faintly purplish bristles, with a few obscure and slender short setae visible at 50 diameters magnification.

Type. South end of Lake Kluane, southwestern Yukon, July 23, 1944, *J. P. Anderson 9384* (Herbarium of the New York Botanical Garden). An isotype is retained in Mr. Anderson's collection at Iowa State College, Ames, Iowa, and another is included in the set laid aside for the University of Lund, Sweden.

New York Botanical Garden,
New York City, New York.

TWO TIOID ASTRAGALUS NOVELTIES FROM THE ROCKY MOUNTAIN REGION[1]

C. L. Porter

Astragalus (*Tium*) racemosus Pursh var. **typicus** nom. nov. *A. racemosus* Pursh, Fl. Am. Sept. 740. 1814.

Astragalus (*Tium*) racemosus Pursh var. **Treleasei** var. nov. A var. *typicus* differt: carina in apice purpurascenta; leguminibus ovato-lanceolatis, 10–20 mm. longis et 4–7 mm. latis.

Differing from var. *typicus* in having the keel of the flowers with a prominent purple tip, and pods which are ovate-lanceolate in outline, the body 10–20 mm. long and 4–7 mm. wide.

Specimens examined. Wyoming. Uinta County: between Carter and Lyman, spring of 1940, *O. A. Beath 125* (type, Rocky Mountain Herbarium, University of Wyoming; isotype, Gray Herbarium, Harvard University); shale outcropping, bluffs of Blacks Fork River, 3 miles north of Lyman, June 10, 1937, *Reed C. Rollins 1650.* Utah. Duchesne County: on the Wasatch formation near Duchesne, June 16, 1940, *O. A. Beath G–509;* 3 miles west of Duchesne, 1941, *Sam F. Trelease H–481;* in cultivation on University of Wyoming campus (seed collected in 1940 by O. A. Beath near Duchesne), July 28, 1943, *C. L. Porter 3300.* All of these collections are deposited in the Rocky Mountain Herbarium.

It was at first thought that this novelty was merely an aberrant form of the species or possibly a hybrid, but it has been found that var. *typicus* does not occur in either of the regions where var.

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[1] Contribution no. 199 from the Department of Botany and the Rocky Mountain Herbarium of the University of Wyoming, Laramie.

Treleasei is common (the former having a more eastern range), and the fact that it has been grown successfully from seed and that such plants retain the characters of the parents suggests at least varietal rank. It is a pleasure to name it for Dr. Sam F. Trelease who has not only collected the plants in the field but who has contributed much to our knowledge of seleniferous vegetation which includes many Astragali.

In this connection it is interesting to note that recent studies by Beath *et al.* (1) and by Trelease (2) indicate that the presence of selenium in significant quantities in certain species of *Astragalus*, and the corresponding lack of that element in others when growing under similar conditions, constitutes what might well be a valuable clue to taxonomic affinities. In this case, for instance, it has been found that whereas *Astragalus racemosus* var. *typicus* commonly contains from several hundred to several thousand parts per million of selenium, var. *Treleasei* has never been found to contain more than 100 parts per million, and when the two were grown under similar conditions experimentally it was found that var. *typicus* consistently contained about five times the selenium found to be present in var. *Treleasei.*

Astragalus (*Tium*) **Schmollae** sp. nov. Herba perennis, caulibus erectis, circa 5 dm. altis, striatis, purpureis inferiore viridibus superiore, ramosis a base strigosis, pilis albis planis appressis; foliis pinnatis, 5–10 cm. longis, pallenter viridibus, strigosis, foliolis plerumque 11 ad 13, oblongo-linearibus, 1–3 mm. latis, 10–30 mm. longis, apice rotunda, base paullo abrupte contracta ad petiolulam 0.5–1 mm. longam; stipulae triangulares, 1–2 mm. latae base, 1–2 mm. longae, strigosae in marginibus; flores in racemis terminalibus 5–15 cm. longae; calyx viridis, pubescente strigosa nigra, tubus circa 6 mm. longus, 3 mm. latus, dentibus lanceolatis, circa 1 mm. longis; corolla ochroleuca, circa 15 mm. longa, vexillo mediocriter arcuato; legumen coriaceum, fere rectum immaturitate sed maturitate sutura dorsali concava, sutura ventrali convexa, valve recurvescente, 25–40 mm. longum, 3–4 mm. latum, sutura sulcata dorsali, sectione transversa obcordata, absente septo interno; stipe 7–10 mm. longo, calicem excedente; semina circa 10 usque ad 15 ad legumen, reniformata.

Plants perennial, the stems apparently erect, about 5 dm. high, striate, purplish below, green above, branching from the base, strigose with flat appressed white hairs; leaves pinnate, 5–10 cm. long, pale green and strigose, the leaflets mostly 11 to 13, oblong-linear, 1–3 mm. wide and 10–30 mm. long, the apex rounded, the base rather abruptly contracted to a petiolule 0.5–1 mm. long; stipules triangular, 1–2 mm. wide at the base and 1–2 mm. long, strigose on the margins; flowers in a terminal raceme 5–15 cm. long; calyx green, with black strigose pubescence, the tube about 6 mm. long and 3 mm. wide, the teeth lanceolate, about 1 mm.

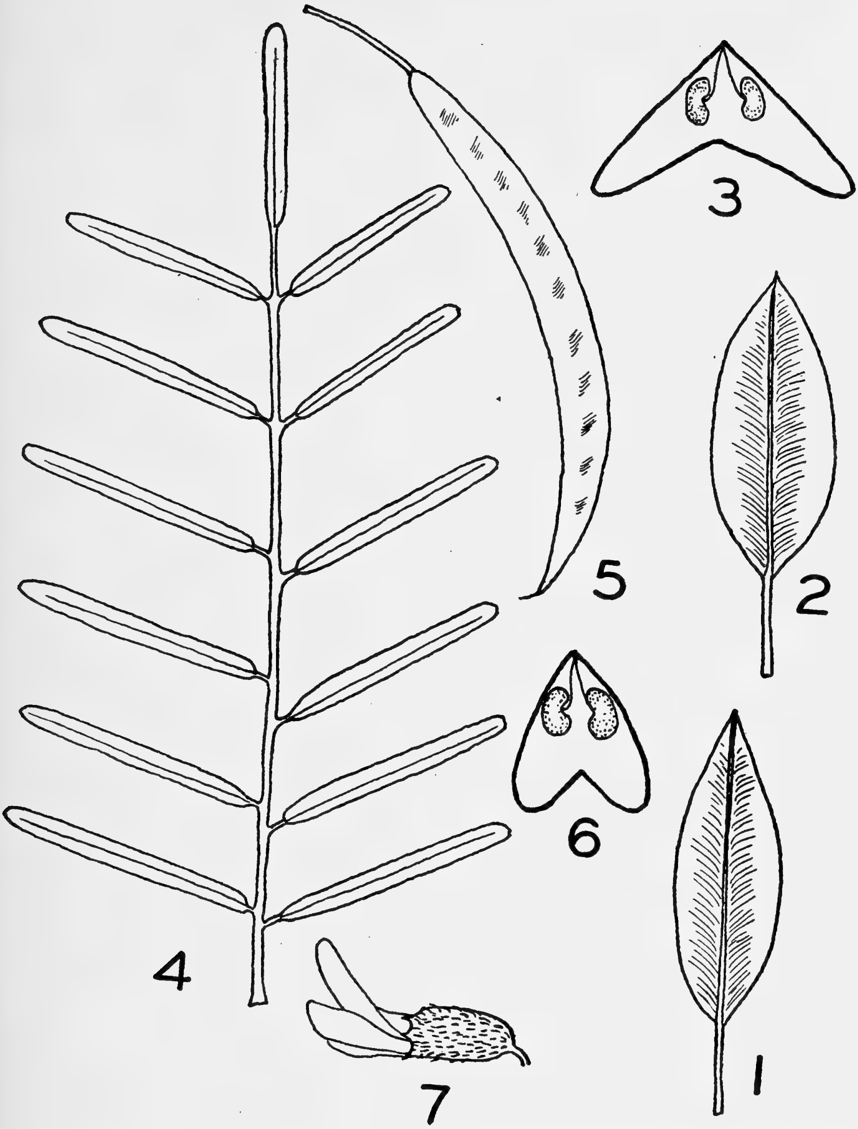

PLATE 9. ASTRAGALUS. FIGS. 1–3, *Astragalus racemosus* var. *Treleasei:* *1, 2,* pods, ×2; *3,* median cross section of pod, ×5. FIGS. 4–7, *A. Schmollae:* *4,* leaf, ×2; *5,* mature pod, ×2; *6,* median cross section of pod, ×5; *7,* flower, ×2.

long; corolla ochroleucous, about 15 mm. long, the banner moderately arched; fruit leathery, nearly straight when young but at maturity the dorsal suture concave and the ventral suture convex making the pod recurved, 25–40 mm. long and 3–4 mm. wide, sulcate on the dorsal suture, the cross section obcordate and without an internal septum; stipe 7–10 mm. long, exceeding the calyx; seeds about 10 to 15 in each pod, reniform.

Type. Northwest of Spruce Tree House, Mesa Verde National Park, Colorado, 6800 feet, May 26, 1925, *Hazel M. Schmoll* & *Deric Nusbaum 1555* (Rocky Mountain Herbarium no. 105889, flowers, no. 105888, fruit). Cotype. Among junipers, Mesa Verde National Park, Colorado, May 12, 1925, *A. Nelson 10420* (Rocky Mountain Herbarium).

The relationships of this species are not clear, but it appears to have the most in common with the Section *Racemosa* as defined by Rydberg. The recurved pod also suggests *Astragalus recurvus* Greene in the Section *Atrata,* but the large flowers, long stipe, and coarse nature of the plants are not in keeping with that group.

Department of Botany,
University of Wyoming, Laramie.

Literature Cited

1. Beath, O. A., C. S. Gilbert, and H. F. Eppson. Am. Jour. Bot. 26: 257–269, 296–315. 1939.
2. Trelease, Sam F., and Helen M. Trelease. *Loc. cit.* 25: 372–380. 1938.

REVIEWS

Experimental Studies on the Nature of Species. II. Plant Evolution through Amphiploidy and Autoploidy, with Examples from the Madiinae. By Jens Clausen, David D. Keck, William M. Hiesey. Carnegie Institution of Washington Publ. 564: viii + 174. 1945.

Part two of "Experimental studies on the nature of species" consists of well-documented discussions of the role of amphiploidy and autoploidy in the reticulate type of evolution that characterizes groups at or below the taxonomic level of genera and species. The documentation is chiefly of data resulting from the experimental synthesis of amphiploids. After cytogenetic investigation their interpretation follows biosystematic principles. Many experimental polyploids developed by others are reviewed and interpreted along the biosystematic pattern. The term "autoploidy" is restricted to "the multiplication of genomes within one ecospecies," while "amphiploidy" involves the addition of the genomes of two distinct species.

The authors point to the organization of living things being in a sort of equilibrium between genetic and ecologic processes. "The natural species consists of individuals whose genes are in internal balance so that a harmonious physiologic and morphologic development is assured generation after generation." The individuals of wild species not only are balanced internally, but are in harmony with their natural environment.

A classification of hybrid auto- and amphiploids is presented based upon circumstances of origin which determine certain observable results involving such features as the loss or preservation of parental genomes, and the complete, partial, or absence of inter-genomal pairing. Plotted against these differentiae is the degree of sterility or fertility of the undoubled F_1. The fully fertile F_1 is regarded as resulting from an intra-ecospecific cross and is known only in autoploids. Where partial sterility results the cross is regarded as inter-ecospecific, and where complete sterility results, the cross is regarded as inter-cenospecific. These latter cases apply to amphiploids.

Although the reticulate nature of evolutionary relationship in the lower taxonomic categories is granted, your reviewer prefers to keep an open mind on the significance of interfertility and sterility, used in a categorical sense, to delimit or merge taxonomic entities. There is much to be learned about the nature and causes of sterility and fertility. This leads him to question the merging of the hexaploid *Madia citrogracilis* and the hexaploid *M. gracilis* on the circumstantial evidence of gene interchange in spite of the difference in origin of the two. Likewise, he maintains an open mind on the meaning of the apparent discrepancies in the classification of the grasses discussed by these authors until we can be sure that speciation in the monocotyledons follows precisely the same cytogenetic patterns as it does in dicotyledons.

The work goes a long ways toward clarifying the problems of amphiploidy and autoploidy and it is of the usual excellence of these authors.—HERBERT L. MASON.

Flora of Illinois. By GEORGE NEVILLE JONES. The University Press, Notre Dame, Indiana. Pp. 317, 1 map. 1945. $4.00.

To an already impressive list of excellent guides to the flora of limited regions of North America, Dr. Jones now adds the "Flora of Illinois," a volume deserving the whole-hearted commendation of amateur and professional botanists. The work consists of carefully constructed keys to the families, genera, and species of plants in the state of Illinois. There are no descriptions, no illustrations, and indications of range beyond state boundaries are omitted. There is no list of proposed new species, new names, or new combinations, but one finds on page 178 a new combination in *Rhus*. There is a short discussion of the flora and vegetation by regions at the beginning, and a lengthy bibliography at the end. The section of the latter dealing with taxonomic monographs and revisions, although incomplete, is perhaps the most useful bibliography of this kind which has appeared in connection with any North American flora.

The key to the families (adapted from an earlier attempt by

Hitchcock and Standley) presents an interesting departure from the usual order for such keys in that it emphasizes vegetative before floral characteristics. Such a key doubtless is useful in identifying sterile specimens, particularly of trees and shrubs, but in most cases one needs flowers to reach the family anyway. Since professional taxonomists rarely use keys to families, it must remain to amateurs and beginners to determine its usefulness. One wonders, though, how one would key such a species as *Cornus canadensis* which the author admits is an "herb or subshrub," but which must be considered a tree or a shrub before it can be placed in the proper family.

The sequence of families and their delimitation follow in general the system outlined in the eleventh edition of Engler's "Syllabus der Pflanzenfamilien," a sound procedure in a work such as the "Flora of Illinois." However, segregation of the Saxifragaceae into five families, while the Liliaceae, Rosaceae, Leguminosae, Ericaceae, and Compositae are retained intact, is hard to defend. Generic limits are essentially traditional and conservative; specific limits, less so. The author leans heavily on recent revisions and monographs but does not always follow them in their entirety, particularly when deciding the status of a given entity. Therefore, the flora cannot be trusted always to reflect the most carefully considered current opinion. Departures from accepted standard monographs and revisions in a flora of this kind should be few or accompanied by reasons.

One is tempted to compare Jones's flora with Deam's masterly "Flora of Indiana," a comparison which is not entirely fair to the younger author. The number of species admitted to the two floras is comparable, 2124 for Illinois; 2140 for Indiana. The plants of Illinois are doubtless not so well known as are those of the neighboring state, but Jones's addiction to giving specific status to entities considered as varieties by Deam (and not included in the above total), and his less rigorous criteria for the inclusion of species, tend to obscure this probability. Lengthy notes and field observations which add so much to Deam's flora are omitted entirely. Aside from those which are recognized as species, most varieties and forms (of which Deam lists 390) are ignored by Jones. Some of these omissions are justifiable in the interest of brevity, but the value of the contribution to critical botanists unquestionably has suffered thereby.

Dr. Jones, however, is to be congratulated on this successful culmination of his five-year field and herbarium study. The publication of a flora covering an area as large as the state of Illinois is always an event of major botanical importance, particularly when there has been no previous comprehensive flora of the area. This flora satisfies a real need of the individual who is interested in the flora of the state. Here he may turn and with a minimum effort determine the plants which he finds.—Marion Ownbey, State College of Washington.

VOLUME VIII NUMBER 4

MADROÑO

A WEST AMERICAN JOURNAL OF BOTANY

Contents

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October, 1945

MADROÑO

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THE NAVAJO YUCCA, A NEW SPECIES FROM NEW MEXICO

John Milton Webber

In May, 1944, while on a yucca survey, the writer and his father, Herbert John Webber, found what they believe to be a new species of *Yucca*. Since this attractive little yucca was found on the Navajo Indian Reservation, near Tohatchi, New Mexico, it is a pleasure to name it in honor of the Navajo Indians.

Yucca navajoa sp. nov. Caulescens caudice erecto demum 1.2 m. alto simplici vel breviramoso ad rosulam vel paulum infra; foliis rigide patentibus pungentibus linearibus vel oblanceolatis, tenuibus sed tamen firmis, anguste albomarginatis, mox tenuiter et saepe crispe filiferis, 5–10 mm. latis, 11.5–41 cm. longis; inflorescentia racemosa densiflora glabra, 0.5–1.1 m. longa, pedunculo brevi, haud vel raro folia superanti; floribus albis plus minusve purpureo-tinctis, globoso-campanulatis, segmentis perianthii latis acutis, sepalis 17–32 mm. latis, 34–58 mm. longis, petalis 24–37 mm. latis, 35–56 mm. longis; filamentis 15–28 mm. longis; pistillis 7–10 mm. diametro, 24–31 mm. longis, ovario pallide viridi lato tumidoque, suturas carpellorum prominentes et depressiones antherarum leves ferenti, stylo pallide viridi vel albescenti, gracili, 6–10 mm. longo; capsulis (immaturis) late oblongis, 27–35 mm. latis, 62–70 mm. longis, haud vel valde constrictis paulum supra medium, capsulis seminibusque maturis ignotis.

Plants forming, at length, a very dense, compact, mass of rosettes, ranging from 1–44 and averaging 10 rosettes per plant, with 0.75–1.47 rosettes per square foot of soil; caudex, from soil level to center of rosette, 0–1.2 m., mainly 0.4–0.7 m. high, 5–8 cm. in diameter, simple or with 2–4 short branches each terminating in 1–3 rosettes; leaves thin but firm, rigid, spreading, dagger-like, linear to oblanceolate, narrowly white-margined, from 5–10 mm. (averaging 8 mm.) wide and 11.5–41.0 cm. (averaging 23 cm.) long; racemes densely flowered, 0.5–1.1 m., but usually 0.7–0.8 m. long; peduncles short, rarely extending above the leaf rosette; flowers short and opening widely, or long, narrow, and remaining closed; sepals generally purple-tinged, 17–32 mm. (averaging 20 mm.) wide, and 34–58 mm. (averaging 43 mm.) long; petals white or slightly purple-tinged, 24–37 mm. (averaging 29 mm.) wide, and 35–56 mm. (averaging 42 mm.) long; pistils 7–10 mm. (averaging 8 mm.) in diameter, and 24–31 mm. (averaging 28 mm.) long; ovary light to dark green, thick, ending abruptly in the style; style white to pale green, gradually tapering into the stigma, 6–10 mm. (averaging 8 mm.) long; filaments generally abruptly bending outward at or near base of style, 15–28 mm.

Corrected date line: Madroño, Vol. 8, pp. 65–104. August 7, 1945.
Madroño, Vol. 8, pp. 105–144. November 5, 1945.

PLATE 10. YUCCA NAVAJOA. Type locality 4.9 miles northeast of Tohatchi, New Mexico, May 28, 1944.

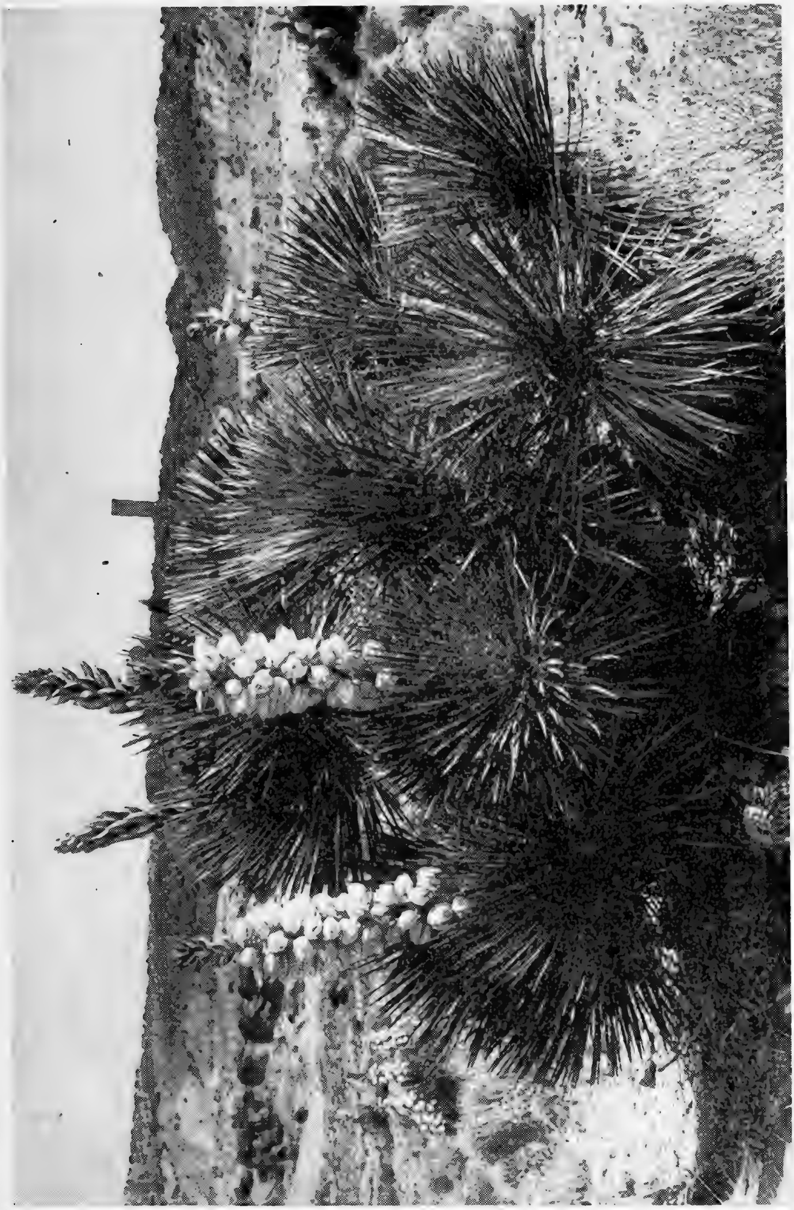

PLATE 11. YUCCA NAVAJOA. Plant from which type specimen was collected, May 28, 1944.

(averaging 21 mm.) long; capsules (immature, 3 to 4 weeks old) broadly oblong, 27–35 mm. (averaging 32 mm.) wide, 62–70 mm. (averaging 67 mm.) long, and from deeply constricted to not constricted.

Type. West side of United States Highway 666, 4.9 miles northeast of Tohatchi, Eastern Navajo Indian Reservation, McKinley County, New Mexico, May 28, 1944, *Webber 300* (United States National Herbarium no. 1872608). At this location there is a mesa referred to by the writer as Yucca Point. This point extends north and west covering an area of from 0.75 to 1.00 square mile, is rather sandy and rocky, and has an elevation of between 6000 and 6500 feet. The luxuriant growth of *Yucca navajoa* growing at Yucca Point is shown in Plate 10. The plant from which the type specimen was collected is shown in Plate 11.

Topotype collections. From type plant, May 28, 1944, *301;* from different plants on Yucca Point, showing typical variations within the species, *302–306, 308;* typical leaf from each of fifteen plants, *307;* a young shoot, June 9, 1944, *299;* pod from type plant, *54;* preserved pistils and stamens from several plants, *8*. All collection numbers are those of the author.

Yucca navajoa belongs to the *Y. glauca* complex (*Yucca glauca* Nutt., *Y. Baileyi* Woot. and Standl., *Y. angustissima* Engelm. ex Trel., and *Y. constricta* Buckley), and is most closely related to *Y. Baileyi*. It, however, differs more from *Y. glauca* than any other species or form of the complex. *Y. navajoa* is unique in that it is the only species in the group with dense clumping mainly due to the branching of an aerial caudex. The formation of a caudex itself is rather unusual, as elongated aerial stems are rarely formed within the *Y. glauca* group, and all other species of the group have been described as acaulescent. A third distinction of the species is the characteristic small leaves, these being mainly linear, but often oblanceolate.

Aside from the preceding major distinctions, *Y. navajoa* differs from *Y. glauca* in that the inflorescence is strictly racemose and densely flowered, the peduncle is short and never extends above the leaves. It also differs from some of the various *Y. glauca* forms in flower color, pistil color and shape, and in the prominence of carpel sutures and of anther depressions on the ovary. *Y. navajoa* has many more leaf rosettes per plant than *Y. Baileyi* and slightly smaller flowers and flower parts. Additional distinctions of the species from *Y. angustissima* and *Y. constricta* are the comparatively large capsules and short peduncle of *Y. navajoa.*

About 20 miles north of Gallup, New Mexico, there is a group of yuccas, which approach *Y. navajoa*. In this vicinity, however, both *Y. Baileyi* and *Y. glauca* occur. Since the plants on this hill show characters of the latter two species as well as of *Y. navajoa,* it is the writer's belief that they represent a complex group of hybrids and hybrid derivatives.

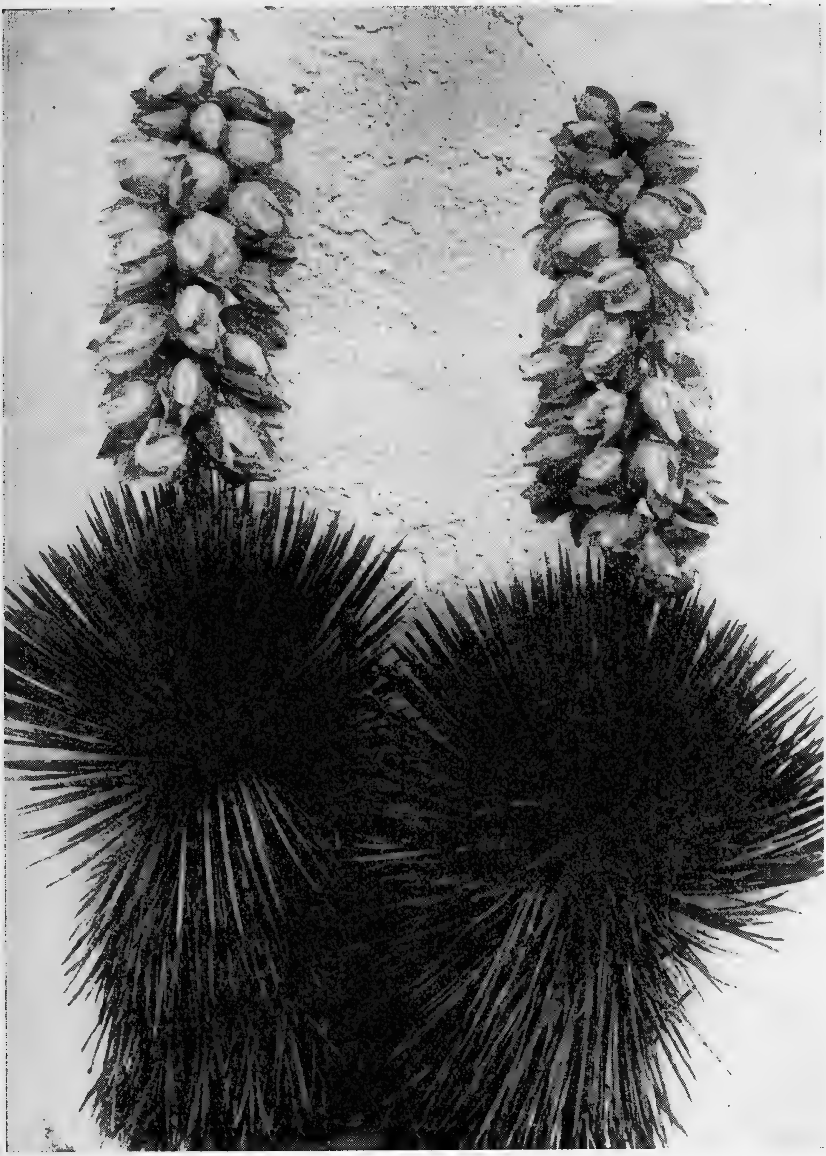

PLATE 12. YUCCA NAVAJOA. Typical plant of species occurring in the vicinity of type locality, May 28, 1944.

Although *Yucca navajoa* is known only from the vicinity of the type locality, plants which approach it have been found as follows: east side of United States Highway 666, 20 miles north of Gallup, New Mexico (not collected); Little Colorado Gorge, Coconino County, Arizona, September 26, 1935, *Kearney* and *Peebles* (United States Cotton Field Station, Sacaton, Arizona, herbarium no. 12819). The Little Colorado Gorge specimen is similar to *Yucca navajoa* in many respects and may prove to be that species. In 1937 Peebles annotated this specimen as a variety of *Y. angustissima* but it was never published. It differs from comparable specimens of *Y. navajoa* only in that the leaf fibers are considerably coarser and more curled. Field notes do not state the number and density of the leaf rosettes—one of the major distinguishing characters of *Y. navajoa.* In 1939 Miss McKelvey annotated this specimen and listed several places where she had found "just such a plant"; she referred it to an unpublished variety of *Y. Baileyi.* She also referred to this unpublished entity a specimen collected at Keams Canyon, Arizona (Sacaton herbarium no. 9374). The writer has carefully studied the yuccas in the vicinity of Keams Canyon, as well as those in the other localities mentioned by McKelvey. In none of these localities have plants similar to the Little Colorado Gorge specimen, or to *Y. navajoa,* been found by the writer. More or less dwarf yuccas occur at the various localities, but none with trunks and oblanceolate leaves characteristic of either the Little Colorado Gorge collection of Kearney and Peebles or *Y. navajoa* has been found. In addition, no yuccas in the localities listed by McKelvey exhibit the major distinguishing growth characters of *Y. navajoa.* The writer has not visited Little Colorado Gorge, Arizona.

Field and experimental plot studies of all southwestern yuccas, as well as nanate forms of several species, strongly indicate that none of the distinguishing characters of *Y. navajoa* is induced by environment. The species, however, is now being subjected to further study in the wild and under cultivation.

The writer wishes to express grateful appreciation to his father, Herbert John Webber, University of California, for assistance given him during his yucca studies, and to John Thomas Howell, California Academy of Sciences, for translating the Latin description from English.

Fiber Crops Field Laboratory,
United States Department of Agriculture,
Riverside, California.

ADDITIONS TO THE OAK FLORA OF EL SALVADOR

John M. Tucker and Cornelius H. Muller

Among the plants collected by John Tucker, a member of the University of California Expedition to El Salvador, Central America, there occur twenty-three collections of *Quercus*. The expedition, under the leadership of Dr. R. A. Stirton of the Department of Paleontology, University of California, was in El Salvador from November, 1941, to May, 1942. Seven different areas in this country were visited by Mr. Tucker, although in only three of them were oaks observed and collected.

The first of these localities was 5100 foot Mount Cacaguatique in the Department of Morazán. Here eleven numbers comprising four species were obtained on, and in the vicinity of, the coffee finca of General José Tomás Calderón. Headquarters of the finca lie on the north side of the mountain at an elevation of 4600 feet. This side of the mountain above 3000 feet, where the original growth has not been cleared for coffee plantations, is occupied by oak woods. The dominant components are *Quercus hondurensis* Trel. and *Q. peduncularis* var. *sublanosa* (Trel.) Mull., and in a few small areas, particularly on dry ridges, *Pinus oocarpa* Schiede. A few scattered individuals of *Quercus Skinneri* Benth. and *Q. vicentensis* Trel. are to be found here also.

The second locality was the 9000 foot mountain, Los Esesmiles, which lies in, and near the northern boundary of, the Department of Chalatenango, not far from the Honduran border. The upper slopes of this mountain proved to be the most interesting and profitable botanically of any of the areas visited in El Salvador. Eleven numbers of *Quercus* were collected here, representing eight species: *Quercus acatenangensis* Trel., *Q. eugeniaefolia* Liebm., *Q. flagellifera* Trel., *Q. oocarpa* Liebm., *Q. sapotaefolia* Liebm., *Q. Seemanni* Liebm., *Q. vicentensis* Trel., and one herein described. The expedition camp was established at an elevation of 7200 feet on the eastern slope of the mountain. It was on this side of Los Esesmiles, which bears a dense, luxuriant cloud forest, that most of the collections were made.

The third locality where *Quercus* was collected was the area lying just to the north of the Volcán de Santa Ana, in the Department of Santa Ana. The upper slopes of this volcano, as well as those of several smaller extinct volcanic cones on its north flank, are clothed with forest growth which in general aspect is rather similar to the cloud forest of Los Esesmiles. Most of the dominant arboreal species are different in the two areas, however. On the east side of the 6000 foot Cerro Del Águila (one of the small, extinct cones), a single collection of *Quercus Skinneri* Benth. was made, representing the only oak species noted in this area.

Had these oak collections been available at the time of the preparation of "The Central American Species of Quercus"

(Muller, Cornelius H. U.S.D.A. Misc. Pub. 477: 1–216. 124 pl. 1942), they would of necessity have occasioned considerable amplification of that paper. El Salvador and Nicaragua were admitted to be very poorly represented in the then extant collections of *Quercus*. The specimens herein reported represent numerous extensions of range and one outstanding new species, and have provided additional information which might have permitted more full specific descriptions and decided improvements in the key to species.

In the following list of species no effort has been made to incorporate specific characters which might be added to our knowledge of the various species nor to revise the key to species to accommodate these characters. Such corrections are nearly valueless if presented separately from the complete treatment and are best left to accumulate until a full revision appears profitable.

The specimens comprising this collection are deposited in the Herbarium of the University of California at Berkeley; duplicates are being distributed. All cited collections are those of Tucker.

Subgen. *Lepidobalanus* (Endl.) Oerst.

Quercus oocarpa Liebm.? A collection without mature leaves is tentatively placed here. This would be the first collection of this species in El Salvador. *Quercus oocarpa* is known from Guatemala to Panama, and its occurrence in El Salvador would not be surprising.

Dept. Chalatenango. Small tree 20 feet tall; bark very light gray; cloud forest on north-facing slope, elevation *ca.* 7300 feet; east side of Los Esesmiles, April 4, 1942, *1200*.

Quercus peduncularis var. sublanosa (Trel.) Mull. This variety, occurring from Guatemala to Nicaragua, was previously known in El Salvador only from the Department of Chalatenango.

Dept. Morazán. Slender tree 25 feet tall; oak woods on northwest-facing slope, elevation *ca.* 3600 feet; *ca.* 3 miles east of finca of General J. T. Calderón, Mount Cacaguatique, January 12, 1942, *779*. Tree 30–35 feet tall; oak woods on northeast-facing slope; *ca.* ½ mile east of finca of General J. T. Calderón, Mount Cacaguatique, January 17, 1942, *808*.

Quercus vicentensis Trel. Known only from El Salvador. Previous collections were from the Department of San Vicente and from Comasagua, in the Department of La Libertad.

Dept. Morazán. Old tree 25–30 feet tall; leaves very pale glaucous beneath; elevation *ca.* 4900 feet; at top of "saddle," ¼ mile due south of hacienda buildings, finca of General J. T. Calderón, Mount Cacaguatique, January 17, 1942, *810*. Dept. Chalatenango. Tree 45 feet tall; top of dry ridge, elevation *ca.* 5000 feet; along trail from San Ignacio to Las Pilas, west side of Los Esesmiles, March 22, 1942, *1109*.

PLATE 13. QUERCUS ESESMILENSIS. Typical habitat at border of cloud forest.

Subgen. *Erythrobalanus* (Spach) Oerst.

Quercus hondurensis Trel. Previously known from El Salvador in the Department of Chalatenango and the Department of Morazán, additional localities in the latter department are now recorded for this species.

Dept. Morazán. Shrubby tree 10 feet tall; oak woods, elevation *ca.* 4500 feet; south-facing slope of easternmost peak, Mount Cacaguatique, January 2, 1942, *699*. Spreading tree 18 feet tall, very young leaves dark red, strongly revolute; oak woods, on north-facing slope, elevation *ca.* 3800 feet; *ca.* ½ mile northeast of finca of General J. T. Calderón, Mount Cacaguatique, January 6, 1942, *736*. Small trees *ca.* 20 feet tall; oak woods on north-facing slope, associated with ***Pinus oocarpa*** Schiede, elevation *ca.* 4250 feet; *ca.* ¾ mile east of finca of General J. T. Calderón, Mount Cacaguatique, January 11, 1942, *762, 762A*. Young tree 7 feet tall; oak-pine woods, on road bank, elevation *ca.* 4000 feet; *ca.* 2¼ miles east of finca of General J. T. Calderón, Mount Cacaguatique, January 11, 1942, *765*. Acorns and cups from under trees conspecific with no. *765;* elevation 3050 feet; *ca.* 4 miles east of finca of General J. T. Calderón, Mount Cacaguatique, January 11, 1942, *768*.

Quercus sapotaefolia Liebm. Previously known from only one locality in the Department of Chalatenango, this species may now be reported from another station.

Dept. Chalatenango. Tree *ca.* 18 feet tall; small stand on north-facing slope, elevation *ca.* 5200 feet; along trail from San Ignacio to Las Pilas, west side of Los Esesmiles, March 22, 1942, *1110*.

Quercus eugeniaefolia Liebm. Not previously recorded from El Salvador. The following collection represents a considerable extension of its known range from Panama and Costa Rica.

Dept. Chalatenango. Straight-trunked tree 45–50 feet tall, bark gray, longitudinally very shallowly fissured; border of cloud forest, on north-facing slope, elevation *ca.* 7200 feet; east side of Los Esesmiles, March 18, 1942, *1089*.

Quercus Seemanni Liebm. Previously known only from Panama and Costa Rica, this species is here recorded for the first time from El Salvador.

Dept. Chalatenango. Specimens from leaders 10–12 feet tall, arising from fallen tree 25 feet long; open, north-facing canyon slope, elevation *ca.* 7200 feet; east side of Los Esesmiles, April 1, 1942, *1182*. Straight-trunked tree 50–55 feet tall; cleared field on north-facing slope, elevation *ca.* 7100 feet; east side of Los Esesmiles, April 4, 1942, *1202*.

QUERCUS ACATENANGENSIS Trel. Not previously reported south of Guatemala where it is very widespread and abundant.

DEPT. CHALATENANGO. Spreading tree *ca.* 20 feet tall, elevation *ca.* 6000 feet; beside trail from San Ignacio to Las Pilas, west side of Los Esesmiles, March 22, 1942, *1115*.

QUERCUS FLAGELLIFERA Trel. Reported here for the first time from El Salvador. Widespread in Guatemala, although sparsely distributed.

DEPT. CHALATENANGO. Large, old tree, young foliage bronze-green, shining, leaves undulate margined; cloud forest on north-facing slope, elevation *ca.* 7200 feet; east side of Los Esesmiles, March 15, 1942, *1066*.

QUERCUS SKINNERI Benth. Ranges from Chiapas, Mexico, to Honduras. Previously recorded from the departments of Ahuachapán, Cuscatlán, and San Vicente of El Salvador. The small-fruited form (*Q. salvadorensis* Trel.) is represented by collections from the Department of Morazán, while the typical large-fruited form is represented by a collection from the Department of Santa Ana.

DEPT. MORAZÁN. Tree 35–40 feet tall, bark dark gray; coffee grove, on northwest-facing hillslope, elevation *ca.* 4700 feet; southeast of hacienda buildings, finca of General J. T. Calderón, Mount Cacaguatique, January 16, 1942, *800*. Tree 50 feet tall, bark black, thin, finely fissured; elevation *ca.* 4900 feet; at top of "saddle," ¼ mile due south of hacienda buildings, finca of General J. T. Calderón, Mount Cacaguatique, January 16, 1942, *801*. DEPT. SANTA ANA. Large tree 60–65 feet tall; in forest, elevation *ca.* 5500 feet; east side of Cerro del Águila, April 21, 1942, *1276*.

Quercus esesmilensis Tucker and Muller sp. nov. Arbor ad 16 m. alta; ramuli 2–3 mm. crassi, glabrati; folia sempervirentia, 10–18 cm. longa, 3.5–6 cm. lata, lanceolata vel ovato-lanceolata, attenuato-acuta, bases acutae vel rotundatae, glabratae exceptis subter cristatis axillaribus, venis utrimque 8–10, supra impressis, subtus prominentibus anastomosantibus, petioli 10–25 mm. longi, complanati dorsale, laminae foliorum in partibus superis petiolorum subtiliter decurrentibus; fructi biennes, cupulae 16–20 mm. latae, 5–10 mm. altae, squamae stricte appressae, glandes 20–25 mm. longae, 18–22 mm. latae, ovoidea, ⅕ inclusae.

Tree 40 or 50 feet tall; twigs 2–3 mm. thick, fluted, at first loosely fulvous-stellate-tomentose, very quickly glabrate, dull brown or grayish with inconspicuous lenticels; buds about 2 mm. long, subrotund, light brown, dull or shiny, glabrate except for the ciliate scale margins; stipules 9–13 mm. long, broadly ligulate, dorsally glabrous, ventrally fulvous-stellate-tomentose, very quickly caducous; leaves evergreen, rather thick and coriaceous, 10–18 cm. (or 23 cm.) long, 3.5–6 (or more) cm. broad, narrowly

PLATE 14. QUERCUS ESESMILENSIS. Branchlet and fruits. (Note the persistent fulvous axillary tufts on ventral surface of leaf.)

elliptic-ovate to ovate or lanceolate, attenuately acute, the drip-tips without aristae, the bases often slightly unequal, rounded to acute, entire or rarely coarsely few-toothed, margins somewhat undulate, crisped, finely revolute, blades densely stellate-tomentose upon unfolding, quickly glabrate except the persistent fulvous axillary tufts beneath, both surfaces rather dull; veins 8–10 on each side, much branched and obviously anastomosing throughout, principal veins impressed above and raised within the depressions, quite prominent and reticulate beneath; petioles 10 to usually 15 or 25 mm. long, dorsally flattened, becoming glabrate, the leaf blade minutely decurrent on the upper portion; pistillate catkins 5–10 mm. long, 1- or 2-flowered, pedunculate; fruit biennial, solitary or paired on a peduncle 10–15 mm. long; cups 16 to usually 18 or 20 mm. broad, 5–10 mm. high, saucer-shaped to subhemispheric, margins not inrolled, scales flat, closely appressed, finely canescent but the tips glabrous, light brown and shiny; acorns usually 20–25 mm. long, 18–22 mm. broad, sometimes smaller, ovoid, broadly rounded to truncate at apex, $\frac{1}{5}$ included.

Dept. Chalatenango. Large tree *ca.* 50 feet tall; border of cloud forest, on northwest-facing slope, elevation *ca.* 7700 feet; east side of Los Esesmiles, April 3, 1942, *1198* (type, Herb. Univ. Calif. no. 694107). Acorns from under trees conspecific with no. *1198;* cloud forest, elevation *ca.* 8900 feet; summit of southern peak of Los Esesmiles, April 3, 1942, *1199* (description of fruit from this collection). Tree *ca.* 40 feet tall; cloud forest, elevation *ca.* 8500 feet; east side of Los Esesmiles, March 24, 1942, *1126.*

Quercus esesmilensis is a member of the series *Acatenangenses* Trel. In Muller's key to the species of Central American *Quercus* (p. 17), *Q. esesmilensis* would fall between *Q. acatenangensis* Trel. and *Q. conspersa* Benth. It differs from *Q. conspersa* in its minutely winged petioles, veins impressed above and very prominently reticulate beneath, leaf surfaces not yellow-glandular-puberulent beneath, lack of aristae on the apical tips or on the rare teeth, and in its rather large fruit. Although *Q. esesmilensis* is more closely related to the polymorphic *Q. acatenangensis* than to any other, it is readily distinguished by its larger leaves, veins impressed above, reticulum very prominent beneath, larger fruit included only at the base, and its very shallow cups. Immature leaves of *Q. esesmilensis* do not exhibit the prominent reticulum. From superficially similar forms of *Q. Seemanni, Q. esesmilensis* is distinguished by its biennial fruition and its very shallow cups. In its highly developed drip-tip this species reflects the impact of a very humid habitat, a response exhibited by divers species of the genus.

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THE MEXICAN, CENTRAL AMERICAN, AND WEST INDIAN LEPIDIA

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When the writer reviewed the genus *Lepidium* in 1936 (Madroño 3: 265–320), there were so many unsolved problems concerning the Mexican and Central American species that it was not considered feasible to try to treat the genus for the whole of North America. While assembling specimens for a study of the South American species, this North American material was borrowed also. It is now felt that the taxonomy of these more southern species is as nearly understood as it ever will be by the use of herbarium methods.

Sources of material borrowed and abbreviations used in citations are as follows: University of California (C), Chicago Natural History [Field] Museum (F), Gray Herbarium (G), private herbarium of B. A. Krukoff, New York Botanical Garden (Kr), Missouri Botanical Garden (MBG), New York Botanical Garden (NY), Stanford University (S), United States National Herbarium (US), University of Washington (W). To the curators of these herbaria I wish to express my sincere appreciation.

Key to Species

1. Plants perennial,[1] sparsely puberulent to glabrous; stamens 6 .... (2)
1a. Plants annual or biennial,[2] often densely pubescent; stamens 2, 4, or 6 .. (3)
2. Styles 0.3–1 mm. long; basal leaves more or less pinnatifid, the cauline 1–5 mm. broad .... 1. *L. montanum*
2a. Styles lacking; all leaves no more than dentate, the cauline as much as 4 cm. broad .... 2. *L. latifolium*
3. Styles 0.2–1 mm. long; silicles sometimes over 5 mm. in length .... (4)
3a. Styles less than 0.2 mm. long; silicles nearly always less than 5 mm. long .... (7)
4. Stamens 6; styles usually at least 0.3 mm. long .... (5)
4a. Stamens 2; styles usually *ca.* 0.2 mm. long .... (6)
5. Silicles 5–6 mm. long; plants without clavate or flattened hairs. 3. *L. sativum*
5a. Silicles 2–3 mm. long; plants with clavate or flattened hairs. 4. *L. Thurberi*
6. Silicles *ca.* 4 mm. long .... 7. *L. Gerloffianum*
6a. Silicles less than 3 mm. long .... 5. *L. sordidum*
7. Plants densely granular-puberulent with clavate or flattened hairs; silicles 1.5–2.2 mm. long .... 5. *L. sordidum*
7a. Plants not puberulent as above; silicles usually over 2.2 mm. long .... (8)
8. Basal leaves deeply pinnatifid, the segments linear; pedicels 2–6 times as broad as thick; silicles ovate to orbicular, glabrous .... 6. *L. nitidum*
8a. Basal leaves not as above, or if so, pedicels not so greatly flattened, or silicles either less rounded or pubescent .... (9)
9. Stamens 6; silicles 5–6 mm. long; cauline leaves mostly pinnatisect. 3. *L. sativum*

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[1] *Lepidium Fremontii* Gray, a shrubby-based perennial with oval silicles 4–7 mm. long, may possibly occur in Mexico, although unreported therefrom.

[2] Also to be expected along the northern boundary of Mexico are *L. flavum* Torr., a yellow-flowered annual with styles 1–1.5 mm. long, and *L. perfoliatum* L., a weedy annual with perfoliate cauline leaves.

9a. Stamens 2 or 4, or if 6 the silicles less than 5 mm. long, or cauline leaves not pinnatisect .... (10)
10. Silicles distinctly wing-tipped for $\frac{1}{5}$–$\frac{1}{3}$ their length, the sinuses *ca.* $\frac{1}{5}$ ($\frac{1}{8}$) length of fruit; fruit not densely pubescent (see also *L. lasiocarpum*). (11)
10a. Silicles not wing-tipped, or if so the wing short, less than $\frac{1}{5}$ length of fruit or the sinuses over $\frac{1}{5}$ length of fruit, or fruit pubescent on lower surface at least .... (14)
11. Silicles *ca.* 3 mm. long .... 8. *L. Schaffneri*
11a. Silicles 3.5–5 mm. long .... (12)
12. Leaves all pinnatifid to bipinnatifid, rarely but deeply lobed. 9. *L. costaricense*
12a. Leaves of stems not pinnatifid, often semi-entire .... (13)
13. Stamens 6; silicles rather pyriform in outline. 13f. *L. virginicum* var. *tepicense*
13a. Stamens 2; silicles ovate-oblong .... 7. *L. Gerloffianum*
14. Silicles elliptic or nearly so in outline, mostly no more than 3 mm. long; cauline leaves mostly linear and entire .... (15)
14a. Silicles not elliptic in outline, or over 3 mm. long, or cauline leaves pinnatifid .... (16)
15. Racemes compound, mostly 1–3 cm. long; silicles mostly *ca.* 3 mm. long; plants not foetid .... 10. *L. ramosissimum*
15a. Racemes elongate, mostly 3–8 cm. long; silicles mostly 2–2.5 mm. long; plants foetid .... 11. *L. ruderale*
16. Sepals often (though not always) persistent until fruits nearly mature in size; silicles 2–3.25 mm. long, rotund or obovate to broadly elliptic, usually ciliate; petals vestigial or lacking; pedicels flattened, sometimes at least twice as broad as thick; cauline leaves usually laciniate or pinnatifid. 12. *L. oblongum*
16a. Sepals caducous with stamens; silicles variable but often over 3.25 mm. long, mostly glabrous, occasionally pubescent on one or both surfaces; pedicels often more than twice as broad as thick; cauline leaves often lobed or serrate to entire .... (17)
17. Cotyledons accumbent to incumbent; cauline leaves mostly toothed to serrate; pedicels terete to flattened and twice as broad as thick; petals mostly 1 to 3 times as long as sepals; silicles elliptic-rotund to broadly ovate-elliptic, scarcely ever pubescent .... 13. *L. virginicum* and vars.
17a. Cotyledons incumbent; cauline leaves often pinnatisect; pedicels often more than twice as broad as thick; petals seldom as long as sepals; silicles variable in shape, but usually pubescent or at least ciliate .... (18)
18. Pedicels mostly at least twice as broad as thick; silicles usually pubescent, generally broader in upper half than in lower; pubescence of plants often rather coarse and stiff .... 14. *L. lasiocarpum* and vars.
18a. Pedicels not over twice as broad as thick; silicles glabrous or very lightly pubescent, rotund to ovate-elliptic, pubescence of plants fine and soft .... (19)
19. Silicles rotund or nearly so, *ca.* 3 mm. long, margins, at least, with short hairs .... 15. *L. pinnatisectum*
19a. Silicles ovate-elliptic to oval-elliptic, glabrous .... 16. *L. filicaule*

1. Lepidium montanum Nutt. var. alyssoides (Gray) Jones, Zoë 4: 266. 1893; C. L. Hitchc. Madroño 3: 310. 1936.

More or less suffrutescent perennials 2–5 dm. tall, sparsely and minutely puberulent; cauline leaves linear, entire, mostly 1–3 mm. broad; petals showy; stamens usually 6; glands 6, 0.1 mm. long; silicles ovate or elliptic-ovate, 3–4 mm. long, glabrous; styles 0.3–1 mm. long. Pl. 15, fig. 1.

Representative Mexican material. Chihuahua: Samalayuca, *Pringle 712*. Coahuila: near La Ventura, *Johnston 7637, Nelson*

3912. Nuevo Leon: Galeana, *Chase 7710.* San Luis Potosi: 2 miles south of Cedral, *Johnston 7581* (G).

This is apparently the only variety of *L. montanum* that extends into Mexico.

2. Lepidium latifolium L. Sp. Pl. 644. 1753; C. L. Hitchc. *op. cit.* 271.

Tall glabrous perennials; basal leaves 3–8 cm. broad; pedicels filiform, terete, several times as long as fruits; stamens 6; glands 6, *ca.* 0.1 mm. long; silicles *ca.* 2 mm. long, sparsely pilose; stigmas sessile. Pl. 15, fig. 7.

Representative Mexican material. Durango: near Durango, *Palmer 168.* Mexico: Valley of Mexico, *Rose* and *Hough 4329, Bourgeau 12.* San Luis Potosi: *Parry* and *Palmer 24.* Puebla: near Puebla, *Arsène 1496.*

An introduced perennial, occasionally established.

3. Lepidium sativum L. Sp. Pl. 644. 1753; C. L. Hitchc. *op. cit.* 270.

Strict erect annuals; leaves all pinnatisect; petals *ca.* 2 mm. long; stamens 6; glands 6, *ca.* 0.1 mm. long; silicles oblong-ovate, 5–6 mm. long, glabrous, margins upturned; styles 0.2–0.3 mm. long; cotyledons dissected, incumbent. Pl. 15, fig. 2.

Only one collection seen. Bermuda: *Brown et al. 2175* (NY).

An occasional escape from cultivation.

4. Lepidium Thurberi Wooton, Bull. Torrey Bot. Club 25: 259. 1898; C. L. Hitchc. *op. cit.* 315.

Large, freely branched annuals 3–6 dm. tall, usually rather grayish with flattened or clavate hairs; leaves mostly pinnatifid to parted; petals very showy, white; stamens 6; glands 6; silicles oval to elliptic in outline, somewhat inflated, 2–3 mm. long, glabrous; styles 0.3–0.6 mm. long. Pl. 15, fig. 3.

Representative Mexican material. Locality uncertain: *Thurber 323.* Sonora: Santa Cruz Valley, *Thurber 695;* Magdalena, *Kennedy 7103.* Chihuahua: *Thurber 695;* 2 miles south of Cruces, *Johnston 7976.*

5. Lepidium sordidum Gray, Pl. Wright. 1: 10. 1852; C. L. Hitchc. *op. cit.* 286.

Densely granular-puberulent annual or biennial with short clavate or flattened hairs; all leaves divided to pinnate; silicles 1.5–2.2 mm. long, glabrous. Pl. 15, fig. 4.

Representative Mexican material. Locality uncertain: *Sessé* and *Mociño 3355.* Chihuahua: near Chihuahua, *Pringle 11, Le Sueur 646.* Coahuila: Jimulco, *Pringle* in 1885. Durango: Durango, *Palmer 136;* Tepehuanes, *Palmer 315.* Sinaloa: Mazatlan, *Rose et al. 13773.* Hidalgo: near Pachuca, *Rose et al. 8809.* Federal District: Mexico City, *Pringle 8488, Rose* and *Hay 5280.*

6. Lepidium nitidum Nutt. ex Torr. & Gray, Fl. N. Am. 1: 116. 1838; C. L. Hitchc. *op. cit.* 291.

Annual, pedicels very greatly flattened, 2 to 6 times as broad as thick; stamens 4 (2 or 6); silicles ovate to orbicular, 3–5 mm. long, margins usually upturned; styles lacking. Pl. 15, fig. 6.

Mexican material seen. Baja California: San Quentin Bay, *Palmer 621, 675;* 40 miles east of Rosario, *Wiggins 4464;* between San Telmo and main road toward San Quentin, *Wiggins 4275;* Ensenada, *Wiggins 4220;* 20 miles north of Ensenada, *Shreve 6811;* south end of Santa Maria plain, *Wiggins 7556.*

7. Lepidium Gerloffianum Vatke ex Thellung, Monog. Lepid. 259. 1906.

Annuals, or more probably, biennials, as much as 60 cm. tall, usually freely branched, the branches ascending, strigillose to hirsute, the hairs mostly 0.5–0.8 mm. long; basal leaves numerous (usually lacking in herbarium specimens), 5–12 cm. long, pinnate into 3–7 pairs of once- or twice-pinnatifid pinnae, long-petiolate, cauline leaves much smaller, mostly 1–3 cm. long, entire, toothed, or less commonly pinnatifid, 1–4 (6) mm. broad; racemes many, 3–10 cm. long, rather closely-flowered; pedicels nearly terete or very slightly flattened, mostly finely pubescent; sepals 1–1.5 mm. long; petals oblanceolate or spatulate, subequal to or longer than sepals; stamens 2; glands 4, *ca.* 0.2 mm. long, oval to lanceolate; silicles *ca.* 4 mm. long, ovate-oblong, not prominently veined, glabrous, or more commonly with few short marginal hairs on lower halves, very conspicuously wing-tipped to below the sinuses, wing-margined to below middle; sinuses narrow, *ca.* $\frac{1}{5}$ length of fruit; styles usually 0.1–0.3 mm. long; seeds *ca.* 1.6 mm. long; cotyledons incumbent. Pl. 16, fig. 17.

Material seen. Mexico: *Berlandier 317* (F, fragment; F and Kr., photo), Mt. Male, near Porvenir, *Matuda 4592,* with considerable doubt (NY); Morelia, Michoacan, *Arsène 6621.* Guatemala: Chichavec, Chimaltenango, *Skutch 131;* Dept. Quezaltenango, *Seler 3164;* near Miramundo, Jalapa, *Steyermark 32830;* Huehuetenango, *Seler 3070, Standley 65584, 81303.*

Lepidium Gerloffianum is most closely related to *L. Schaffneri,* from which it differs chiefly because of the larger fruits. However, as judged from determinations on herbarium labels, it has most frequently been mistaken for *L. virginicum,* from which it differs because of the larger, differently shaped, winged fruits.

8. Lepidium Schaffneri Thell. Monog. Lepid. 261. 1906. *L. monticola* Brandegee, Zoë 5: 232. 1907.

Annuals or biennials, 10–60 cm. tall, their pubescence and basal leaves as in *L. Gerloffianum,* the cauline leaves similar but smaller and entire or somewhat toothed; racemes very numerous, often in the axils of nearly all main leaves, mostly 1–3 (10) cm. long, many-flowered; pedicels subequal to fruits, terete or nearly so, short-pubescent; sepals mostly *ca.* 0.75 mm. long; petals from spatulate and larger than sepals to only linear vestiges $\frac{1}{3}$ their length; stamens 2; glands 4, 0.1–0.2 mm. long, lance-oblong; silicles mostly 3 mm. long or slightly less, ovate-elliptic or ovate-oblong to oblong-obovate, glabrous (rarely with few marginal hairs near base), the upper $\frac{1}{5}$–$\frac{1}{3}$ winged; sinuses $\frac{1}{8}$–$\frac{1}{5}$ length of fruit, narrow to open; styles lacking, seeds 1.25–1.5 mm. long; cotyledons incumbent. Pl. 15, figs. 8–13.

Mexican material seen. Locality uncertain: *Uhde 1052* (photograph, F, Kr); *Consul Woelflin* (NY). VERA CRUZ: *Seaton 284*. PUEBLA: *Pringle 10023, Kenoyer A394, Rose* and *Hay 6075, Purpus 1649,* from Popocatepetl (C, type of *L. monticola,* isotypes F, G, MBG, NY). FEDERAL DISTRICT: *Orcutt 3700, 3586, Pringle 7260, 7445, Rose* and *Hay 5307* (US), *Lyonnet 1256*. MEXICO: *Hinton 4236, 8328, Rose* and *Painter 6461, 6845, 7159, 7966, Kenoyer A391, Hitchcock* and *Stanford 7035, 7218, Schery 74, O. Kuntze 23732, Rose* and *Hay 5712*. HIDALGO: *Pringle 10023, 13461, Rose* and *Painter 6695*. SAN LUIS POTOSI: *Palmer 182*.

Lepidium Schaffneri is, in practically all respects, merely a small replica of *L. Gerloffianum;* however, the two species apparently do not intergrade, and it is felt that they both should be maintained. The two can most easily be distinguished from other species with which they show resemblance by their flowers. Even at the beginning of anthesis the ovary is nearly always distinctly cordate in shape, because of the winged tips.

Lepidium monticola was described from very mature, compact, rounded plants which can easily be matched in flower, fruit, and leaf character by many collections of *L. Schaffneri,* as is partially shown by figures 8 to 13 (pl. 15). In habit, however, an exact match for Brandegee's type has not been seen, although there are collections (*Rose* and *Hay 6845, Hinton 8328*) that include specimens enough like it that one is left with little doubt that *L. monticola* must fall to synonymy.

9. LEPIDIUM COSTARICENSE Thell. Bull. Herb. Boiss. II, 4: 713. 1904; Monog. Lepid. 251. 1906. *L. Humboldtii* Smith, Enum. Pl. Guat. 4: 6. 1895 (not *L. Humboldtii* DC.). *L. bipinnatifidum* Smith in Pittier Fl. Cost. II, 1: 19. 1898 (not of Desv.).

Annuals (or biennials?), 5–40 cm. tall, usually simple at base but much branched above, or branched from base, rather sparsely strigillose below, often more densely pubescent or strigillose above; leaves all divided or pinnatifid, the basal ones as much as 10 cm. long, mostly twice pinnatifid and again lobed or incised, the ultimate divisions mostly 1–2.5 (3) mm. broad, sparsely strigillose on lower sides, cauline leaves more reduced but mostly pinnatifid or deeply incised, occasionally merely with few teeth; racemes 4–10 cm. long, often scarcely exceeding leaves; pedicels subequal to fruits, slightly flattened and very slightly wing-margined, pubescent on upper surfaces, usually glabrous on lower surfaces, ascending to spreading, the racemes as much as 1.5 cm. in diameter; sepals 1–1.5 mm. long, sparsely pubescent on back, caducous; petals entirely lacking or if present only linear vestiges from $\frac{1}{3}$ as long to as long as sepals; stamens 2; glands 4, oblong-lanceolate, 0.1–0.2 mm. long; silicles (3.5) 4–4.4 (5) mm. long, broadly elliptic to obovate, margins usually glabrous but sometimes scabrous-ciliolate, the tips usually alate, the sinuses V-shaped, acute, $\frac{1}{6}$ ($\frac{1}{8}$–$\frac{1}{4}$) length of fruits; styles 0.1–0.2 mm. long, the stigmas nearly sessile; seeds 1.5–2 mm. long; cotyledons incumbent to oblique. Pl. 16, fig. 14.

North American material seen. COSTA RICA: *Polakowsky* (photo, F, Kr), *Standley 32323, 32653, 32833, 34526, 35323, 39029, 41293, 42761, Cooper 5707, Tonduz 437, 2129b, Valerio 199, Smith H143, O. Kuntze* in 1874, (NY), *Standley* and *Valerio 49629.* GUATEMALA: *von Tuerckheim 671.*

The type, collected in Costa Rica (*Hoffmann 139*), was at Berlin, so it is probably destroyed. No other specimen of this collection has been seen, but there can be little doubt concerning the identity of this group of plants. It can be told easily from all other North American species by the rather large, usually obovate wing-tipped silicles which have a very deep sinus. The much-divided leaves also help to distinguish it. Although the silicles of most plants are glabrous, occasionally a specimen is to be seen with ciliolate-margined fruits.

Material from Guatemala is uniform in having much shallower sinuses and less wing to the tip of the fruits. In the case of two of these collections (*Steyermark 34190, Standley 67712*), most leaves have dropped. The plants are very heavy rooted and might well be thought to be perennial. Nevertheless, I believe they are probably the same as the others from Guatemala, and should probably be catalogued as var. *Friedrichsthalii* as Thellung treated them.

9a. L. COSTARICENSE Thell. var. FRIEDRICHSTHALII Thell. Monog. Lepid. 252. 1906.

Plants annual, often with several stems from base, inflorescence more strigose than in the Costa Rican plants, the silicles less winged and with shallower sinuses. Pl. 16, fig. 16.

GUATEMALA: *Standley 61479, 67712, Steyermark 34190, 35932, Palm 61.*

The type collection (*Friedrichsthal 1199*) has not been seen but surely the description would indicate its similarity to the plants of the Steyermark collection (*34190*).

10. Lepidium ramosissimum Nelson, Bull. Torrey Bot. Club 26: 124. 1899; C. L. Hitchc. *op. cit.* 276.

Much branched annual or biennial to 5 dm. tall, finely pulverulent or pubescent; basal leaves at least pinnatifid, the cauline mostly linear and entire; racemes numerous, compounded, mostly only 1–3 cm. long; pedicels very slightly flattened, minutely wing-margined; petals minute or wanting; stamens 2; glands 4, *ca.* 0.1 mm. long; silicles elliptic or elliptic-ovate, mostly *ca.* 3 (2.5–3.5) mm. long, glabrous to sparsely pubescent, especially on margins, sinuses $\frac{1}{8}$–$\frac{1}{6}$ length of fruit; styles lacking.

Mexican material seen. Southwest Chihuahua, August to November, 1885, *Palmer* (US).

I am not sure of the identity of this plant, but believe it to be *L. ramosissimum,* rather than either *L. Schaffneri,* which it resembles in the compounded racemes (differing in lack of winged apices to silicles) or *L. ruderale* which it also resembles, but from which it seems to differ chiefly in the compounded racemes and slightly larger fruits. As pointed out before (Hitchc. *loc. cit.*), *L. ruderale* and *L. ramosissimum* are more than superficially alike.

11. Lepidium ruderale L. Sp. Pl. 645. 1753; C. L. Hitchc. *op. cit.* 275.

A foetid puberulent annual or biennial; sepals scarcely 1 mm. long, caducous; petals absent; stamens 2; glands 4, *ca.* 0.1 mm. long; silicles ovate-elliptic to ovate, 2–2.5 (3) mm. long, glabrous, sinuses $\frac{1}{8}$–$\frac{1}{6}$ length of fruit; styles lacking. Pl. 15, fig. 5.

Occasional as a weed in South America and United States; to be expected in Mexico.

12. Lepidium oblongum Small, Fl. Southeastern U. S. 468, 1331. 1903.

Annuals, usually branched from base, prostrate to ascending, as much as 3 dm. tall, hirtellous to villose-hirsute; leaves laciniate to pinnatifid or (the basal ones) bipinnatifid, the segments mostly 1–3 mm. broad; racemes many, 3–9 cm. long; pedicels subequal to silicles, more or less flattened, often twice as broad as thick, wing-margined, pubescent-strigillose on upper surfaces, glabrous (strigillose) on lower surfaces; sepals *ca.* 1 mm. long, pubescent on back, usually persistent until fruits are about half mature, or caducous with stamens; petals usually linear vestiges $\frac{1}{4}$–$\frac{1}{2}$ as long as sepals, or wanting; stamens 2; glands 4, oblong-lanceolate, *ca.* 0.2 mm. long; silicles rotund to oblong-elliptic or broadly elliptic, less commonly more nearly ovate or obovate, 2–3 (3.25) mm. long, very indistinctly veined, glabrous, or much more commonly, margined with few short stiff hairs, not winged, sinuses usually open, $\frac{1}{8}$–$\frac{1}{6}$ length of silicles; styles lacking; cotyledons incumbent. Pl. 16, fig. 15.

As mentioned previously (Hitchc. *op. cit.* 274), there has seemed to be good reason to suppose this species was an introduction from South America, but thorough study of South American material has failed to reveal the presence of these plants there. The lack of auriculate leaves, the presence of marginal hairs on the silicles, and the early shed of the sepals are sufficiently distinctive characters to exclude them from such species as *L. bipinnatifidum* and *L. auriculatum,* the two species they most closely resemble. They are, then, apparently native to and found only in North America.

Key to Varieties of Lepidium oblongum

Fruits rotund to obovate in shape; lower surfaces of pedicels often strigillose. 12b. var. *insulare*

Fruits more nearly elliptic or obovate-elliptic in shape; lower surfaces of pedicels glabrous .... 12a. var. *typicum*

12a. L. oblongum Small var. **typicum** nom. nov. *L. oblongum* Small, *loc. cit.;* C. L. Hitchc. *op. cit.* 273, in part; Thell. *op. cit.* 255. *L. reticulatum* Howell *apud* Thell. *op. cit.* 253, in part.

Silicles glabrous or pubescent on margins only, usually broadest at about center, thus more or less elliptic in shape, 2.5–3 mm. long.

Type. Sapulpa, Oklahoma, *Bush 1163.*

Representative material seen, in addition to that previously cited. United States: near Salina, Kansas, *Hancin 2097, 2259, 2260* (W); Musquiz Canyon, Brewster County, Texas, *Innes* and *Warnock 473.* The foregoing plants are glabrous-fruited, and possibly should be distinguished, in nomenclature, from the following, which have pubescent-margined silicles: Marfa, Presidio County, Texas, *Hinckley 959.* Mexico: Coahuila, Saltillo, *Gregg 270* mixed with *L. virginicum* var. *pubescens;* Nuevo Leon, *Palmer 43;* San Luis Potosi, *Schaffner 146, Parry* and *Palmer 21,* in part only (G); Mexico, *Rose* and *Painter 6525, 6791, 7016, Hinton 4979;* Hidalgo, *Fisher 35331, Pringle 7901, 9192, 11920, Rose* and *Painter 6707;* Puebla, *Arsène 2346, Purpus 3487;* Vera Cruz, *Seaton 475.* Guatemala: *Steyermark 32117, Standley 61713, Kellerman 4538.*

I have seen none of the material Thellung (*loc. cit.*) cited as *L. reticulatum* var. *Karwinskyanum,* but feel confident that it would be included here.

12b. L. oblongum Small var. **insulare** var. nov. *L. reticulatum* Howell *apud* Thell. *op. cit.* 253, in part. *L. oblongum* Small *apud* Hitchc. *op. cit.* 273, in part.

Siliculis 2–2.5 mm. longis, rotundibus vel ovatis, marginibus ciliatis; pedicellis saepe strigillosis.

Silicles mostly 2–2.5 mm. long, rotund to obovate in outline, margins pubescent; pedicels often strigillose on lower surfaces. Pl. 16, fig. 15.

Type. Guadalupe Island, Baja California, 1875, *Palmer 7* (NY; isotypes, MBG, G).

Material seen. Baja California, Mexico: Guadalupe Island, *Palmer 897, Rose 16006, Drent,* mixed with *L. lasiocarpum* (C), *Greene* in 1885 (C, S in part), *Brown 65;* San Benito Island, *Anthony 275, Pond 2, Rose 16058, 16077, Brandegee* in 1897; Cedros Island, *Palmer 709, Rose 16127;* Natividad Island, *Brandegee* in 1897. United States: Santa Cruz Island, California, *Brandegee* in April and June, 1888; Del Mar, California, *Brandegee* in 1894.

Most material from the mainland of California and of Lower California has larger silicles than do the insular plants, and is otherwise somewhat intermediate in character with the typical variety (pl. 16, fig. 15b); besides material of such a nature cited previously, the following Mexican collections can be included. Sonora: 34 miles southwest of Sasabe, *Keck 3990.* Baja California: Ensenada, *Wiggins 4221;* 23.5 miles south of Hamilton Ranch, *Wiggins 4299* (G, S in part, US).

Although this variety of the species, especially, approaches *L. lasiocarpum* in nature, in nearly all cases it can be recognized by the more divided leaves, smaller pubescent-margined fruits, and less flattened, more wing-margined pedicels. That the two plants are sufficiently distinct to merit their maintenance as separate species, there seems little doubt.

13. Lepidium virginicum L. Sp. Pl. 645. 1753.

Annuals, winter annuals or biennials, to 6 (7) dm. tall, rather freely branched, especially above, the branches sparsely pubescent to densely strigillose or hirsute; basal leaves (usually lacking in fruiting specimens) mostly 5–15 cm. long, 1–5 cm. broad, usually pinnatifid into several remote pairs of lobed to incised pinnae, sparsely to densely pubescent or hirsute, cauline leaves smaller, pinnatifid, or more commonly somewhat lobed, toothed, or serrate; racemes numerous, 3–20 (25) cm. long; pedicels slender, (1) $1\frac{1}{2}$ to 3 times as long as fruits, spreading, terete or more or less flattened, sometimes as much as twice as broad as thick, very finely pubescent to hirsutulous, usually glabrous on lower surfaces, sometimes pedicels and rest of inflorescence entirely glabrous; sepals *ca.* 1 mm. long, glabrous or sparsely hairy on back, caducous, or rarely persistent until fruits considerably enlarged; petals usually more or less spatulate, mostly 1 to 3 times as long as sepals, less commonly linear and shorter than sepals, rarely wanting; stamens 2 (4 or 6 very rarely); glands 4, scarcely 0.1 (0.2) mm. long, somewhat broader; silicles 2.5–4 mm. long, elliptic-rotund or semi-orbicular to broadly ovate-elliptic, the lower half usually at least as broad as the upper half, indistinctly veined, very slightly winged, glabrous or very rarely with some pubescence, sinuses scarcely $\frac{1}{10}$ length of fruits, open; styles barely evident, *ca.* 0.1 mm. long; seeds *ca.* 1.5 mm. long; cotyledons accumbent or oblique to incumbent. Pl. 16, figs. 19–21.

Lepidium virginicum is fairly easily distinguished from most other species, especially in Mexico and in South America, where *L. densiflorum* apparently does not occur. It would be more consistent with my present views, perhaps, to recognize some of the following entities as subspecies rather than varieties, but varietal categories are being used since this procedure requires less nomenclatural reshuffling.

Key to Varieties of Lepidium virginicum

1. Pedicels terete or nearly so, very sparsely short-pubescent, cotyledons accumbent .... 13a. var. *typicum*
1a. Pedicels somewhat flattened, glabrous or rather copiously pubescent, cotyledons oblique to incumbent .... (2)
2. Inflorescence and upper part of stem glabrous (not found in Mexico). var. *medium*
2a. Inflorescence and upper portion of stem pubescent .... (3)
3. Cauline leaves parted or lobed into narrow segments 1–2 mm. broad, plants mostly only 1–2 dm. tall .... 13e. var. *Robinsonii*
3a. Cauline leaves various, but if divided the segments usually over 2 mm. broad, or plants mostly over 2 dm. tall .... (4)
4. Basal leaves rather thick, fleshy, forming very heavy rosettes of 20–80 leaves, pubescence dense, crisped; plants usually with several stems (not in Mexican flora) .... var. *Menziesii*
4a. Basal leaves not thick and fleshy, rosettes, if any, mostly with no more than 30 leaves; pubescence variable, but usually not markedly crisped; plants mostly single-stemmed .... (5)
5. Silicles more nearly oval-elliptic than oval or rotund; petals usually mere vestiges or wanting; pedicels distinctly flattened and very narrowly wing-margined .... 13b. var. *centrali-americanum*
5a. Silicles usually oval to rotund, petals usually nearly or quite as long as sepals, pedicels slightly flattened to terete .... (6)
6. Plant grayish pubescent with short stiff hairs, the stems almost powdery with hairs 2–3 (5) times as long as thick; fruits less than 3 (mostly *ca.* 2.5) mm. long .... 13c. var. *durangense*
6a. Plant not cinereous as above, the hairs of stems usually over 3 times as long as thick; fruits usually over 2.75 mm. long .... (7)
7. Cauline leaves narrowly lobed to parted; plants 1–2 dm. tall. 13e. var. *Robinsonii*
7a. Cauline leaves mostly simple, entire to incised; plants mostly 3–6 dm. tall .... (8)
8. Stamens usually 2; silicles oval or nearly so, margins usually not ciliate. 13d. var. *pubescens*
8a. Stamens 6; silicles pyriform, the apices winged, margins usually ciliate. 13f. var. *tepicense*

13a. L. virginicum L. var. typicum C. L. Hitchc. *op. cit.* 282.

Characterized by the sparse, short pubescence, terete pedicels, and accumbent cotyledons. Pl. 16, fig. 20.

Representative material from the West Indian Islands. Cuba: *Wright 2494, Shafer 151, 1130, 1451, 1815, 4357.* Jamaica: *Harris 6914, Orcutt 3245, Maxon 971.* Haiti: *Leonard 3633, 7985, 8166.* Dominican Republic: *Abbott 658, Valeur 137, Rose et al. 4218.* Puerto Rico: *Britton* and *Shafer 2143, Shafer 2443, Urban 6678.* St. Croix: *Ricksecker 312, 357.*

The following Mexican collections are more or less intermediate with var. *pubescens* but are more properly placed under var. *typicum,* since they have accumbent cotyledons. SINALOA: San Ignacio, *Ortega 310;* Elota, *Ortega 5441;* Culiacan, *Rose et al. 14862;* Villa Union, *Rose et al. 13943.* NAYARIT: Tepic, *Palmer 2029, Rose et al. 14401.* TAMAULIPAS: San Jose, *Le Sueur 156,* plant glabrous except for few hairs on leaves, yet cotyledons accumbent. MICHOACAN: Coalcoman, *Hinton 12978.*

Good reason can be advanced for the maintenance of the typical phase of the plant as a species, or at the very least a subspecies, distinct from its more western relatives in North America. In general it can be recognized very easily by its terete pedicels. However, since much of the material from Tepic and vicinity is intermediate in character with the variety *pubescens,* the species is being treated as one large complex.

13b. L. VIRGINICUM L. var. **centrali-americanum** (Thell.) comb. nov. *L. virginicum* subsp. *centrali-americanum* Thell. *op. cit.* 231.

Plants 2–6 dm. tall; pedicels not quite twice as broad as thick, glabrous on lower surfaces, narrowly wing-margined, scarcely if at all longer than silicles; petals linear and no longer than fruits to mere vestiges or lacking entirely; silicles mostly conspicuously longer than broad and tending to be elliptic in outline.

Representative material. ISLAND OF COZUMEL: *Millspaugh 1567.* YUCATAN: *Gaumer 456, 1776, 1777, 24001, 24205, Lundell 820, Seler 3954, Valdez 14.* BRITISH HONDURAS: *Lundell 358, 4741, Bartlett 12913.* GUATEMALA: *Bartlett 12687, von Tuerckheim 671, 1676, 11653, Standley 61373, 66422, 69831, 77823, 83252.* EL SALVADOR: *Renson 155, Standley 22827, Calderon 452,* intermediate with var. *pubescens.* COSTA RICA: *Orozco 91, Solis 343.* NICARAGUA: *Artemio 76, Maxon et al. 7390* (US), *Chaves 318.*

The following collections are placed here only because of their small petals, otherwise they are more similar to var. *pubescens.* EL SALVADOR: *Standley 19640, 21156, 22694.* MEXICO: Morelia, *Arsène 3346.*

If varieties *medium* and *pubescens* were separated from *L. virginicum* var. *typicum* as distinct species, then this entity would need to be included under *L. medium* unless it, too, were recognized as a distinct species. It intergrades with var. *pubescens,* however, and in some localities, especially in Guatemala, the apparent hybrids between the two are more numerous than either of the

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EXPLANATION OF THE FIGURES. PLATE 15.

PLATE 15. FLOWERS AND FRUITS OF LEPIDIUM. Fig. 1, *L. montanum* var. *alyssoides.* Fig. 2, *L. sativum.* Fig. 3, *L. Thurberi.* Fig. 4, *L. sordidum.* Fig. 5, *L. ruderale.* Fig. 6, *L. nitidum.* Fig. 7, *L. latifolium.* Figs. 8–13, *L. Schaffneri:* fig. 8, from *Hitchcock* and *Stanford 7035;* fig. 9, *Hinton 8328;* fig. 10, *Consul Woelflin;* fig. 11, *Rose* and *Painter 6845;* fig. 12, from type of *L. monticola, Purpus 1649;* fig. 13, *Fischer, July 25, 1924.* All figures $\times 6\frac{2}{3}$. In nearly all cases fig. *a* represents a mature silicle, fig. *b,* a flower at late anthesis.

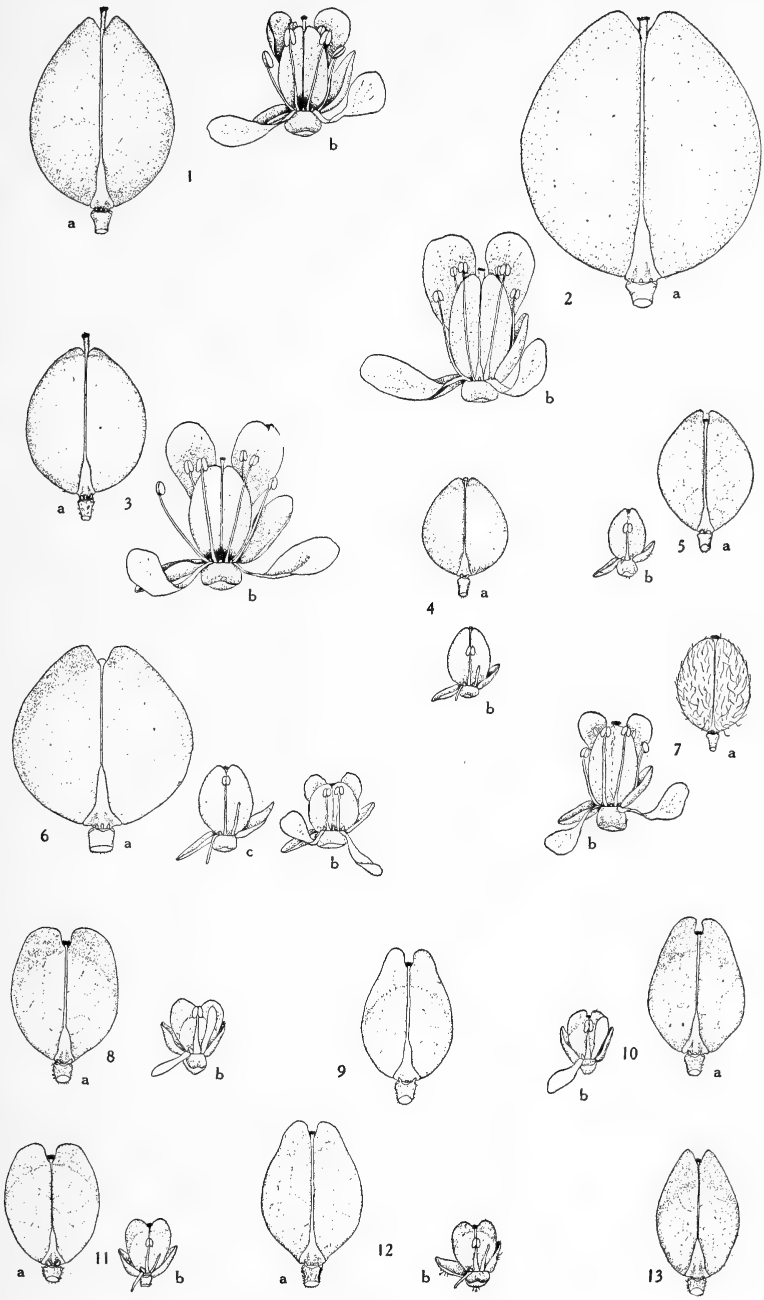

PLATE 15. FLOWERS AND FRUITS OF LEPIDIUM.

two varieties. Examples of such intermediate forms are: GUATEMALA: *von Tuerckheim 8375, Muenscher 12514, Steyermark 35053, Standley 62828, Johnston 240, Kellerman 6732.*

Since these three collections are practically apetalous, they appear to belong here, but more properly belong with var. *pubescens.* MEXICO: El Rosario, D. F., *MacDaniels 644;* La Cruz, Sinaloa, *Ortéga 5441;* Cordoba, Vera Cruz, *Orcutt 3133.*

The following plants, chiefly from the region of Tampico, Mexico, are puzzling. In most particulars they resemble *L. virginicum* var. *centrali-americanum,* yet the fruits are rounded more like those of var. *pubescens.* Since they have flattened pedicels and vestigial petals, they are also suggestive of *L. lasiocarpum* var. *orbiculare.* They serve to illustrate, further, the complete transition between *L. lasiocarpum* and *L. virginicum* as the latter is represented by vars. *pubescens* and *centrali-americanum.* MEXICO: Vera Cruz, *Orcutt 2864, 3133;* Orizaba, *Batteri 309;* Tampico, *Palmer 76.*

13c. L. VIRGINICUM L. var. **durangense** var. nov. Planta plus minusve incana; pilis cauliorum brevissibus, 0.1–0.2 mm. longis; foliis caulinis 1–3 (5) mm. latis; sepalis petalisque *ca.* 0.5 mm. longis; siliculis *ca.* 2.5 mm. longis.

Plants grayish with dense pubescence, the pubescence of stems and inflorescence very short (0.1–0.2 mm. long) and thick; cauline leaves mostly 1–3 (5) mm. broad; sepals and petals *ca.* 0.5 mm. long; silicles mostly *ca.* 2.5 mm. long.

Type. Tepehuanes, Durango, Mexico, June 4 to 25, 1906, *Ed. Palmer 320* (G; isotypes, C, F, MBG, NY, US).

Other material seen. DURANGO: Durango, *Palmer 167* (C, F, G, MBG, NY); Tepehuanes, *Palmer 321* (G, NY, US); Otinapa, *Palmer 413* (C, F, G, NY, US), *414* (F, G, MBG, NY, US).

The variety is well marked and easily recognized, but is approached in character by the following Mexican collections, all of which should more properly be placed in *L. virginicum* var. *pubescens.* COAHUILA: Saltillo, *Palmer 196.* DURANGO: *Palmer 19;* San Ramón, *Palmer 56.*

13d. L. VIRGINICUM var. PUBESCENS (Greene) C. L. Hitchc. *op. cit.* 283. *L. lasiocarpum* Nutt. var. *tenuipes* Watson, Proc. Am. Acad. 17: 322. 1882 (*nomen dubium*).

Plants usually 2–7 dm. tall, the cauline leaves 1–20 mm. broad, usually sparsely hairy; pedicels flattened to nearly terete, but less slender than in var. *typicum;* sepals *ca.* 1 mm. long; petals usually present, mostly subequal to, or longer than sepals; silicles (2.5) 3–4 mm. long, oval to nearly rotund. Pl. 16, fig. 21.

Representative material. MEXICO: Baja California, La Encantada, *Wiggins* and *Demaree 4876, 4924, Brandegee* in 1893; Chihuahua, near Chihuahua, *Palmer 34;* Coahuila, Parras, *Palmer 41,* type collection of *L. lasiocarpum* var. *tenuipes* (US, 2 sheets), Saltillo, *Gregg 261;* Tamaulipas, Victoria, *Palmer 560;* Sinaloa, Puerto a Tamiapa, *Gentry 5847;* Zacatecas, near Plateado, *Rose 2779;* San Luis Potosi, *Schaffner 553, 145, Palmer 606, Parry* and *Palmer 21* in part, *22, 23;* Vera Cruz, Cordoba, *Orcutt 3133;* Orizaba, Boca del Monte, *Nelson 205,* in part; Hidalgo, near El Salta, *Rose* and *Painter 7092;* Guanajuato, *Dugès 164a, 164b;* Michoacan, 4 miles west of Hidalgo, *Hitchcock* and *Stanford 7187;* Federal District, Mexico City, *Pringle 8284;* Mexico, Toluca, *Frye* and *Frye 2620,* Rio Hondo Canyon, *Pringle 7724;* Puebla, Tehuacan, *Rose* and *Hay 5921,* intermediate to *L. lasiocarpum;* Oaxaca, Valle de Oaxaca, *Conzatti 1734* (US). GUATEMALA: Dept. Huehuetenango, *Seler 3070, Standley 65736, 65763.* COSTA RICA: *Standley 33404.* EL SALVADOR: *Standley 19640, 21156.*

This is by far the largest of the varieties of *L. virginicum* except for the var. *typicum* and it is surely the most variable of the different phases, exhibiting all the tendencies which characterize the other varieties and almost without exception, merging with them.

Although the pedicels are usually slightly flattened, many plants, especially those from Chihuahua, Mexico, have pedicels that are terete and scarcely any thicker than those of var. *typicum.* In such cases, the presence of incumbent cotyledons indicates that the specimens belong here. A few such examples follow. MEXICO: Chihuahua and vicinity, *Le Sueur 1327, Palmer 34, White 2371;* El Cima, *Le Sueur 641;* base of Sierra Madre, *Pringle 1528;* Guerrero, *Mexia 2536;* Tepic, *Rose 2125, Palmer 2029;* Guadalajara, Jalisco, *Abrams 12892.* GUATEMALA: *Heyde 569.* On the other hand, a few specimens have pedicels as greatly flattened as those of some plants of *L. lasiocarpum.* Such individuals could with equal reason be considered to be either *L. virginicum* or glabrous-fruited specimens of *L. lasiocarpum.* That they are hybrids seems not unlikely.

Watson's *L. lasiocarpum* var. *tenuipes* included plants of the nature mentioned above. Most of the material Watson cited (e.g., *Schaffner 145, Parry* and *Palmer 21, 22*) actually belongs here, and most of the type collection, and probably the type itself, must be included also. Watson pointed out the intergradation between var. *tenuipes* and *lasiocarpum* proper, citing *Palmer 38* and *42* and *Berlandier 2488* as such examples. These latter specimens are being assigned to *L. lasiocarpum* by the writer, under the var. *orbiculare.*

In nearly all instances, the fruits of *virginicum* are glabrous. An occasional plant with hairy fruits is to be found as is shown by such sporadic collections as: 15 miles north-northwest of Rosarito, Baja California, *Wiggins 10,005A* (S); Luna, Catron County, New Mexico, *Hitchcock et al. 4479* (W), and Charleston Mountains, Nevada, *Clokey 8367* (W).

A collection from Saltillo, Mexico (*Palmer 196,* G, US), is abnormal and perhaps diseased; the pedicels of the plants are greatly flattened and bear minute bracteoles lateral to their winged margins.

A collection from 15 km. west of Concepcion del Oro, Coahuila, Mexico, (*Stanford et al. 256*) is possibly significant enough to merit nomenclatural status. The plants have small fruits, like those of var. *durangense,* but lack the pubescence of that variety. They are apetalous and have linear glands *ca.* 0.4 mm. long, or nearly twice as long as those of any other specimen of *L. virginicum* seen.

13e. L. virginicum var. Robinsonii (Thell.) C. L. Hitchc. *op. cit.* 285.

Plants usually less than 2 dm. tall; cauline leaves mostly divided into various segments.

Mexican material seen. Baja California: Vallecitos, April 5, 1886, *Orcutt* (F, MBG, NY). This peculiar phase of the species is more commonly found in southern California. Whether or not it is other than a depauperate form of var. *pubescens* that occasionally appears I cannot be sure.

13f. L. virginicum L. var. **tepicense** var. nov. Planta pulverulento-pubescenta; pedicellis aliquid compressis; petalis spathulatis, sepaliorum longitudinis aequalibus vel longioribus; staminibus 2; glandulis 0.1–0.2 mm. longis; siliculis 3–4 mm. longis, pyriformis, alatis, marginibus sparse breve ciliatis; cotyledonibus obliquis vel incumbentibus.

Plant finely puberulent-pubescent; pedicels flattened slightly, finely pubescent; petals spatulate, slightly longer than sepals; stamens 6; glands 0.1–0.2 mm. long; silicles 3–4 mm. long, pyriform in outline, apices winged, margins sparsely short ciliate; cotyledons oblique to incumbent. Pl. 16, fig. 19.

Type. Tepic, Nayarit, Mexico, February 16, 1927, *Jones 22840* (C; isotype, F).

Because of the peculiarly shaped, ciliolate fruit, and presence of six stamens, this plant might be thought to merit specific status. There is enough similarity to var. *pubescens,* however, to convince me it merits no more than varietal status.

14. Lepidium lasiocarpum Nutt. ex Torr. & Gray, Fl. N. Am. 1: 115. 1838.

Annual, prostrate to erect and frequently as much as 30 cm. tall, usually branched from base, but sometimes branched above only, strigillose to densely hirsutulose-hispidulose, the hairs 0.2–1.2 mm. long; basal leaves 2–15 cm. long, mostly lyrately pinnatifid to bipinnatifid, the ultimate divisions 1–15 mm. broad, cauline leaves similar but sometimes subentire, as much as 15 mm. broad; racemes 2–15 cm. long; pedicels from subequal to fruits to twice as long, from moderately to greatly flattened (2 to 5 times as broad as thick), usually pubescent on both surfaces, or glabrous on lower surfaces; sepals 1–1.5 mm. long, usually pubescent to hirsutulous on back; petals usually linear vestiges less than half as long as sepals, occasionally as long as sepals, not uncommonly lacking entirely; stamens 2 (4 or 6); glands 4 (6), 0.1–0.2 (0.5) mm. long, lanceolate; silicles (2.5) 3–3.5 (4) mm. long, from oval to oblong-elliptic or oblong-obovate, usually hispidulous on both surfaces but not uncommonly hispidulous on margins only, infrequently glabrous, sinuses ($\frac{1}{10}$) $\frac{1}{8}$–$\frac{1}{6}$ ($\frac{1}{5}$) length of fruit, narrow to open, the apices of fruits usually winged; styles lacking; cotyledons incumbent. Pl. 16, figs. 22–23.

In general, *L. lasiocarpum* can be recognized from our other species because of the pubescent fruits, stiff pubescence, and flattened pedicels. However, the species is apparently in an extremely unstable condition, and great variation is to be found in every attribute which has been thought to characterize it. Especially is this true in Mexico where it simulates or actually merges with such apparently different species as *virginicum* (var. *pubescens*), *densiflorum, dictyotum,* and *oblongum,* the evidence indicating that this is due in part, at least, to hybridization. The following key represents an attempt to separate a few of the more conspicuous variations which are known to occur in Mexico, even though complete transition appears to exist between all the groups considered.

Key to Varieties of Lepidium lasiocarpum

1\. Hairs more or less pustular-based, stiff; plants grayish-hispidulous; pedicels at least 3 times as broad as thick; glands 0.2–0.5 mm. long. 14f. var. *Wrightii*

1a. Hairs not pustular-based; if plants grayish pubescent, pedicels usually not 3 times as broad as thick; glands usually not over 0.2 mm. long .... (2)

2\. Pedicels 3 to 5 times as broad as thick; leaves pinnatisect into divisions 1–2 (3) mm. broad .... 14g. var. *Palmeri*

2a. Pedicels less than 3 times as broad as thick, or leaves not pinnatisect as above .... (3)

3\. Lower surfaces of pedicels usually glabrous, mostly at least twice as broad as thick, plants usually branched from base, the hairs of stems mostly not over 0.5 mm. long .... (4)

3a. Lower surfaces of pedicels usually pubescent, or not twice as broad as thick, or plants simple at base, or hairs of stems over 0.5 mm. long .... (5)

4\. Cauline leaves, in part, 5–20 mm. broad, lobed or toothed; racemes 5–20 cm. long, loosely flowered .... 14c. var. *latifolium*

4a. Cauline leaves chiefly less than 5 mm. broad, if broader, usually pinnatisect; racemes mostly less than 10 cm. long .... 14b. var. *georginum*

5\. Plants prostrate, less than 5 cm. tall; leaves pinnatisect into divisions usually less than 2 mm. broad; racemes 1–5 cm. long, densely crowded with fruits, silicles less than 3 mm. long .... 14d. var. *rosulatum*

5a. Plants usually more erect; leaves usually with divisions over 2 mm. broad; racemes to 12 cm. in length; silicles as much as 4 mm. long .... (6)

6\. Pedicels scarcely twice as broad as thick, usually glabrous on lower surfaces; plants mostly simple below .... 14e. var. *orbiculare*

6a. Pedicels usually at least twice as broad as thick, mostly pubescent on lower surfaces; plants commonly prostrate or branched from base. 14a. var. *typicum*

14a. L. LASIOCARPUM var. TYPICUM C. L. Hitchc. *op. cit.* 289, exclusive of *L. Palmeri* and *L. lasiocarpum* subsp. *Palmeri.*

Plants pubescent to hispidulous, the hairs not pustular-based; leaves various, but usually with ultimate divisions less than 5 mm. broad; pedicels usually much flattened and pubescent on both surfaces; silicles mostly over 3 mm. long.

Representative Mexican material. COAHUILA: Saltillo, *Palmer 196½,* approaching var. *orbiculare, Gregg 364.* SINALOA: Mazatlan, *Rose et al. 13866.* SONORA: 23.6 miles southwest of Sonoyta, *Wiggins 8347A;* San Bernardo, *Gentry 1363;* near Alamos; *Rose et al. 12952.* BAJA CALIFORNIA: Santa Aqueda, *Palmer 234,* intermediate with var. *latifolium* (G).

Although the type of the species was collected in coastal California, plants similar enough to the type to be inseparable from it occur as far east as Colorado and to the south as far as Sonora and Baja California. The several entities here recognized as varieties intergrade with the typical variety.

As an illustration of the intergradation between *L. lasiocarpum* and *L. virginicum* var. *pubescens,* a collection from Tehuacan, Puebla (*Rose* and *Hay 5921,* NY, US), will suffice. These plants could be placed in either of the two species by pubescence, leaf size and shape, and habit, although they are perhaps more like *L. virginicum* than *L. lasiocarpum.* The pedicels are flattened more than usual for *L. virginicum* var. *pubescens.* The fruits are the ovate fruits of *L. virginicum,* but have a few marginal hairs, a *lasiocarpum*-character, as is the lack of petals. Since the collection would be out of range for *L. lasiocarpum,* I am calling it *L. virginicum* var. *pubescens.*

14b. L. LASIOCARPUM var. GEORGINUM (Rydberg) C. L. Hitchc. *op. cit.* 291.

Plants scarcely hispid, the pubescence shorter and softer than in var. *typicum,* sometimes whole plant subglabrous; cauline leaves entire to toothed, usually less than 5 mm. broad; pedicels glabrous on lower surfaces at least; silicles mostly 3–3.5 mm. long, usually glabrous on lower surfaces but hairy on upper, or with marginal hairs only, or entirely glabrous. Pl. 16, fig. 22.

Representative material. MEXICO: 7 miles northeast of Cajeme, Sonora, *Wiggins 6381;* 3 miles south of Los Bolinas, Sonora,

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EXPLANATION OF THE FIGURES. PLATE 16.

PLATE 16. FLOWERS AND FRUITS OF LEPIDIUM. Fig. 14, *L. costaricense.* Fig. 15, *L. oblongum: a* var. *typicum, b* intermediate *typicum-insulare, c* and *d* var. *insulare.* Fig. 16, *L. costaricense* var. *Friedrichsthalii.* Fig. 17, *L. Gerloffianum.* Fig. 18, *L. pinnatisectum.* Fig. 19, *L. virginicum* var. *tepicense.* Fig. 20, *L. virginicum* var. *typicum.* Fig. 21, *L. virginicum* var. *pubescens.* Fig. 22, *L. lasiocarpum* var. *georginum.* Fig. 23, *L. lasiocarpum* var. *orbiculare.* Fig. 24, *L. filicaule.* All figures × 6⅔. In nearly all cases fig. *a* represents a mature silicle, fig. *b,* a flower at late anthesis.

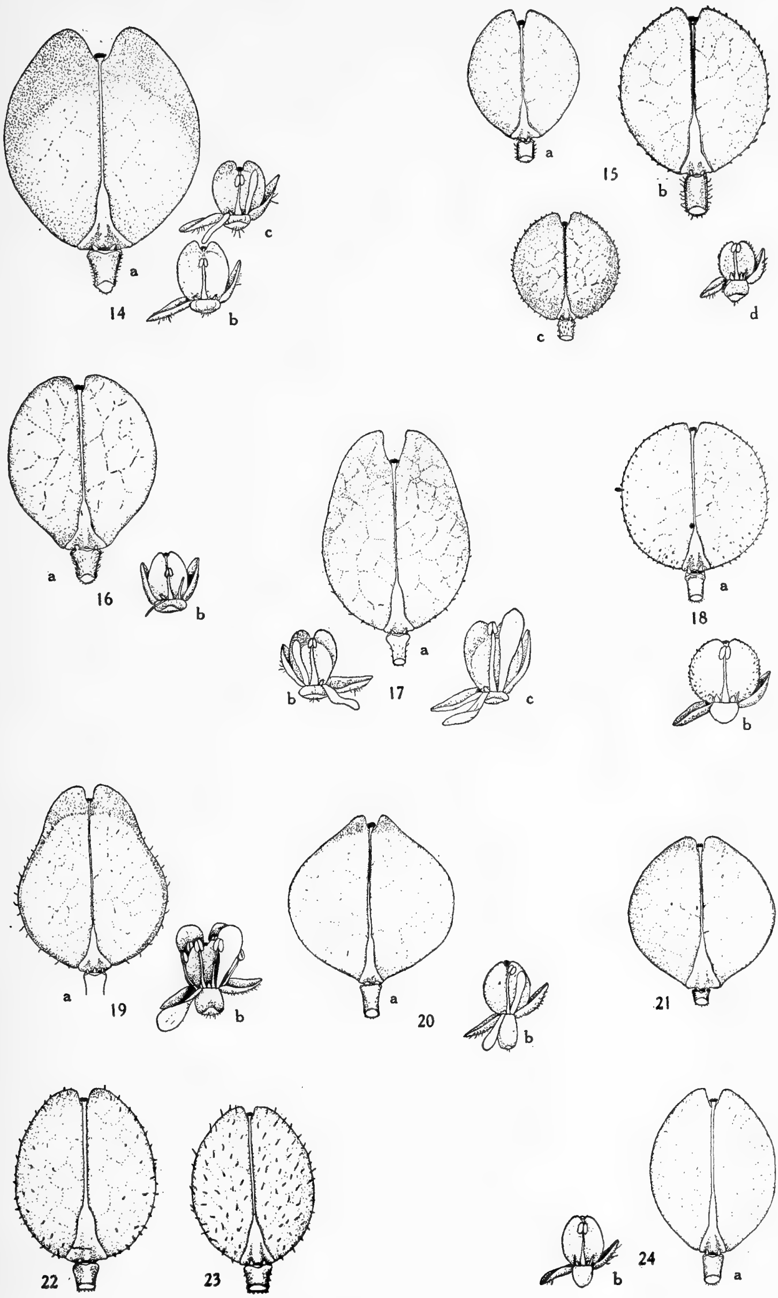

Plate 16. Flowers and Fruits of Lepidium.

Keck 3990. United States: *Hitchcock 2996, 3048, Clokey 7937, 7938, Yates 6426,* the latter from Riverside County, California. Material intermediate to var. *typicum:* 10 miles northwest of Kingston, Riverside County, California, *Hitchcock 6156* (W); Ensenada, Baja California, *Purer 7174* (MBG).

This weakly pubescent form of the species was described from a plant collected in Utah, but is to be found south of the border in Baja California as well as in Sonora. It is an ill-marked variant that simulates the variety *orbiculare* (including *austrinum* and "*tenuipes*") and merges with the equally glabrate but broader leaved var. *latifolium* of Lower California. Occasional plants (e.g., *Wiggins 6381, Yates 6426*) have glabrous fruits. Such specimens might easily be mistaken for *L. virginicum* var. *pubescens.* If the young ovaries are examined, however, tiny hairs can be detected, thus substantiating their inclusion under *L. lasiocarpum.* They would key out to var. *georginum,* but it is felt that they are more or less depauperate and that they more properly belong with var. *latifolium.* The following specimens are representative: 24.3 miles south of Rosario, Baja California, *Wiggins 5281;* Cucopa Mountains, Baja California, *MacDougal 201;* Natividad Island, *Brandegee* in 1897 (C).

14c. L. lasiocarpum var. **latifolium** var. nov. Planta sparse pubescente, pilis rare plusquam 0.5 mm. longis; foliis caulinis saepe leviter lobatis, 5–20 mm. latis; racemis saepe 10–20 cm. longis; pedicellis patentibus, compressissimis, ca. 3-plo latioribus quam crassioribus, pubescentibus, vel superficie inferiore glabra, 1–2 longitudinis siliculorum; siliculis ca. 3.5 mm. longis, superficiis inferioribus et superioribus pubescentibus vel glabris sed marginibus pubescentibus.

Plants sparsely pubescent, the hairs seldom over 0.5 mm. long; cauline leaves usually shallowly lobed, 5–20 mm. broad; racemes mostly 10–20 cm. long, loosely-flowered; pedicels spreading, mostly about 3 times as broad as thick, pubescent, or glabrous on lower surfaces, as much as twice as long as silicles; fruits *ca.* 3.5 mm. long, pubescent on both surfaces or on margins only.

Type. Todos Santos, Baja California, Mexico, February 11, 1929, *M. E. Jones 24097* (MBG no. 969259; isotypes, C, F, MBG, NY).

Other material seen. Baja California: near Calmalli, *Haines* and *Stewart* in 1935, *Shreve 6966, Wiggins 7773;* Mulege, *Johnston 3700;* Santa Agueda, *Palmer 234;* 22 miles south of Pozo Aleman, *Wiggins 7854;* 7 miles south of Sasabe, *Wiggins 8186;* San Gregorio, *Brandegee* in 1889 (C); Laguna Maguata, *Epling et al.* in 1933; 23.5 miles south of Hamilton Ranch, *Wiggins 4299* (C, NY, S in part, but not G or US); 3½ miles north of Punta Prieta, *Wiggins 7634;* Pescadero, *Brandegee* in 1893; Guadalupe Island, *Palmer*

8, 841, 851, Howell 8275, Brandegee in 1897, *Mason 1516;* Clarion Island, *Anthony 405;* Magdalena Island, *Brandegee* in 1889.

These plants can be recognized by their habit and broad leaves although they are approached in leaf character by some specimens such as: Death Valley, Inyo County, California, *Hitchcock 6192* (W), a plant that more properly belongs under var. *georginum,* and by the following collections all of which must be considered intermediate to var. *typicum:* southern Utah, *Hitchcock 2996* (G), *Jones* in 1880 (NY); 10 miles west of Wenden, Arizona, *Wiggins 8472* (S); Alamos, Sonora, Mexico, *Rose et al. 12952* (NY), San Bernardo, Sonora, Mexico, *Gentry 1363* (F).

A few collections seen have pinnatifid cauline leaves, and suggest *L. oblongum* var. *insulare.* Plants of such a nature include: 3½ miles north of Punta Prieta, *Wiggins 7632,* and Santa Catarina Landing, *Wiggins 4431.* Of the two, the latter is more truly like *L. lasiocarpum,* the former more like *L. oblongum.* Such intermediates are believed to be hybrid in origin.

14d. L. LASIOCARPUM var. **rosulatum** var. nov. Planta prostrata, strigillosa vel hirsutulosa; caulibus 3–10 cm. longis; foliis 1–2 cm. longis, divisis vel 1–2-plo pinnatifidis, pinnulis 1–2 mm. latis; racemis multis, 1–5 cm. longis, multifloris; pedicellis siliculis subaequilongis, leviter compressis, ca. 2-plo latioribus quam crassioribus, superficie inferiore saepe glabra; siliculis 2–3 mm. longis, saepe oblongo-obovatis, hirsutulosis, marginibus pubescentibus.

Plants prostrate, the branches scarcely 10 cm. long, whole plant strigillose to hirsutulose; leaves scarcely over 2 cm. long, all divided or once or twice pinnatifid into narrow divisions scarcely 2 mm. wide; racemes many, 1–5 cm. long, very densely congested, nearly hiding the leaves, pedicels about equal to silicles, flattened slightly, about twice as broad as thick, usually glabrous on lower surfaces; silicles scarcely 3 mm. long, mostly oblong-obovate, from hirsutulous to pubescent-margined or entirely glabrous, scarcely winged, sinuses *ca.* ⅛ length of silicles, U-shaped.

Type. Rocky hillside 20 miles south of Nogales, Sonora, Mexico, April 5, 1939, *T. C.* and *E. M. Frye 2265* (W no. 65660; isotypes, G, NY, S).

Other material seen. MEXICO: 25 miles south of Nogales, Sonora, *Abrams 13138* (S); 3 miles west of Petiquito, Sonora, *Wiggins 8227* (S, US); 9 miles from Imuris in canyon of Magdalena River, *Ferris 8797* (S). The following two collections, both from Arizona, are intermediate in character between vars. *rosulatum* and *typicum:* 6 miles west of Mohawk, Yuma County, *Wiggins 8649* (US); Santa Rita Mountains, *Nelson* and *Nelson 1381* (G).

The variety *rosulatum* is characterized by the small fruits, densely crowded racemes, slightly flattened pedicels, and small pinnatifid leaves. It is somewhat suggestive of var. *orbiculare*, but differs because of the crowded racemes and small compound leaves. There is considerable variation in the amount of pubescence on the silicles, some collections, such as *Wiggins 8227*, include plants with silicles from hirsutulous all over to pubescent on the margins only.

The varietal name is taken from a sheet distributed by Dr. and Mrs. Aven Nelson, which was annotated as a new form.

14e. L. LASIOCARPUM var. **orbiculare** (Thell.) comb. nov. *L. austrinum* Small, Fl. Southeastern U. S. 468, 1331. 1903; Thellung, *op. cit.* 239; Hitchcock, *op. cit.* 287. *L. austrinum* var. *orbiculare* Thell. *op. cit.* 240. *L. austrinum* var. *conspicuiflorum* Thell. Fedde Rep. Sp. Nov. 11: 309. 1912 (with some doubt). *L. lasiocarpum* var. *tenuipes* of authors, but not of Wats. Proc. Am. Acad. 17: 322. 1882.

Plants mostly freely branched above to branched from base only, strigose to hirsutulose-hispidulose, the hairs as much as 1 mm. long; pedicels from subequal to twice the length of fruits, flattened slightly, scarcely twice as broad as thick, usually glabrous on lower surfaces. Pl. 16, fig. 23.

Material seen. MEXICO: Matamoras, *Berlandier 2488;* San Luis Potosi, Estacion de Catorce, *Pennell 17561,* 2 of 3 plants with glabrous fruits (US); Tamaulipas, near Victoria, *Palmer 111,* 12 km. northwest of Palmillas, *Stanford et al.;* Nuevo Leon, Monterrey, *Palmer 38, 42,* isotype of Thellung's var. *orbiculare* (US); 35 miles south of Monterrey, *White 1641,* near Monterrey, *Sargent* and *Trelease 30, Mueller* and *Mueller 547,* Linares, *Frye* and *Frye 2517, 2522,* Galeana, *Chase 7748, Taylor 43, ca.* 15 miles southwest of Galeana, *Mueller* and *Mueller 784,* near Sabinas Hildalgo, *Frye* and *Frye 2433, Chase 7038,* Derrumbadero, *Mueller 2556.* UNITED STATES: Texas, Kerrville, Kerr County, *Heller 1651,* type collection of *L. austrinum* (W); Maravillas Creek, Brewster County, *Cory* in 1939 (W); Fort Worth, *Ruth 4* (NY); Dallas, *Reverchon 2726* (G), *Bush 583* (NY).

The following Mexican collections are more or less intermediate in character between var. *orbiculare* and var. *typicum:* Monterrey, *C. T. Dodge 1;* Saltillo, Coahuila, *Palmer 196, 531, 753;* near Musquiz, Coahuila, *White 1846;* 59 km. south of Saltillo, *Stanford et al. 292.*

It is rather regrettable that the name to be used for this variety is somewhat misleading, since the bulk of the material does not have orbicular fruits.

On the whole, this is the most puzzling of the entities included under *L. lasiocarpum.* In the first place, when Watson described the variety *tenuipes* he cited, as belonging to it, certain specimens, such as *Schaffner 145,* which belong under *L. virginicum* var. *pubescens.* He was well aware of the peculiar nature of the type specimen and of its position in the species, since it is glabrous-fruited, and looks much like *L. densiflorum* var. *ramosum*. In fact, the type itself could be placed in either *L. densiflorum* or *L. lasiocarpum* with equal reason, if it were not known that it was found far out of the normal range of the former species; also, of course, the presence of petals nearly as long as the sepals is an unusual condition for *L. densiflorum*. It therefore might be considered to be a glabrous-fruited plant of *L. lasiocarpum,* since glabrosity of the fruits is by no means rare in this species. If the type specimen, alone, were to be considered, I should be inclined to believe that Watson was dealing with a plant referrable to *L. lasiocarpum*. Two isotypes (US), however, can with less hesitation be assigned to *L. virginicum* var. *pubescens,* so it is felt that Watson's varietal name *tenuipes* belongs to some entity under *L. virginicum,* even though it has been applied by most workers to this phase of *L. lasiocarpum*.

Thellung and the author both accorded *L. austrinum* specific status in previous work. The type consists of plants that have pubescent silicles, and is similar, in habit and leaf-character, to Mexican material of *L. lasiocarpum*. There is every degree of intergradation between the two in fruit size, pubescence, and other characters. Consideration of one collection (*V. H. Chase 7748*), for instance, shows the following variation: the sheet at Gray Herbarium contains two very similar plants, one with glabrous silicles, the other with very pubescent fruits, whereas that at Missouri Botanic Garden includes two plants, one glabrous-fruited, the other pubescent-margined; the sheet at Field Museum contains three plants, all with fairly numerous marginal hairs on the fruits.

The specimens of the type of *L. austrinum* (*Heller 1651*), have no basal leaves, and the cauline are but 2 to 3 mm. broad. The plants tend to be erect and simple at the base. Such plants are to be found in considerable abundance between Kerr County, Texas, and Monterrey, Mexico. Another phase of the plant that commonly has been called *L. austrinum* is a broad-leaved form, the cauline leaves being as much as 15 mm. wide. It is exemplified by the following collections. MEXICO: Monterrey, *Palmer 38, Gregg* (G, MBG), *Sargent* and *Trelease 31;* near Victoria, Tamaulipas, *Palmer 559*. TEXAS: Brewster County, *Sperry T594, Warnock 64;* Mission, *H. C. Hanson 323* (G). The extremes of the two phases would scarcely be considered to belong to the same variety. However, some sheets (*Palmer 38, 42* [G], and *111, 559* [US]), indicate that there is enough variation due to ecological conditions to account for this apparent discrepancy in leaf character. There is also evidence that part, at least, of this apparent difference is due to the early drying and shedding of these broader leaves in the bulk of this material. The type (*Heller 1651*) was originally identified as *L. lasiocarpum* var. *tenuipes*. It is almost perfectly matched by many specimens from Monterrey, Mexico (such as *Frye* and *Frye 2517*).

I have not seen the type of *L. austrinum* var. *conspicuiflorum* of Thellung (Garcia, Nuevo Leon, *R. Endlich* in 1905), which was at Berlin, so cannot be sure it belongs here.

14f. L. LASIOCARPUM var. WRIGHTII (Gray) C. L. Hitchc. *op. cit.* 289.

Whole plant densely hispidulous, the hairs 0.5–1.2 mm. long, usually with somewhat pustular bases; cauline leaves mostly pinnatifid, the ultimate divisions 1–5 mm. broad; pedicels mostly at least 0.5 mm. broad, not more than $\frac{1}{6}$–$\frac{1}{4}$ as thick; glands as much as 0.5 mm. long; silicles 3.5–4 mm. long, densely hispidulous.

Mexican material seen: Rio Grande Valley near Diaz, Coahuila, *Pringle 8317*. The two following Texan collections are similar to var. *Wrightii* in most respects, but have silicles pubescent on the margins only: Carrizo Springs, *Whitehouse 802* (NY), Hebbronville, *Whitehouse* in 1934 (NY).

14g. L. LASIOCARPUM var. **Palmeri** (Wats.) comb. nov. *L. Palmeri* Wats. Proc. Am. Acad. 24: 39. 1889. *L. lasiocarpum* subsp. *Palmeri* (Wats.) Thell. *op. cit.* 267; *L. lasiocarpum* var. *typicum* C. L. Hitchc. *op. cit.* 290, in part.

Plants 3–15 cm. tall, more or less prostrate, densely hirsutulous with hairs to 0.5 mm. long; leaves pinnatifid or bipinnatifid, the segments 1–2 (3) mm. broad; racemes scarcely exceeding basal leaves, 1–3 (7) cm. long, densely crowded; pedicels very strongly flattened, *ca.* 0.6 mm. broad, not over $\frac{1}{4}$ as thick, usually soft-pubescent on both sides; silicles *ca.* 4 mm. long, oblong-ovate, densely pubescent to glabrous, sinuses $\frac{1}{6}$–$\frac{1}{5}$ length of fruit.

Mexican material seen. BAJA CALIFORNIA: Los Angeles Bay, *Palmer 560* (type collection, C, G, US); 10 miles west of Los Angeles Bay, *Wiggins 7673* (US); 14 miles northeast of Punta Prieta on road to Desengana Mine, *Wiggins 7644* (S, US).

This entity, formerly merged by the writer with var. *typicum*, is perhaps the most distinctive variant in the species, and may well merit status as a subspecies, rather than a variety. It has the habit of *L. latipes* and *L. dictyotum*, but the fruit shape, venation, and pubescence set it apart from them. It is most similar to var. *Wrightii*, but the finely dissected leaves, crowded racemes, and soft pubescence are sufficient to distinguish it from that variety. Wiggins' collections indicate that it is an established plant.

15. **Lepidium pinnatisectum** (Schulz) comb. nov. *L. virginicum.* L. var. *pinnatisectum* O. E. Schulz, Urb. Symb. Ant. 3: 495. 1903. *L. virginicum* L. subsp. *eu-virginicum* Thell. var. *pinnatisectum* (Schulz) Thell. *op. cit.* 224, 229, in part only.

Plants annual, 5–20 cm. tall, the few basal branches finely strigillose with curled hairs 0.1–0.2 mm. long; basal leaves few, 3–6 cm. long, sparsely strigillose beneath, lyrate-pinnatifid, the 5–9 pinnae few-toothed to entire, 3–10 mm. broad, petioles subequal to blades, cauline leaves smaller and less compounded, the upper ones few-toothed, 2–6 mm. broad, sparsely strigillose below, the margins usually coarsely ciliate-strigillose with short curved hairs; racemes few, 3–10 cm. long, loosely-flowered and open; pedicels from about equal to fruits to twice as long, spreading to slightly reflexed, slightly flattened, scarcely twice as broad as thick, finely pubescent-strigillose on upper surfaces, glabrous on lower; sepals scarcely 1 mm. long, glabrous, caducous; petals wanting or but tiny linear vestiges; stamens 2; glands 4, *ca.* 0.2 mm. long, lanceolate; silicles *ca.* 3 mm. long, nearly perfectly rotund, lightly veined, margins and adjacent surfaces sparsely pubescent with very short coarse hairs, sinuses scarcely $\frac{1}{10}$ length of fruit, open; styles lacking; seeds *ca.* 1.5 mm. long; cotyledons incumbent. Pl. 16, fig. 18.

Material seen. Haiti: "common and abundant along dry tracts near Cabaret," Baie de Moustiques, January 12–18, 1929, *E. C.* and *G. M. Leonard 12048* (G, NY, US).

The fact that the collectors remarked at the prevalence of the species makes it seem certain that it was common at the time of collection. The fifteen plants of their collection that I have seen are remarkable for their great uniformity, there being scarcely any variation in plant size, leaf character, or flower or fruit.

The collection was first identified as *L. virginicum,* the common species of *Lepidium* in the West Indies. However, these plants differ in being apetalous, and in having more flattened pedicels, pubescent fruits, and incumbent cotyledons. They are more similar to *L. viriginicum* var. *pubescens* but differ from it, too, in being apetalous and in having pubescent fruits. Of course, either of these conditions is occasionally met in plants included in *L. virginicum* var. *pubescens,* but these plants do not have the general habit of that variety, even of depauperate specimens thereof. They are also suggestive of *L. lasiocarpum,* but are sufficiently different from that species in pubescence, rounded fruit, almost complete lack of petals, and less flattened pedicels to make it seem unlikely that they represent an insular introduction of that southwestern species.

If the collectors had not noted the habitat "along dry tracts," one would suspect these plants to be ones that had grown in partial shade as the large, apparently more or less tender leaves and elongate racemes suggest such a habitat.

I am not certain the plants described here are the same as those comprising Schulz's type (Porto Rico, prope Mayagüez, *L. Krug 29*), but that collection, too, was said to be suggestive of *L. virginicum,* differing because of the pinnate leaves and lack of petals. Thellung listed it for Mexico and the United States, as well as the West Indies. I have seen no other material identical with this Leonard collection, so feel confident that Thellung did not interpret Schulz's variety correctly.

16. **Lepidium filicaule** C. L. Hitchcock sp. nov. Annui, caulibus simplicibus vel ad basim ramosis, 5–20 cm. altis, hirsutulosis, pilis 0.2–0.4 mm. longis, patentibus; foliis basi paucis, 3–8 cm. longis, saepe lyrato-pinnatifidis vel lobatis, pinnis paucis, 3–12 mm. latis, petiolis longis gracilisque, foliis caulinis parvioribus, saepe serrulatis, 3–6 mm. latis, sparse hirsutulosis; racemis paucis, 3–10 cm. longis, paucifloribus; pedicellis siliculis aequalibus, patentibus, leviter compressis; sepalis saepe linearibus et $\frac{2}{3}$ longitudinis sepalorum, vel parvioribus, vel absentibus; staminibus 2; glandulis 4, 0.1 mm. longis; siliculis saepe 2.5–3.5 mm. longis, ovato-ellipticis, glabris, reticulatis sine discrimine, ad apicis alatis; sinibus $\frac{1}{10}$–$\frac{1}{8}$ siliculorum longitudinis aequalibus, latis; stilibus absentibus; seminibus 1–1.25 mm. longis; cotyledonibus incumbentibus.

Annuals, simple or branched from base, 5–20 cm. tall, the branches very slender, finely hirsutulous, the hairs 0.2–0.4 mm. long, spreading; basal leaves few, 3–8 cm. long, mostly lyrate-pinnatifid or lobed, the lobes or pinnae few, 3–12 mm. broad, the petioles long and slender, cauline leaves similar but reduced, often merely serrulate, 3–6 mm. broad, sparsely hirsutulous; racemes few, 3–10 cm. long, loosely flowered; pedicels *ca.* equal to fruits, spreading, flattened slightly, scarcely twice as broad as thick, lower surfaces glabrous, upper surfaces finely short-hirsute as is the axis of the raceme; sepals *ca.* 0.75 mm. long, sparsely hairy on back, caducous; petals mostly linear vestiges *ca.* $\frac{1}{2}$–$\frac{2}{3}$ as long as sepals, or more reduced or even lacking; stamens 2; glands 4, scarcely 0.1 mm. long, oblong-lanceolate; silicles mostly *ca.* 2.5–3.5 mm. long, ovate-elliptic to oval-elliptic, glabrous, very lightly veined, sinuses $\frac{1}{10}$–$\frac{1}{8}$ length of fruit, open, the silicles very slightly wing-tipped; styles lacking; seeds 1–1.25 mm. long; cotyledons incumbent. Pl. 16, fig. 24.

Type. Rocks of east shore, Ambergris Cay, the Caicos Group of Bahamas Islands, March 12, 1911, *C. F.* and *C. M. Millspaugh 9309* (F; isotypes, G, NY).

Other material seen. South Caicos, Caicos Islands, *Wilson 7623* (F, G, NY).

These plants have all been identified as *L. virginicum* and look not unlike depauperate specimens of that species. They are the only collections of *Lepidium* I have seen from the Caicos Islands and are remarkably alike in habit, pubescence, and flower and fruits, varying in leaf character only. Since they include about twenty plants, some of which were collected in December, the rest in March, it would seem certain that they are representative of the entity as it occurs in this part of the Bahamas Islands, and that they are not depauperate specimens of *L. virginicum* such as the collection from Inagua (*Nash* and *Taylor 1461*). The pedicels of these plants are too large and too flat to be those of *L. virginicum,* the fruits are more nearly elliptic, and the lack of petals and the incumbent cotyledons are unlike *L. virginicum.* The plants are most suggestive of *L. pinnatisectum,* but differ in pubescence (hairs finer and more abundant), fruit shape, and lack of pubescence on the silicles. The glands are apparently shorter than in that species, also.

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A NEW SPECIES OF LINUM FROM THE COAST RANGES OF CALIFORNIA

Helen K. Sharsmith

In the preparation of a monograph of the section *Hesperolinon* Gray, genus *Linum* Tourn. ex Linn., one new species has been described; it is published separately herein.

Linum bicarpellatum sp. nov. Herba annua, 8–20 cm. alta; inflorescentia paniculata cymulis plerumque dichasialibus ramis secundariis oppositis; sepalis binis exterioribus saepe porrectis, iis ternis interioribus minoribus vix porrectis; petalis 3–4 mm. longis, luteis, appendiculis lateralibus crassis, eo medio oblongo pubescente; tubo stamineo 10-dentato, filamentis 3 mm. longis, antheris 1.5 mm. longis; ovario 2-carpellato; stylis binis 3 mm. longis.

Stem 8–20 (mostly 15) cm. tall, puberulous near the forks of the branches; leaves linear, narrowed at base, strongly channelled, 15–20 mm. long, 1–1.5 mm. wide, stipular glands present except at bases of bracts; branches of inflorescence spreading, secondary branches predominately opposite, forming a dichasium, flowers scattered, the ultimate branchlets bearing loose clusters of 2–3 flowers on pedicels 0.5–2 mm. long, fruiting pedicels 1–2 mm. long near tips of branches, 4–5 (or up to 12) mm. long in lower axils; sepals 2–3 mm. long, 0.5–1 mm. wide, acute, the two outer sepals often spreading in both bud and flower, the three inner sepals smaller and connivent in bud, only slightly spreading at anthesis; petals 3–4 mm. long, 2–3 mm. wide, bright yellow often tinged with red on back, horizontally spreading at anthesis, lateral appendages thickish, ventrally glandular-papillate or with a few scattered hairs, united to central oblong appendage, this hairy ventrally; stamen cup 10-toothed, filaments 3 mm. long, anthers 1.5 mm. long, yellow, pollen grains yellow; ovary 2-carpellary (infrequently 3), ovules 4 (infrequently 6); styles 2 (infrequently 3), 3 mm. long; capsule equal or slightly shorter than sepals, false septa one-third complete.

Range. Chaparral and openly wooded areas, Lake and Napa counties of the inner north coast ranges, California.

Specimens examined. Lake County: three miles east of Middletown, May 27, 1937, *H. K. Sharsmith 3949* (type, Herb. Univ. Calif. no. 694109, duplicates distributed to various herbaria); eight miles southeast of Middletown, *Keck 2464* (Herb. Univ. Calif.); four miles east of Middletown, *Mason 5689* (Herb. Univ. Calif.). Napa County: Butts Canyon near Aetna Springs, 1911, *Brandegee* (Herb. Univ. Calif.).

This hitherto unrecognized species is easily mistaken for *Linum Clevelandii* because of the bright yellow petals and the similarity in habit and habitat. Undoubtedly the two species are closely related, but they are readily distinguished on the basis of carpel number. *Linum bicarpellatum* is the only bicarpellary species in the otherwise tricarpellary section *Hesperolinon.* Infrequently a tricarpellary flower will be found in *L. bicarpellatum,* and as infrequently the reverse is true in *L. Clevelandii,* but these instances are rare.

Other features distinguishing *Linum bicarpellatum* from *L. Clevelandii* are as follows: in *L. bicarpellatum* the secondary branches of the inflorescence are mostly opposite, forming a dichasium, while in *L. Clevelandii* the inflorescence branches are mostly alternate, forming a monochasium. The sepals, because of a difference in position, appear more obviously subequal in *L. bicarpellatum,* the three inner being connivent, the two outer spreading. Petals, filaments, and styles average one to two millimeters longer in *L. bicarpellatum* than in *L. Clevelandii.* Finally, the stamen cup at the base of the filaments is 10-toothed in *L. bicarpellatum,* 5-toothed in *L. Clevelandii.*

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NOTES AND NEWS

We welcome the receipt of Volume one, number one, of "Wrightia," a new journal of botany emanating from the Institute of Technology and Plant Industry, Southern Methodist University, under the editorship of Dr. C. L. Lundell. Judging from the contents its interests are wide and it gives promise of a vigorous and valuable future.

Dr. W. S. Boyle, formerly on the staff of the Regional Research Laboratory, United States Department of Agriculture, Albany, California, is now Assistant Professor of Botany at Utah State Agricultural College, Logan.

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A WEST AMERICAN JOURNAL OF BOTANY

Contents

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A COMPARISON OF ANCIENT AND MODERN SEQUOIA WOOD

Paul F. Cundy

When wood remains buried for extremely long periods of time without losing its fibrous or "woody" character, some very interesting changes take place in its structure and chemical constitution. These changes are shown quite strikingly when the ancient wood is compared with a modern specimen of the same species. In the present instance the comparison has been made between a fossil wood believed to be an ancient form of *Sequoia gigantea* and a specimen of modern Big Tree, *Sequoia gigantea* Decaisne. The fossil wood was unearthed in a bed of Miocene gravel in a mine tunnel in Eldorado County, California, where, it has been estimated, it lay buried thirty million years. The gravel bed, located about a mile from the mouth of the tunnel, is overlaid with eight hundred feet of lava and is part of the bed of an ancient stream. The modern specimen is from Whitaker's Forest in Tulare County, California.

Except for the fact that the ancient wood has a dark brown color and some pieces are twisted and bent, it appears, superficially, to be much like normal wood. In contrast to the modern wood, however, it is quite soft and friable. Most of the pieces may be pulled apart by hand and the fragments thus separated reduced to the size of very coarse sawdust by rolling them firmly between the fingers. Similar characteristics have been noted by other investigators of fossil woods (6).

The structure of the ancient wood resembles very closely that of modern Big Tree wood (pls. 17, 18). The wide band of large thin-walled springwood tracheids makes an abrupt transition to the narrow band of flattened thick-walled summerwood tracheids. The tracheids have bordered pits on the radial walls in one or two rows and smaller bordered pits on the tangential walls in the last few rows of summerwood cells. The pits leading to the ray parenchyma are fairly large, quite uniform in size, and usually oval; there are one to five (generally two) pits per ray crossing. The rays are uniseriate or occasionally in part biseriate, consisting entirely of ray parenchyma cells, and range up to thirty-one cells (800 μ) in height. There are approximately five rays per millimeter tangentially on the transverse section and fifteen to twenty per square millimeter on the tangential surface. The longitudinal parenchyma are metatracheal-diffuse (there seem to be fewer than in the modern wood) and are located chiefly in the summerwood zone. Although normal resin canals are absent, a short tangential row of traumatic (wound) canals is present; these occur occasionally in *Sequoia gigantea*. It is apparent from the

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photomicrographs that many of the cells of the ancient wood have been distorted; in fact, they are almost collapsed in certain areas.

The modern wood was reduced to sawdust, using a power saw with a box for retaining the sawdust; the ancient material was picked apart by hand, with the occasional aid of a knife, and crushed by rolling between the fingers. Both samples were further reduced in a Wiley mill to wood meal passing the forty-

TABLE 1. CHEMICAL ANALYSIS OF ANCIENT AND MODERN SEQUOIA WOOD. (All calculations are on the basis of ovendry, unextracted wood.)

	Ancient, per cent	Modern, per cent
Ether solubility	0.33	0.74
Alcohol solubility	1.36	12.13
Hot-water solubility	1.71	3.10
Total extractives	3.4	16.0
Ash	1.98	0.77
Lignin	57.1	33.5
Methoxyl of lignin	13.66	13.63
Pentosans	4.0	12.3
Uronic anhydride ($CO_2 \times 4$)	1.72	4.68
Cross and Bevan cellulose	38.2	37.3
Alpha-cellulose (determined on Cross and Bevan cellulose)	26.4	29.1
Viscosity of Cross and Bevan cellulose	6.2 cp.	23.6 cp.

mesh sieve. Extractives and ash were determined on the original unextracted wood meal. The extracted wood used for the other determinations was prepared by subjecting a large portion of wood meal to a treatment analogous to that used in the determination of the extractives present in the unextracted wood. This treatment is described later. For the determination of Cross and Bevan cellulose, the fraction of the wood meal which passed the forty-mesh sieve but was retained on the sixty-mesh sieve was used; in all other determinations, the whole wood meal passing the forty-mesh sieve was used.

The ether and alcohol solubilities were determined by extracting the wood meal, successively, eight hours with ether and sixteen hours with 95 per cent ethyl alcohol in a Soxhlet extractor. The hot water solubility was determined by heating water suspensions of this extracted wood meal in a hot water bath for three one-hour periods. The lignin, methoxyl of the isolated lignin, and the alpha-cellulose and viscosity of the Cross and Bevan cellulose were determined by TAPPI standard methods (7). Cross and Bevan cellulose was determined by a modification of the Forest Products Laboratory procedure (2), the principal difference being that the wood meal, after being chlorinated, was heated four minutes instead of thirty minutes with 2 per cent sodium sulfite solution. Pentosans were determined by distillation with 12 per cent hydrochloric acid followed by precipitation with phloroglucinol (1). Uronic anhydrides were determined by a modification of the method of Burkhart, *et al.* (3); the principal change involved heating the hydrochloric acid suspension of the wood fifteen minutes at a temperature of 70° centigrade to remove carbonate CO_2 before the absorption tube was attached.

In contrast to the experience of other investigators (4, 5, 6) no difficulty with gelatinization was encountered in the preparation of Cross and Bevan cellulose from the ancient wood. The delignification proceeded much more rapidly than did that of the modern specimen. The results of the analyses are shown in Table 1.

If the composition of the woods is compared on the whole wood basis, it will be noted that there have been marked decreases in extractives, pentosans, and uronic anhydride in the ancient wood, and a large increase in lignin. Cross and Bevan cellulose appears to be practically unchanged.

The greatest differences in composition are in lignin, which apparently increased, and extractives (particularly alcohol extractives), which decreased. The increase in lignin content is particularly intriguing. It is conceivable that extractives might, upon aging, become insoluble in 72 per cent sulfuric acid, as well as in the usual solvents, and be isolated with the lignin, thereby accounting for some of the increase in the latter. However, the remarkable similarity of the methoxyl content of the lignin isolated from the two woods makes this assumption untenable because the methoxyl content of the extractives is much lower than that of lignin. Since the alcohol-soluble portion would be partially water-soluble as well, it is more likely that most of the extractives have been lost. Therefore, to explain the increased lignin content, it must be assumed that lignin is more resistant to deterioration than are any of the other major constituents of wood and thus appears to increase in quantity because the other constituents are lost so much more rapidly, a suggestion which has been made by other investigators.

If the further assumption is made that none of the lignin has been lost, the basis is provided for a more rational comparison of the two woods. In other words, if it is assumed that instead of 57.1 per cent, the lignin content of the ancient wood was originally the same as that shown by the modern wood (33.5 per cent) and no lignin was lost, 58.7 per cent [$(33.5/57.1) \times 100$] of the original wood remains and the other analyses should be adjusted accordingly. Although it is impossible to say how nearly correct this assumption may be, it furnishes the only logical basis of comparison. Jahn and Harlow (5) found that, in ancient beechwood, the loss in weight as calculated from the increase in lignin, assuming no loss of lignin, agreed almost exactly with the loss in weight as calculated from apparent density measurements. This would

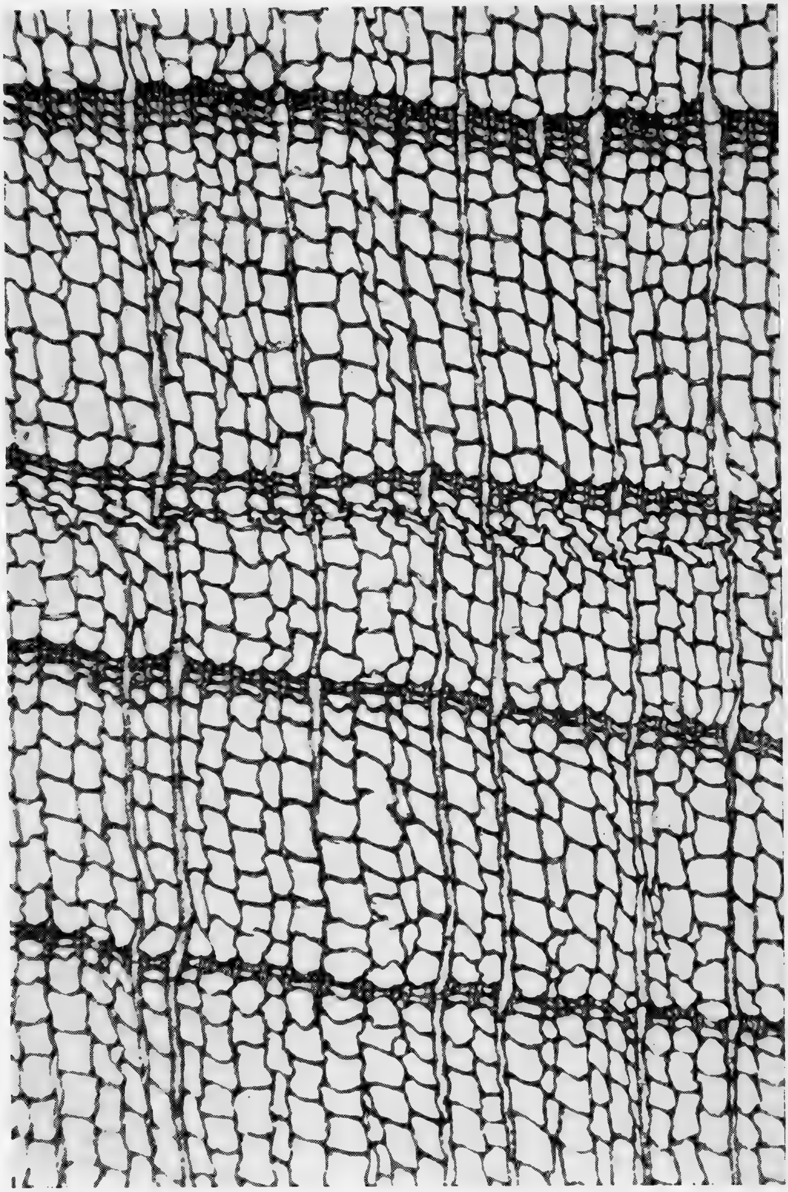

Plate 17. Structure of Ancient Wood, × 100.

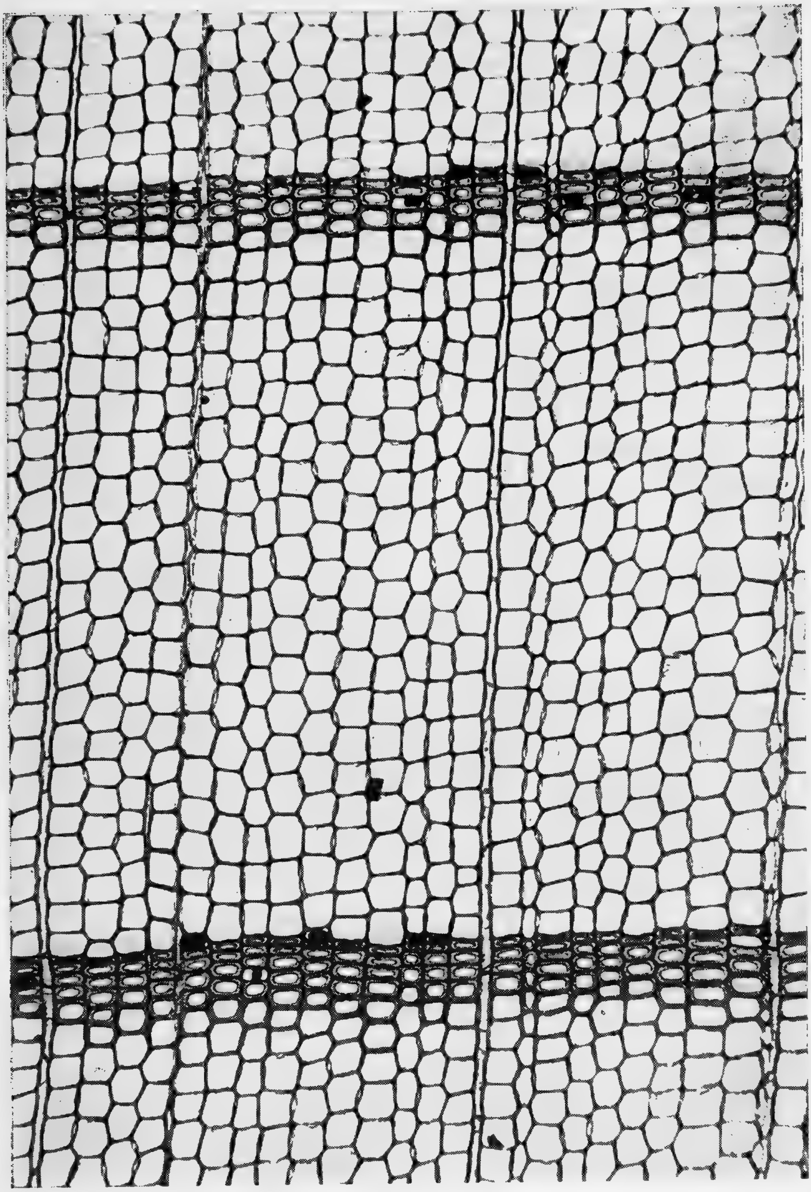

PLATE 18. STRUCTURE OF SEQUOIA GIGANTEA, ×100.

indicate that, in this case, there had been neither a loss nor an accumulation of lignin. In an attempt to provide such an independent check in the case of the sequoia wood, density measurements were made on both samples. Small rectangular blocks of the woods, dried to constant weight, were dipped in hot paraffin, and then weighed in and out of water, weighting the wood sufficiently to overcome its tendency to float. The weight of water absorbed by the wood during the period of immersion necessary to complete a weighing was negligible.

On the ash-free basis, the apparent densities of the ancient and modern samples are, respectively, 0.222 and 0.323. These

TABLE 2. ADJUSTED CHEMICAL ANALYSIS OF ANCIENT WOOD

	Basis—Wood of normal lignin content, per cent	Loss—Basis, normal wood, per cent
Extractives	2.00	87.5
Ash	1.16	33.6*
Cross and Bevan cellulose	22.4	39.9
Alpha-cellulose	15.5	46.7
Pentosans	2.3	81.3
Uronic anhydride ($CO_2 \times 4$)	1.01	78.4

* Gain.

results were confirmed by calculations made from actual measurement of the dimensions of the blocks. Using these density values, it would appear that 68.7 per cent of the original wood remains, as compared with 58.7 per cent as calculated from the gain in lignin. From this, it might be concluded that some lignin has accumulated in the aging process but, as previously mentioned, the methoxyl content of the two lignins lends little credence to this view. At least part of the discrepancy might be explained by assuming that the pressure of the lava and other overburden has had a compressing effect on the ancient wood, thereby increasing its apparent density. An examination of the cell structure of this wood (plate 17) shows cell deformation amounting, in some cases, almost to collapse. Such a change would, of course, increase the apparent density of the wood and lead to a fictitiously low value for the loss in weight as calculated from the decrease in apparent density.

Thus, although density measurements do not confirm the assumption that lignin is neither lost nor accumulated, neither do they interpose any serious objections to its use as a basis for calculation. It need hardly be pointed out, of course, that the one basic assumption upon which all these comparisons are made can never be affirmed—namely, that the modern wood has the same chemical and physical constitution as did its ancient prototype in its original state.

In the first column of Table 2 is shown the composition of the ancient wood adjusted to conform to the assumption that no lignin has been lost and, accordingly, that 58.7 per cent of the original wood remains. The second column shows the percentage difference from the composition of modern big tree wood.

When this basis of comparison is used, it appears that only about 12 per cent of the original extractives and 20 per cent of the pentosans and uronic anhydrides of the ancient wood remain, as compared with a retention of about 55–60 per cent of the cellulose. The loss of so-called hemicelluloses is, in other words, approximately twice as great as that of cellulose, a point which is not too surprising because they represent, principally, molecules of a lower degree of polymerization than cellulose. There is some evidence, however, that the cellulose suffered greater deterioration during burial than is indicated by the percentage loss shown in Table 2. Alpha-cellulose and viscosity measurements made on Cross and Bevan cellulose from the ancient wood showed losses of 12.7 and 73.3 per cent, respectively, from the values of corresponding measurements made on Cross and Bevan cellulose from the modern wood, despite the fact that a greater number of chlorinations were required to delignify the modern wood. This suggests that what cellulose remains in the ancient wood possesses a considerably lower degree of polymerization than it did originally. The increase in ash content, which is found in all woods which have been buried for long periods of time, is to be expected. No evidence of petrification was found.

Grateful acknowledgment is made to Professor Emanuel Fritz, of the Department of Forestry at the University of California, who obtained the samples of the two woods and to the Pacific Lumber Company who made them available to this laboratory. Especial thanks are due Dr. I. H. Isenberg who prepared the sections of the wood, examined them microscopically, and provided the portion of the description which relates to that examination, and to Dr. B. L. Browning who made valuable suggestions regarding the analytical work. Thanks are also due Miss Eda Nihlen for preparing the photomicrographs and Miss Virginia West for making the viscosity measurements.

The Institute of Paper Chemistry,
Appleton, Wisconsin.

Literature Cited

1. Association of Official Agricultural Chemists. Methods of analysis. 5th ed., p. 361. 1940.
2. Bray, M. W. Methods used at the Forest Products Laboratory for the chemical analysis of pulps and pulpwoods, 1939: 12–13. 1939.
3. Burkhart, B., L. Baur, and K. P. Link. A Micromethod for the determination of uronic acids. Jour. Biol. Chem. 104: 171–181. 1934.

4. Gortner, W. A. Analysis of glacial and preglacial woods. Jour. Am. Chem. Soc. 60: 2509. 1938.
5. Jahn, E. C., and Wm. M. Harlow. Chemistry of ancient beech stakes from the fishweir. Papers Robt. S. Peabody Foundation Archeol. 2: 90–95. 1942.
6. Mitchell, R. L., and G. J. Ritter. Composition of three fossil woods from the Miocene auriferous gravels of California. Jour. Am. Chem. Soc. 56: 1603. 1934.
7. Technical Association of the Pulp and Paper Industry. Tentative and official testing methods.

NOTES ON TRIFOLIUM ERIOCEPHALUM NUTTALL

James S. Martin

During a recent taxonomic study of the native clovers of the United States, several nomenclatural ambiguities were discovered. Two varieties of *Trifolium eriocephalum* Nuttall long have been known under invalid names and the distinctions between the several varieties never have been very clear-cut. The species and its four varieties are revised here in an attempt to correct these difficulties. Herbarium material from the following institutions has been studied: University of California, Berkeley, California; Dudley Herbarium, Stanford University, California; Gray Herbarium, Harvard University, Cambridge, Massachusetts; New York Botanical Garden, New York, New York; Pomona College, Claremont, California; Philadelphia Academy of Sciences, Philadelphia, Pennsylvania; Utah State Agricultural College, Logan, Utah; University of Washington, Seattle, Washington. I am deeply grateful to the curators of these herbaria for the loan of their material.

Trifolium eriocephalum Nutt. in Torrey and Gray, Fl. N. Am. 1: 313. 1838.

Usually villous or rarely glabrous perennials; stems branching from apex of thick, deep root, erect or spreading, 5–45 cm. tall, 1–3 mm. in diameter; leaflets always 3, varying in shape; inflorescence 25–85-flowered, 15–30 mm. in diameter, without an involucre, the pedicels less than 0.8 mm. long, the entire inflorescence often horizontal or sometimes inverted because of the bending of the peduncle just beneath the head; flowers yellowish, pink, purplish or ochroleucus, 8–16 mm. long, sharply reflexed, the curvature sharp near the base; calyx somewhat shorter than the banner, the tube 1–3 mm. long, membranous, strongly 10(9–11)-veined, teeth slenderly subulate, sharp but not spine-tipped, often curved and twisted, usually villous with long diverging hairs 0.7–2.5 mm. long, the lower teeth 2–5 times as long as the tube, the upper teeth subequal to or shorter than the lower; banner ovate, oblong, or elliptical, the apex rounded (rarely acute), apiculate or slightly retuse, adnate to the claws of the wings for 0.7–2 mm. at the base; wings from equal to 2 mm. shorter than the banner, the blades usually much shorter than the claws, blunt or shortly acute; keel equal to 1 mm. shorter than the wings, the blades much shorter than the claws, boat-shaped, sometimes slightly rostrate; legume sessile, small, densely villous especially towards the apex (rarely glabrous), membranous, often nearly veinless, 2–7-ovuled, 1–4-seeded; seeds smooth, 1.5–3 mm. long.

Key to Varieties

Ovaries mostly with more than two ovules (usually 4-ovuled).
  Leaflets of at least the basal leaves broad and rounded, rarely retuse; upper leaves with elliptical or oblong, rounded or acute leaflets, but never linear and acuminate.
    Basal leaves glabrous; northeastern Oregon and adjacent Washington and Idaho . . . . b. *T. eriocephalum* var. *Piperi*
    All leaves noticeably villous; Utah . . . . d. *T. eriocephalum* var. *villiferum*
  All leaflets narrow, linear, acuminate, rarely acute . . . . c. *T. eriocephalum* var. *Cusickii*
Ovaries 2-ovuled, rarely a few ovaries with 3 ovules . . . . a. *T. eriocephalum* var. *typicum*

a. T. eriocephalum Nutt. var. **typicum** nom. nov. *T. eriocephalum* Nutt. in Torrey and Gray, Fl. N. Amer. 1: 313. 1838. *T. scorpioides* Blasdale, Erythea 4: 187. 1896; type, along Mad River, Humboldt County, California, June 8, 1896, *W. C. Blasdale* (Herb. Univ. Calif.). *T. arcuatum* Piper, Bull. Torrey Bot. Club 28: 39. 1901, as to type only, other specimens cited and other material identified as such by Piper belong in the variety *Piperi;* type, Simcoe Mountains, Klickitat County, Washington, June 6, 1884, *W. N. Suksdorf 270* (Gray Herb.). *T. eriocephalum* Nutt. f. *arcuatum* (Piper) McDermott, N. Am. Species Trifolium 231. 1910, as to name only, not material cited. *T. eriocephalum* Nutt. var. *arcuatum* (Piper) McDerm. *apud* Peck, Man. Higher Plants of Oregon 429. 1941. *T. eriocephalum* Nutt. var. *Butleri* Jepson, Fl. Calif. 2: 302. 1936; type, Log Lake, Shackleford Creek, Siskiyou County, California, August 3, 1908, *G. D. Butler 384* (isotype, Herb. Univ. Calif.).

Leaflets mostly elliptical or oblong, acute to narrowly rounded and often apiculate at the apex, 4–12 mm. wide, 20–50 mm. long, densely villous on both sides, rarely glabrous; calyx one-half to three-fourths as long as the banner; legume densely villous towards the apex, rarely nearly glabrous, 2-ovuled, rarely a few ovaries with 3 ovules, 1(2)-seeded. Flowering from early May to July.

Type. Prairies of the Wahlamet [Willamette], Oregon, *T. Nuttall* (Herb. N. Y. Bot. Gard.).

Distribution. From Klickitat County, Washington, to Mendocino County, California; foothills and lower mountain slopes, 2000 to 7000 feet elevation.

Representative material. *W. C. Cusick 2811a; H. M. Hall 4076; A. A. Heller 10047, 13636; L. F. Henderson 36, 196, 3095, 12330, 12341; J. W. Thompson 710, 4284, 4377, 4675, 10195, 13081; J. P. Tracy 2641, 2759, 5834, 7729, 8728, 8769, 8770, 8821, 8835.*

A discussion of *T. arcuatum* is given under var. *Piperi.* The variety *Butleri* of Jepson includes some of the smaller specimens of the typical variety occurring in northern California. A part of the type collection and Jepson's other cited specimen (*Chandler 1712*) are reduced in size but otherwise not different. In Humboldt County, California, a few plants have been collected which are nearly glabrous but do not otherwise differ from other specimens in the same region. All gradations from nearly glabrous to densely villous are found and consequently no recognition is given these plants.

b. T. ERIOCEPHALUM Nutt. var. **Piperi** var. nov. *T. arcuatum* Piper, Bull. Torrey Bot. Club 28: 39. 1901, as to material cited except for the type.

Caules villosi vel glabrati, 5–30 cm. longi, 1–3 mm. lati. Foliolae foliorum superiorum ovatae vel ellipticae vel oblongae, apicibus rotundis vel acutis, glabratae vel aliquantae villosae, 4–13 mm. latae, 20–40 mm. longae; foliolae foliorum inferiorum latae et breves, saepe obovatae et retusae, integerrimae; stipulae superiores 15–30 mm. longae, lanceolatae vel ovatae. Flores 12–15 mm. longi, petalis flavis vel puniceis pallidis vel albis (?); calycibus $\frac{2}{3}$–$\frac{3}{4}$ longitudinum vexillorum, fistulis calycum 1.5–2.7 mm. longis; dentibus inferioribus 5–8.5 mm. longis, 3–4 longitudinum fistularum, subglabratis vel aliquantis villosis. Legumina ad apicis villosa aliquanta 4–5(3–7)-ovulatis, 1–3-seminibus.

Leaflets of the upper leaves ovate, elliptical or oblong, rounded or acute at the apices, glabrous or moderately villous, 4–13 mm. wide, 20–40 mm. long; leaflets of the basal leaves broader and shorter, often obovate and retuse, entire; calyx two-thirds to three-fourths as long as the banner; legume moderately villous at the apex, 4–5(3–7)-ovuled, 1–3-seeded. Flowering in June and July.

Type. Paradise, Wallowa County, Oregon, June 12, 1900, *W. C. Cusick 2405* (Gray Herbarium; isotypes, Herb. Univ. Calif., N. Y. Bot. Gard., Pomona College, Univ. Wash.).

Distribution. Northeastern Oregon and adjacent Washington and Idaho; moist mountain meadows and woods, 3500 to 6500 feet elevation.

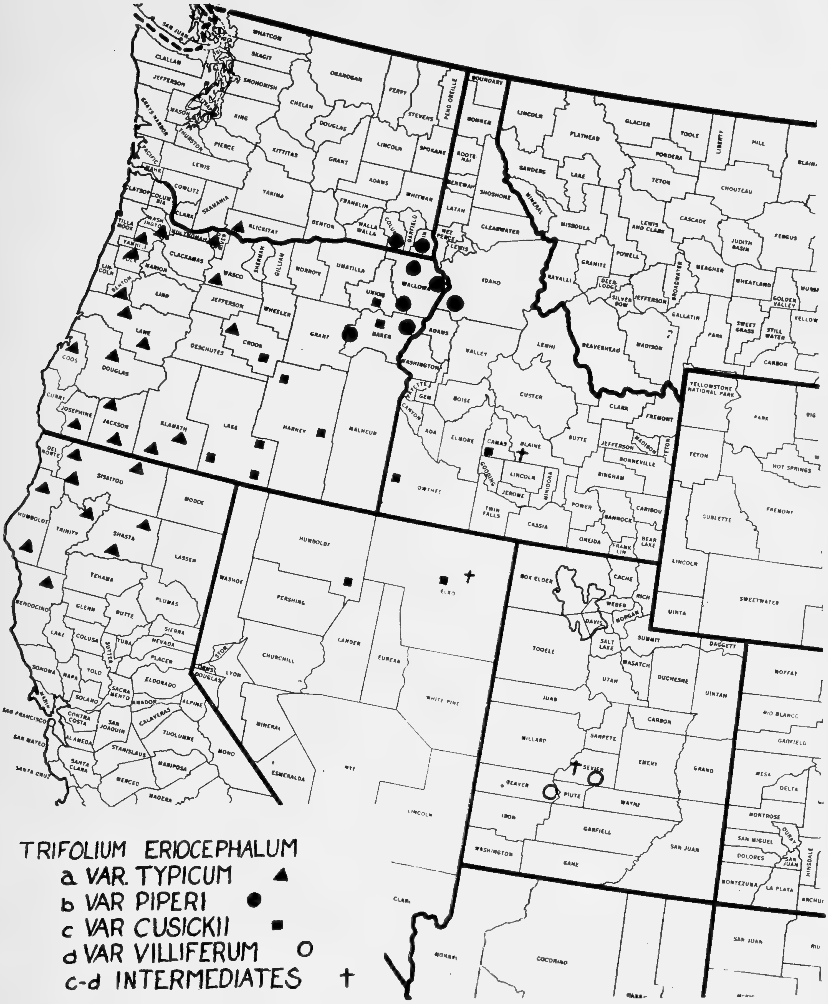

Fig. 1. Distribution of *Trifolium eriocephalum.*

Representative material. *W. C. Cusick 943, 2432, 2797, 3258d; R. Ferris 1158; L. F. Henderson 5386; G. N. Jones 1877; M. E. Peck 17544, 17993.*

This variety is distinguished easily from the typical variety by the more numerous ovules. Two-ovuled pods are found occasionally but the majority of the ovaries on any plant have more than two. A very few plants are intermediate in this respect, having a rather large number of 2-ovuled pods (*Cusick 2797; Peck 17993*). From var. *villiferum,* var. *Piperi* is distinguished less clearly. The var. *Piperi* has broad, glabrous basal leaflets while var. *villiferum* has narrower leaflets all of which are villous. Since var. *Cusickii* has the leaflets all narrow with slender apices, it is distinguishable from var. *Piperi* although in some cases the upper leaflets of the two varieties may be rather similar.

The plants included here have long been known as *T. arcuatum* Piper or as f. *arcuatum*. In his original description Piper cited a type and four other specimens. I have examined three of these and they are var. *Piperi,* but Piper's type specimen is a two-ovuled plant belonging with the typical variety. It is therefore necessary to redescribe the entity as a new variety.

c. T. ERIOCEPHALUM Nutt. var. **Cusickii** (Piper) comb. nov. *T. arcuatum* Piper var. *Cusickii* Piper, Bull. Torrey Bot. Club 29: 641. 1902. *T. harneyense* Howell, Fl. N. W. Am. 1: 134. 1897; type, Harney Valley, Oregon, 1887, *T. Howell. T. arcuatum* Piper var. *harneyense* (Howell) McDerm. N. Am. Species Trifolium 231. 1910. *T. tropicum* Nelson, Bot. Gaz. 54: 409. 1912; type, Jordan Valley, Owyhee County, Idaho, June 22, 1911, *J. F. Macbride 967* (isotypes, Gray Herb.).

Leaflets all linear or very narrowly lanceolate, 2–6 mm. wide, 30–75 mm. long, with slender acuminate apices, glabrous or more often villous, especially along the midveins, often folded and falcate; calyx one-third to one-half as long as the banner; legume sparingly to densely villous towards the apex, 4–5-ovuled, 1–3-seeded. Flowering in June and July.

Type. Camp Creek, Maureys Mountains, Oregon, July 2, 1901, *W. C. Cusick 2628* (istoypes, Univ. Calif., Gray Herb.).

Distribution. Eastern Oregon, northeastern Nevada, and adjacent Idaho; in moist meadows and open woodland, 4000 to 7000 (?) feet elevation.

Representative material. *E. I. Applegate 7724, 7754; C. C. Bruce 2290; L. Constance (Henderson 9646); W. C. Cusick 1659a, 2049, 2075a; A. A. Heller 9032; M. E. Peck 2327, 10375, 13895; J. W. Thompson 12058.*

McDermott called this entity f. *harneyense,* basing her usage on Piper's reduction of *harneyense* to a variety under *arcuatum.* She gives the date for this change as 1901 but does not cite the publication by name. I suspect that the combination actually never had been made and therefore *Cusickii* is the earliest valid varietal name.

d. T. ERIOCEPHALUM Nutt. var. **villiferum** (House) comb. nov. *T. villiferum* House, Bot. Gaz. 41: 335. 1906. *T. eriocephalum* Nutt. f. *villiferum* (House) McDerm. N. Am. Species Trifolium 242. 1910.

Leaflets elliptical or oblong, rounded, more rarely acute, 7–13 mm. wide, 30–50 mm. long, all leaflets moderately to densely villous on both sides; calyx one-half or less the length of the banner; legume villous, 4-ovuled, 1–2-seeded. Flowering in June and July.

Type. Beaver City, Beaver County, Utah, 1877, *E. Palmer 91* (isotype, N. Y. Bot. Gard.).

Distribution. South central Utah, 6000 to 7000 (?) feet elevation.

Representative material. Deep Creek, June 6, 1891, *M. E. Jones;* Ibapah, June 22, 1891, *M. E. Jones.*

A number of collections show characters intermediate between the varieties *Piperi* and *Cusickii,* from which this variety is distinguished mainly by the possession of broad, always villous leaflets. The range of the available specimens is so far removed from those of the other varieties that I recognize the variety with less basis than usual. In some ways var. *villiferum* is intermediate between var. *Cusickii* and var. *Piperi.*

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PINUS: THE FERTILE SPECIES HYBRID BETWEEN KNOBCONE AND MONTEREY PINES

PALMER STOCKWELL AND F. I. RIGHTER

Fresh pollen collected from Monterey pine (*Pinus radiata* Don) growing a few feet above sea level near Monterey, California, was applied in April, 1927, to receptive conelets of the Sierra foothill form of knobcone pine (*Pinus attenuata* Lemmon) growing at an altitude of 3000 feet near Placerville, California, by Messrs. J. S. Barnes and W. C. Cumming of the Institute of Forest Genetics (then known as the Eddy Tree Breeding Station). The hand-pollinated cones were harvested in the autumn of 1928, and the hybrid seeds from these cones were sown in a seedbed the following spring. Twenty-eight two-year-old seedlings from this cross were planted in a block at 15 by 15-foot intervals in the Eddy Arboretum. Adjacent to them were planted a few seedlings of the two parent species.

In February, 1932, a cold wave swept the Sierra foothills. Minimum air temperatures at 16.4° F. at four feet above the ground and 15.4° F. at ground level were recorded at the Institute weather station. Seedlings of the knobcone pine were not injured by this temperature; some foliage of the hybrids was lightly frosted; and all the Monterey pine seedlings were either killed or permanently deformed. Absence of permanent injury to the hybrids, at a temperature that was ruinous to one of the parent species, stimulated interest in their subsequent behavior. Later, in January, 1937, when the trees withstood a temperature of 11.8° F., their resistance to cold was further emphasized.

When the hybrid trees were 16 years old, in April, 1945, they presented a relatively uniform appearance, although measurements revealed considerable difference in size between trees. The tallest tree was 61.7 feet, the shortest 42.0 feet, and the average was 52.3 feet. The tree of greatest girth was 19.3 inches in diameter at breast height, the smallest was 9.5 inches, and the average was 12.8 inches. Adjacent knobcone pines of the same age averaged 39.6 feet in height and 10.1 inches in diameter. Adjacent Monterey pines planted at the same time had been killed or so badly damaged by frost that measurements were meaningless; however, other Monterey pines that escaped the freeze in another part of the arboretum have shown a somewhat greater growth rate than that of the hybrid trees.

The F_1 hybrid is more limby than Monterey pine but otherwise similar in general appearance. Because of its numerous, heavy branches, it is not recommended as a timber tree; it may prove to be a desirable ornamental tree, however, in localities that are slightly too cold for Monterey pine.

Some of the hybrid trees produced cones and catkins when they were four years old, and ten years all were bearing a dozen or more cones per tree annually. In 1940 seed from open-pollinated cones (mutual wind pollination between F_1 hybrids) and seed of knobcone pine were planted in a seedbed. After five years the seedlings were compared. While there was much variation in individual growth rate, in general the F_2 hybrids grew faster than knobcone pine seedlings. Although the F_1 hybrid grew more slowly than Monterey pine, the growth rate of some individuals of the F_2 population compares favorably with that of the best Monterey seedlings.

Because many of the F_2 hybrids had not yet borne cones, the preliminary survey was limited to the distribution of needle characters. Of 73 seedlings examined, 76.6 per cent had fine or medium slender needles resembling those of Monterey pine, while 23.4 per cent had coarser needles much like those of knobcone pine. The needles of 21.9 per cent of the trees had the chalky-white stomata characteristic of knobcone pine, 28.7 per cent had translucent stomata similar to those of Monterey pine, and 49.4 per cent had stomata that were intermediate in character.

The character segregation (Table 1) is based on small numbers of specimens, and must be regarded with suspicion because possible disturbing factors are not yet known. However, the fertility of the F_1 hybrid seed, the small percentage of abortive pollen, and the general segregation of other characters all suggest that the parents of this hybrid are closely related forms, at most ecospecies of the Turesson relationship concept, rather than distinct or remote species of the Linnaean concept. The natural crossing of these entities where their ranges impinge adds corroborative evidence to this concept of their relationship. Monte-

TABLE 1

Morphological characters that distinguish *Pinus attenuata* × *P. radiata* F_1 and F_2 from the parent species

Characters	*Pinus attenuata*	*Pinus radiata*	F_1 hybrid (*P. attenu-radiata*)	F_2 hybrid
Tree form	low, spreading, or erect	tall, excurrent	tall, excurrent	excurrent
Branching	profuse, ramified, irregular	less profuse, whorled	intermediate	segregation not known
Growth rate	moderate	rapid	rapid	rapid
Frost resistance	uninjured at 16° F.	killed or deformed at 16° F.	uninjured at 16° F.	not known
Bark	gray-green, late forming, trunk smooth	dark gray, early forming, trunk rough	intermediate	not known
Foliage color	gray-green	dark clear green	dark clear green	mostly dark green
Needle arrangement	in threes, sparse	in threes, abundant	in threes, abundant	in threes
Needle thickness	relatively coarse	slender, flexible	relatively slender or intermediate	23.4% coarse 76.6% fine or intermediate
Resin canals	usually two, sometimes more	two	two	two, occasionally absent
Stomata, color	glaucous, chalky white	translucent, not glaucous	all more or less chalky	21.9% chalky, others translucent or intermediate
Stomata, shape	sunken, margins flat	conic, margins raised	segregating, mostly intermediate	segregation approximately 37% sunken; 63% conic or intermediate
Cones, position	many on trunk, often embedded in the wood	few on trunk, seldom embedded	intermediate	not known
Cone scale, apophysis	yellow, carinate, narrowly tuberculate	brown, tumescent-tuberculate	brown, shape intermediate and variable	not known
Cone scale, spine	prominent, spine introrse	obscure, spine retrorse or absent	variable, introrse, retrorse, or obsolete	not known
Pollen	2% approximately abnormal	4% approximately abnormal	6–12% abnormal	not known

rey pine hybridizes naturally with the coastal form of knobcone pine near Swanton, Santa Cruz County, California.

The findings regarding this hybrid illustrate a considerable and growing body of experimental evidence that challenges the accepted taxonomic placement of the recognized species of the genus *Pinus*. It is suspected that the commonly recognized species may, in many instances, conform closely to the subspecies of present-day thinking. One ancillary value of the pine breeding work being done at the Institute of Forest Genetics is the accumulation of experimental evidence that may contribute to a revision of the genus.

To record this hybrid form it is herewith described. The name proposed was chosen to show the derivation of the hybrid and to avoid the confusion that might follow the use of an orthodox name that gives no clue to the origin of the form described.

Pinus attenuradiata hybr. nov.

Arbor hybrida (*Pinus attenuata* × *P. radiata*), altitudo mediocris, recta, pyramidata vel sub-rotunda, *Pinus radiata* similis; ramis numerosis, verticillatis, adscensis, apicibus diffusis; ramulis asperatis, squamis superioribus hyalinis; corte asperato, crasso, obscuro; gemmis terminalibus ovatis, acutis, 5–8 mm. longis, fuscis vel sub-rufis; foliis ternis, raro binis aut quaternis, circa 10 cm. longis, tenuibus, obscuro-viridibus; vaginis 10–15 mm. longis, adpressis, persistentibus, membranaceis, squamis pallidis aut sub-rufis, marginibus albidis, fimbriatis; canalibus resiniferis, medianis; iulis staminiferis ovato-cylindratis, 10 mm. longis; conis inaequalibus, ovatis, 2–5 verticillatis, sub-sessilibus, 8–15 cm. longis, 4–8 cm. crassis, squamis obscuro-fuscis, apophysis pyramidatis, tumidis; umbonibus planis aut elatis, spinis retrorsis, introrsis aut obsoletis; seminibus obovatis, truncatis, rugosis, 5 mm. longis, 3 mm. latis, 1.5 mm. crassis, testis coriaceis, nigris; alis oblongis, obliquis, obtusis.

Type. Eddy Arboretum, Placerville, Eldorado County, California, August 21, 1945, *Stockwell* and *Kimbrough 2012* (Herbarium of the University of California no. 694111; isotype, Dudley Herbarium, Stanford University, California).

Institute of Forest Genetics, Placerville, California,
a branch of the California Forest and Range Experiment Station,
maintained by the Forest Service,
United States Department of Agriculture,
in cooperation with the University of California at Berkeley.

A NEW ALPINE GLYCERIA FROM CALIFORNIA

Alan A. Beetle

The number of grass species confined to elevations of 9000 feet or higher in the Sierra Nevada of California is remarkably few. As reported to date they appear to be comprised of a pair of species each for *Poa* and *Agrostis* as follows: *Poa rupicola, P. Suksdorfii, Agrostis humilis,* and *A. Rossae.* Here, also, *Alopecurus geniculatus, A. aequalis* and *Koeleria cristata* occur as a disrupted and isolated part of their distribution for they are known also from northern and coastal California. Study has failed to reveal specific differences in the high montane phases of these last three species. It is of unusual interest, then, to find in these California mountains a dwarf species of *Glyceria,* of the section *Hydropoa* Dum., associated on the margins of alpine lakes with the equally restricted *Scirpus Clementis* Jones.

Glyceria californica sp. nov. Perennis pusilla; culmi erecti, usque ad 2 dm. alti; laminae usque ad 5 mm. latae; paniculae viride aut purpurascentes, erectae, scabrae, 3–6 cm. longae; spiculae circa 3 mm. longae, cum 3 ad 5 floris; glumae obtusae, gluma prima 1.26 mm. longa, gluma secunda 1.75 mm. longa; lemmae inferiorae cum 7 nervis, scabrae; paleae subaequalae.

Dwarf perennial; culms not over 2 dm. tall; blades up to 5 mm. broad, frequently exceeding the panicle; panicle green or becoming purple, 3–6 cm. long, erect, the short branches ascending, strongly scabrous; spikelets ca. 3 mm. long, 3- to 5-flowered; glumes broadly obtuse, the first 1.25 mm. long, the second 1.75 mm. long; lower fertile lemmas 3 mm. long, prominently 7-nerved, scabrous on and between the nerves, the apices erose; palea subaequal.

Type. Farewell, Tulare County, California, altitude 10,000 to 11,000 feet, *C. A. Purpus 2057* (type, Herbarium of the University of California, no. 121966). Also known from Rae Lake, Fresno County, *Mrs. Joseph Clemens* in 1910 (Clokey Herbarium at the University of California, Berkeley).

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A LIST OF ALGAE CHIEFLY FROM THE ALPINE ZONE OF LONGS PEAK, COLORADO

Walter Kiener

Phytogeographic considerations make it important to call attention to the fact that Colorado has a range of elevation from 3350 feet above sea level (at the Arkansas River, Prowers County) to 14,420 feet at Mount Elbert. The approximate mean elevation for the entire state, as determined by the United States Geological Survey, is 6800 feet, which is higher than the average elevation of any other of the United States of America.

This wide range of elevation implies a wide range of climatic conditions to which the vegetation is adapted and results in the presence of a great variety of floral elements. Climatic conditions and characteristics of the flora in the alpine zone on Longs Peak are similar in many ways to those prevailing above the Arctic Circle. Not enough is known at the present time about the distribution of the algae in the alpine zone of the mountains of the United States to draw conclusions regarding the characteristic distribution patterns of the ninety-two entities here enumerated.

The data and the specimens here reported came chiefly from the alpine zone on Longs Peak, and were made as a part of a detailed survey of the vegetation of the alpine zone on that mountain. A few other collections from the lower life zones of Longs Peak and vicinity, as well as from other areas are listed here for the phytogeographic record. The collection numbers are those of the author. A given number may appear under several species because the collection contained an inseparable mixture. On the herbarium label the most abundant species is listed first, and the mixed specimen is filed under that species name.

Longs Peak is located at about latitude 40 degrees north. The alpine zone reaches from approximately 11,000 feet to 14,255 feet, the summit of Longs Peak. There is much overlapping of habitats between the alpine zone and the subalpine zone. Some alpine habitats may be as low as 11,000 feet, whereas, subalpine habitats under favorable conditions may be found up to nearly 12,000 feet. A habitat is here considered alpine or subalpine, respectively, on the basis of the kind of vegetation it supports. The county line between Larimer and Boulder counties crosses Longs Peak almost on its summit. Boulder Field is a shallow basin on the north flank of Longs Peak, and Chasm Lake in Chasm Gorge is on the east flank.

The writer is indebted to Mildred Hallberg Jones for many identifications in the earlier stages of the work. For the determinations of the diatoms, credit is due Dr. Ruth Patrick of the Philadelphia Academy of Sciences. But the identifications of nearly all specimens were made by Dr. Francis Drouet of the Chicago Natural History Museum, where the specimens are now on file in the cryptogamic herbarium. Without his help, always courteous and efficient, this list could not have been completed.

Chroococcaceae

Chroococcus turgidus (Kütz.) Näg. Larimer County: Boulder Field, 12,560 feet; alpine; with other algae in small streamlet, September 16, 1933, *171*. Custer County: South Colony Basin at base of Humboldt Peak, 11,500 feet; subalpine; over mosses on soil, July 9, 1941, *10393*.

Gloeocapsa violacea Kütz. Boulder County: Middle St. Vrain Valley, 7900 feet; montane; with other algae forming a purple-reddish crust on north-facing, intermittently wet, siliceous cliffs, October 11, 1937, *6245*.

GLOEOCAPSA GRANOSA (Berk.) Kütz. Larimer County: north slope of Mount Lady Washington, 12,000 feet; alpine; among squamulose lichens of snowpatch vegetation, July 31, 1936, *4434;* Boulder Field, 12,700 feet; alpine; on thallus of the lichen *Solorina crocea* in snowpatch vegetation, September 5, 1935, *7640*. Boulder County: alpine shore of Chasm Lake, 11,900 feet; alpine; among hepatics and squamulose lichens, July 25, 1938, *6410*.

GLOEOCAPSA MAGMA (Breb.) Kütz. Larimer County: near Chasm Lake, 11,700 feet; alpine; with other algae forming a blackish crust on wet, siliceous cliffs near Chasm Lake, October 7, 1937, *5682*. Boulder County: Middle St. Vrain Valley, 7900 feet; montane; with other algae forming a reddish crust on north-facing, intermittently wet, siliceous cliffs, October 11, 1937, *6245*. Custer County: South Colony Basin at base of Humboldt Peak, 11,500 feet; subalpine; on soil over mosses and pebbles, July 9, 1941, *10392, 10393, 10394*.

APHANOCAPSA RIVULARIS (Carm.) Rabh. Larimer County: east slope of Longs Peak at timberline, 11,100 feet; subalpine; with diatoms in shallow streamlet, September 8, 1933, *156;* Boulder Field, 12,700 feet; alpine; on thallus of *Solorina crocea* in snowpatch vegetation, September 5, 1935, *7644*. Custer County: South Colony Basin at base of Humboldt Peak, 11,500 feet; subalpine; over mosses on soil, July 9, 1941, *10393a*.

ANACYSTIS MARGINATA Menegh. Boulder County: Peaceful Valley, 9500 feet; subalpine; with other algae in shallow pool in spruce-fir forest, August 5, 1934, *1268;* summit of Longs Peak, 14,250 feet; alpine; growing over moss on intermittently wet rocks, September 14, 1936, *4768;* near Sandbeach Lake, 10,350 feet; subalpine; over lichen on wet ground of spruce-fir forest, September 12, 1937, *5597*.

ANACYSTIS PENIOCYSTIS (Kütz.) Dr. and Daily. Boulder County: Peaceful Valley, 9500 feet; subalpine; with other algae in shallow pool in spruce-fir forest, August 5, 1934, *1268;* near Chasm Lake, 11,800 feet; alpine; on intermittently wet, siliceous cliffs, September 18, 1934, *1277*.

ANACYSTIS RUPESTRIS (Lyngb.) Dr. and Daily. Park County: Hoosier Pass, 11,000 feet; subalpine; growing over moss on wet ground, September 1, 1938, *6705a*. Larimer County: Lily Lake, 9000 feet; montane; shallow water of shore, September 22, 1942, *13175*.

SYNECHOCOCCUS AERUGINOSUS Nag. Custer County: South Colony Creek, 11,500 feet; subalpine; growing over moss on rock ledge, July 9, 1941, *10393a*.

CHAMAESIPHONACEAE

CHAMAESIPHON INCRUSTANS Grun. Boulder and Larimer counties: alpine; apparently fairly common on filaments of various algae in streamlets and on wet cliffs at altitudes from 11,000 to 13,800 feet on Longs Peak. Tentative determinations were made, but no herbarium specimens prepared. The species was found to grow in one instance also on moss protonema and in another on fragments of submerged dead moss leaves.

Chamaesiphon polonicus (Rostaf.) Hansg. Boulder County: Chasm Gorge, 12,000 feet; alpine; on wet cliffs with lichen, September 21, 1936, *4187a*.

Chamaesiphon Rostafinskii Hansg. Larimer County: Alpine Brook at base of Longs Peak, 8900 feet; montane; shallow, running water, September 22, 1942, *13126*.

Oscillatoriaceae

Oscillatoria amphibia Gom. Larimer County: Boulder Field, 12,500 feet; alpine; with other algae in shallow streamlet, August 22, 1933, *154, 155, 156;* east slope at timberline on Longs Peak, 11,200 feet; subalpine; in shallow streamlets supplied by snow water, September 20, 1933, *178;* Granite Pass on Longs Peak, 11,900 feet; alpine; with other algae in shallow streamlet, September 20, 1932, *1428*.

Oscillatoria limosa Gom. Larimer County: Boulder Field, 12,500 feet; alpine; in shallow streamlet, August 22, 1933, *156*.

Oscillatoria proboscidea Gom. Larimer County: Boulder Field, 12,500 feet; alpine; in shallow streamlet, September 16, 1933, *157*.

Phormidium ambiguum Gom. Boulder County: north face of Longs Peak, 13,800 feet; alpine; among wet, siliceous rocks, September 10, 1937, *5570*.

Phormidium autumnale Gom. Boulder County: east face of Longs Peak, 12,500 feet; alpine; over wet mosses, August 9, 1936, *3860;* Chasm Gorge, 12,000 feet; alpine; with lichens on wet rocks, September 21, 1936, *4197*.

Phormidium subfuscum Gom. Boulder County: west face of Longs Peak, 13,300 feet; alpine; with lichens on wet, siliceous rocks, September 20, 1935, *3408a*.

Phormidium subfuscum var. Joannianum Gom. Boulder County: Mount Alice, 11,700 feet; alpine; with *Hydrurus foetidus* in cold spring rivulet, August 23, 1938, *6453*.

Phormidium uncinatum Gom. Larimer County: Alpine Brook at base of Longs Peak, 8900 feet; montane; reddish film in shallow running water, September 22, 1942, *13127*.

Lyngbya Diguetii Gom. Larimer County: Longs Peak, 9600 feet; subalpine; in rapids of Alpine Brook, September 11, 1935, *3361a*.

Lyngbya versicolor Gom. Boulder County: north face of Longs Peak, 14,000 feet; alpine; over mosses on wet ledge (cultured in laboratory), July 25, 1933, *167b*.

SYMPLOCA MUSCORUM (Ag.) Gom. Larimer County: east slope of Longs Peak, 11,100 feet; subalpine; over mosses among willows, August 15, 1934, *1603a;* among mosses and grasses, August 15, 1934, *1606;* on rotting wood on soil, September 16, 1934, *1753.* Park County: south side of Hoosier Pass, 11,100 feet; subalpine; over moss on wet ground, September 1, 1938, *6710.* Custer County: South Colony Basin at base of Humboldt Peak, 11,500 feet; subalpine; on soil among *Riccia* and *Selaginella, 10210;* on soil among mosses, July 8, 1941, *10262.*

MICROCOLEUS LACUSTRIS Gom. Custer County: South Colony Basin at base of Humboldt Peak, 11,700 feet; subalpine; soil among mosses, August 8, 1941, *10275.*

MICROCOLEUS VAGINATUS Gom. Larimer County: east slope of Longs Peak at timberline, 11,100 feet; subalpine; over mosses on ground, September 16, 1934, *1753.* Boulder County: Keyhole on Longs Peak, 13,200 feet; alpine; damp walls inside of primitive stone shelter, September 20, 1935, *3404.* Custer County: South Colony Basin at base of Humboldt Peak, 11,700 and 12,000 feet; subalpine; soil among bryophytes and lichens, July 8, 1941, *10207, 10262, 10275.*

SCHIZOTHRIX HEUFLERI Gom. Larimer County: near Chasm Lake, 11,700 feet; alpine; with other algae forming a blackish, shiny crust of considerable extent on wet, siliceous cliffs, October 7, 1937, *5682.* Teton County, Wyoming: on rocks at the subalpine shore of Jenny Lake, 6775 feet, September 8, 1936, *6065.*

SCHIZOTHRIX LACUSTRIS Gom. Larimer County: Alpine Brook on Longs Peak, 9600 feet; subalpine; on rocks in rapids, September 18, 1935, *3361b.*

SCHIZOTHRIX MUELLERI Gom. Larimer County: east slope on Longs Peak, at timberline, 11,100 feet; subalpine; among grasses and mosses, August 15, September 16, 1934, *1603, 1606, 1611.*

SCHIZOTHRIX PURCELLII W. R. Tayl. Larimer County: Boulder Field, 12,570 feet; alpine; soil among mosses in *Elyna Bellardi* community, September 12, 1935, *3253a.* Custer County: South Colony Basin at base of Humboldt Peak, 11,700 feet; subalpine; on ground over mosses, July 21, 1939, *6956.* Clear Creek County: Berthoud Pass, 10,500 feet; subalpine; among mosses, July 10, 1942, *W. L. Tolstead 10181a.*

SCHIZOTHRIX TINCTORIA Gom. Larimer County: Alpine Brook on Longs Peak, 9600 feet; subalpine; on rocks in rapids, September 18, 1935, *3361.*

SCHIZOTHRIX FRAGILIS Gom. Larimer County: Boulder Field, 12,700 feet; alpine; on thallus of the lichen *Solorina crocea* in snowpatch vegetation, September 5, 1935, *7642.*

PLECTONEMA NOSTOCORUM Gom. Larimer County: near Chasm Lake, 11,800 feet; subalpine; on intermittently wet, siliceous cliff, September 18, 1934, *1277;* Alpine Brook on Longs Peak, 9600 feet; subalpine; on rocks in rapids, September 18, 1935, *3361;*

Lily Lake, 9000 feet; montane; shallow water of shore, September 22, 1942, *13175*.

Plectonema purpureum Gom. Larimer County: east slope at timberline on Longs Peak, 11,100 feet; subalpine; inside of old bottle on soil under willows, September 15, 1933, *168*.

Nostocaceae

Nostoc commune B. and F. Larimer County: Boulder Field, 12,560 feet; alpine; shallow streamlet, August 22, 1933, *142, 146*. Boulder County: east face of Longs Peak, 13,800 feet; alpine; over mosses on wet, siliceous rock-ledges, August 16, 1934, *1286*. Park County: Hoosier Pass, 11,000 feet; subalpine; on wet ground over mosses, September 1, 1938, *6709*. Saguache County: Kit Carson Peak, 13,000 feet; alpine; in shallow cold-water pool, August 27, 1938, *6511*. Custer County: South Colony Basin at base of Humboldt Peak, 11,700 feet; subalpine; soil among bryophytes and lichens, July 8, 1941, *10262*.

Nostoc cf. muscorum B. and F. Microscopic study of mosses and lichens collected on Longs Peak at elevations ranging from 8000 to 13,700 feet showed this species to be present in eight collections. It was identified tentatively according to descriptions in the literature.

Nostoc parmelioides B. and F. Larimer County: Alpine Brook at base of Longs Peak, 8900 feet; montane; rocks in swift water, September 22, 1942, *13132;* Roaring River below Lawn Lake, 10,500 feet; subalpine; rocks in swift water, September 22, 1942, *13206*.

Cylindrospermum majus B. and F. Larimer County: base of Longs Peak, 9000 feet; montane; on soil among bryophytes and grasses, June 29, 1931, *10201a*.

Scytonemataceae

Scytonema Hofmannii B. and F. Boulder County: Long Lake, 10,400 feet; subalpine; soil among grasses and mosses, August 15, 1938, *6935*.

Scytonema figuratum B. and F. Larimer County: Boulder Field, 12,560 feet; alpine; with other algae in small streamlet, August 22, 1933, *140, 144, 147;* Granite Pass, 11,900 feet; alpine; shallow streamlet, September 17, 1934, *1276*. Boulder County: below Chasm Lake, 11,800 feet; subalpine; in shallow streamlet, August 1, 1934, *1285*.

Scytonema ocellatum B. and F. Custer County: South Colony Basin at base of Humboldt Peak, 11,700 feet; subalpine; soil among bryophytes and lichens, July 8, 1941, *10264*.

Scytonema tolypotrichoides B. and F. Larimer County: Boulder Field, 12,500 feet; alpine; in small streamlet with other algae, August 22, 1933, *141;* Granite Pass, 11,900 feet; alpine; shallow streamlet, September 17, 1934, *1275*.

Tolypothrix conglutinata B. and F. Larimer County: Boulder Field, 12,560 feet; alpine; in shallow streamlet, August 22, September 17, 1933, *142, 146, 158.*

Tolypothrix penicillata B. and F. Larimer County: Alpine Brook at base of Longs Peak, 9100 feet; montane; on submerged, siliceous rocks, October 12, 1936, *5079.*

Tolypothrix tenuis B. and F. Larimer County: Granite Basin, 11,300 feet; subalpine; shallow streamlet, September 14, 1932, *126.*

Desmonema Wrangelii B. and F. Larimer County: Boulder Field, 12,560 feet; alpine; in small streamlet with other algae, August 22, 1933, *142.* Boulder County: east face of Longs Peak, 13,800 feet; alpine; with other algae over mosses on wet, siliceous rock, August 16, 1934, *1288.*

Stigonemataceae

Stigonema mamillosum B. and F. Larimer County: Boulder Field, 12,560 feet; alpine; with other algae in small streamlet, August 22, September 16, 1933, *141, 159.*

This species is probably more abundant than these two records would indicate, but it seems impossible in the field to separate it from *Ephebe solida,* a lichen. Apparently it is only a matter of time and development when fungal hyphae infest the filamentous alga and transform it into the lichen. This lichen is fairly common in cold water and on wet ledges in the alpine zone.

Stigonema minutum B. and F. Larimer County: Boulder Field, 12,560 feet; alpine; with other algae in small streamlet, August 22, 1933, *140.* Boulder County: South St. Vrain Canyon, 7200 feet; montane; wet ground among mosses, September 29, 1938, *8804.*

Stigonema panniforme B. and F. Larimer County: Boulder Field, 12,570 feet; alpine; on ground on squamulose lichens, September 12, 1935, *3253a.*

Stigonema turfaceum B. and F. Larimer County: Boulder Field, 12,560 feet; alpine; with other algae in small streamlet, August 22, 1933, *139;* Granite Pass, 11,900 feet; subalpine; with other algae in shallow streamlet, September 17, 1934, *1276.*

Rivulariaceae

Calothrix parietina B. and F. Boulder County: creek at St. Malo, 8700 feet; montane; on rocks in creek, October 13, 1936, *2346.* Larimer County: near Chasm Lake, 11,700 feet; subalpine; with other algae forming a blackish crust on wet, siliceous cliffs, October 7, 1937, *5682.* Custer County: South Colony Basin at base of Humboldt Peak, 11,700 feet; subalpine; soil among bryophytes and lichens, July 8, 1941, *10275.*

Tribonemataceae

Tribonema bombycinum (Ag.) Derb. and Sol. Larimer and Boulder counties: 22 collections of this species were recorded during the months June, July, August and September at altitudes ranging from 10,400 to 14,000 feet. The plants were found in shallow streamlets, on wet, siliceous rock-cliffs, and over intermittently wet mosses on Longs Peak and vicinity.

Hydruraceae

Hydrurus foetidus (Vill.) Kirchn. Larimer County: Longs Peak, 10,800 feet; subalpine; in shallow streamlet among willows, September 16, 1935, *3384*. Boulder County: Mount Alice, 11,700 feet; alpine; with *Phormidium* in cold, spring rivulet, August 23, 1938, *6453*.

Coscinodiscaceae

Melosira ambigua (Grun.) Müll. Larimer County: east slope at timberline on Longs Peak, 11,100 feet; subalpine; in sediment in shallow pool among willows, September 20, 1933, *162, 163*.

Meridionaceae

Meridion circulare (Grev.) Ag. Boulder County: Hunters Creek on the south side of Longs Peak, 10,000 feet; subalpine; with *Spirogyra* in shallow, running water, September 1, 1934, *1293*.

Diatomaceae

Odontidium anceps Ehr. Larimer County: recorded seven times in August and September, 1933, from the alpine zone on Longs Peak where it was found among other algae or in the sediment of shallow streamlets ranging in elevation from 11,100 at timberline to 13,800 feet on the east face of Longs Peak; Alpine Brook at base of Longs Peak, 9100 feet; montane; on sediment at edge of water, October 2, 1936, *4933*. Boulder County: Hunters Creek on the south side of Longs Peak, 10,000 feet; subalpine; with *Spirogyra* in shallow, running water, September 1, 1934, *1293*.

Odontidium hiemale (Lyngb.) Kütz. Boulder County: Hunters Creek on the south side of Longs Peak, 10,000 feet; subalpine; with *Spirogyra* in shallow, running water, September 1, 1934, *1293*.

Odontidium hiemale var. mesodon (Ehr.) Grun. Larimer County: east slope of Longs Peak at timberline, 11,100 feet; subalpine; in sediment in shallow pool, September 20, 1933, *163a;* Alpine Brook at base of Longs Peak, 9100 feet; montane; on sediment at edge of water, October 2, 1936, *4933*.

Fragilariaceae

Fragilaria Vaucheria (Kütz.) Boyl. Boulder County: Hunters Creek on the south side of Longs Peak, 10,000 feet; subalpine; September 1, 1934, *1293*.

Eunotiaceae

Eunotia monodon Ehr. Larimer County: Boulder Field, 12,560 feet; alpine; shallow streamlet, August 22, 1933, September 12, 1935, *155, 3254*. Boulder County: east face of Longs Peak, 13,800 feet; alpine; with other algae over mosses on wet, siliceous rock, August 16, 1934, *1288*.

Eunotia praerupta Ehr. Boulder County: east face of Longs Peak, 13,800 feet; alpine; with other algae over mosses on wet, siliceous rock, August 16, 1934, *1288*. Larimer County: Boulder Field, 12,567 feet; alpine; with sterile *Zygnema* in shallow streamlet, September 12, 1935, *3254*.

Eunotia robusta Ralfs. Larimer County: Boulder Field, 12,567 feet; alpine; with sterile *Zygnema* in shallow streamlet, September 12, 1935, *3254*.

Eunotia tridentula var. perminuta Grun. Larimer County: east slope of Longs Peak, at timberline, 11,100 feet; subalpine; in sediment in shallow pool among willows, September 20, 1933, *163a;* Granite Pass, 11,900 feet; alpine; with other algae in shallow streamlet, September 17, 1934, *1274*.

Ceratoneis arcus (Ehr.) Kütz. Boulder County: Hunters Creek on the south side of Longs Peak, 10,000 feet; subalpine; with *Spirogyra* in shallow, running water, September 1, 1934, *1293*. Larimer County: Alpine Brook on Longs Peak, 9100 feet; montane; in creek, October 2, 1936, *4933*.

Achnanthaceae

Achnanthes lanceolata (Breb.) Grun. Larimer County: east slope of Longs Peak at timberline, 11,100 feet; subalpine; in shallow pool among willows, September 8, Sept. 20, 1933, *137, 163a*. Boulder County: Hunters Creek on the south side of Longs Peak, 10,000 feet; subalpine; with *Spirogyra* in shallow, running water, September 1, 1934, *1293*.

Achnanthes marginulata Grun. Larimer County: Boulder Field, 12,560 feet; alpine; in sediment of small streamlet, August 22, 1933, *148*.

Naviculaceae

Pinnularia borealis Ehr. Boulder County: east face of Longs Peak, 13,800 feet; alpine; with other algae over mosses on wet, siliceous rock, August 16, 1934, *1288*. Larimer County: Boulder Field, 12,567 feet; alpine; with sterile *Zygnema* in shallow streamlet, September 12, 1935, *3254*.

Nitzschiaceae

Hantzschia amphioxys (Ehr.) Grun. Larimer County: east slope at timberline on Longs Peak, 11,100 feet; subalpine; from sediment of shallow pool among willows, September 8, 1933, *137*.

Chlamydomonadaceae

Chlamydomonas nivalis Wille. Larimer County: Jims Grove, Longs Peak, 11,200 feet; alpine; in surface of snow on snowpatch, September 14, 1933, *180;* Iceberg Lake, 12,000 feet; alpine; in surface of snow on snowpatch, September 21, 1935, *3362*. Custer County: Crestone Needle, 12,500 feet; alpine; in surface of snow, July 10, 1941, *10227*. This species is the cause of the phenomenon known as "red snow." It occurs sporadically during certain years and not in others, but when it does occur it usually is found on all the larger patches of snow. Numerous microscopic examinations were made of this snow organism in the living condition, but no motile cells were ever observed. Based on literature and illustrations, the writer identifies the organism as this world-wide species. Much more, however, needs to be known about the taxonomy and biology of this interesting plant.

Chlamydomonas yellowstonensis Kol. Custer County: South Colony Basin at base of Humboldt Peak, 10,700 feet; subalpine; inside of surface of snow in residual snowdrifts in spruce forest, July 2, July 11, 1941, *10228*.

On parts of residual, fast-melting snowdrifts, whose surfaces were soiled by dirt and pine needles, a greenish tinge was observed. Upon scratching these tinged surfaces, a much more vivid green color appeared. A small glass jar was filled with "green snow" and taken along to camp at timberline where the jar was kept in a snowdrift for eight days. The snow inside the jar melted and the green algae settled on the bottom of the jar, but before eight days were ended, the algae had deteriorated. On July 11, upon leaving camp, another collection was made and preserved in formalin. These plants seem to agree with the description and illustrations as recently published by Erzsebet Kol (Am. Jour. Bot. 28: 185–190. 1941). There were, however, no motile cells observed. On the whole the cells averaged slightly larger in size in this material. The snow drifts were similar to those figured by Kol and also were from the spruce-fir life zone.

Palmellaceae

Gloeocystis vesiculosa Näg. Boulder County: east face of Longs Peak, 12,500 feet; alpine; growing on lichen squamules on siliceous rock-ledges, August 9, 1936, *3866*.

Asterococcus superbus (Cienk.) Scherff. Larimer County: Boulder Field, 12,560 feet; alpine; with other algae in shallow streamlet, September 16, 1933, *173*.

Tetrasporaceae

Tetraspora gelatinosa (Vauch.) Desv. Boulder County: near Sandbeach Lake, 10,400 feet; subalpine; in small brook, September 1, 1934, *1273*.

Coccomyxaceae

Ourococcus bicaudatus Grobety. Boulder County: north face of Longs Peak, 14,000 feet; alpine; growing with *Schizogonium* on wet, siliceous rock-ledges, July 25, 1933, *167*.

Ulotrichaceae

Ulothrix aequalis Kütz. Larimer County: Boulder Field, 12,560 feet; alpine; with other algae in shallow streamlet, September 16, 1933, *160*.

Ulothrix tenerrima Kütz. Larimer County: Boulder Field, 12,560 feet; alpine; with other algae in shallow streamlet, August 22, 1933, *153*.

Ulothrix zonata (W. and M.) Kütz. Larimer County: Big Thomson Canyon, west of Loveland, 6500 feet; montane; floating in still water, September 26, 1942, *13274*.

Stichococcus bacillaris Näg. Boulder County: north face of Longs Peak, 14,000 feet; alpine; growing with *Schizogonium* on wet, siliceous rock-ledges, July 25, 1933, *167*.

Stichococcus subtilis (Kütz.) Klerck. Larimer County: east slope at timberline on Longs Peak, 11,100 feet; subalpine; inside of old bottle on soil under willows, September 16, 1933, *168;* between siliceous rocks in snow water, September 20, 1933, *178*. Boulder County: north face of Longs Peak, 14,000 feet; alpine; growing on wet ledges, July 25, 1933, *167a, 167b*.

Microsporaceae

Microspora Willeana Lagerh. Larimer County: east slope of Longs Peak at timberline, 11,100 feet; subalpine; between siliceous rocks in snow water, September 20, 1933, *165*. Boulder County: Sandbeach Lake, 10,400 feet; subalpine; floating in shaded streamlet in spruce forest, September 1, 1934, *1291;* east face of Longs Peak, 13,700 feet; alpine; over wet mosses on siliceous rock-ledges, August 21, 1936, *4005*.

Microspora amoena (Kütz.) Rabh. Larimer County: Alpine Brook, at base of Longs Peak, 8900 feet; montane; shallow, running water, September 22, 1942, *13126*.

Chaetophoraceae

Draparnaldia acuta (Ag.) Kütz. Boulder County: Sandbeach Lake, 10,350 feet; subalpine; shallow water of outlet, September 12, 1937, *5595*.

Schizogoniaceae

Schizogonium spp.

Prasiola spp.

Many representatives of these two genera were found but they need further study.

Chlorococcaceae

Chlorococcum humicola (Näg.) Rabh. Boulder County: north face of Longs Peak, 14,000 feet; alpine; growing on wet rock-ledges, July 25, 1933, *167a*. Larimer County: Alpine Brook on Longs Peak, 9600 feet; subalpine; in rapids of creek, growing with *Prasiola*, September 18, 1935, *3361b*.

Trebouxia Cladoniae (Chod.) G. M. Smith. Larimer County: Hewes Kirkwood at base of Longs Peak, 9100 feet; montane; granite rock on ground, from surface to 5 mm. deep under quartz crystals, October 14, 1936, *2444*, *2445*; Cabin Rock on Twin Sisters Mountain, 9500 feet; subalpine; in surface layer of granitic rock, September 25, 1937, *6297*; east slope of Longs Peak at timberline, 11,100 feet; subalpine; over moss on ground, September 13, 1939, *9085*; east slope of Longs Peak, 9400 feet; subalpine; on soil and over mosses, September 23, 1942, *13187*. Boulder County: summit of Longs Peak, 14,250 feet; alpine; in surface layer of granitic rock, September 14, 1936, *4146*. Saguache County: Crestone Needle, 13,000 feet; alpine; soil and over *Selaginella*, July 8, 1941, *10300b*. Custer County: South Colony Basin at base of Humboldt Peak, 11,500 feet; subalpine; growing on lichen squamules, July 9, 1941, *10390*.

Oocystaceae

Chlorella vulgaris Beyer. Boulder County: west face of Longs Peak, 13,750 feet; alpine; growing with *Schizogonium* over wet, siliceous rocks, July 26, 1932, *1282*.

Ankistrodesmus falcatus (Corda) Ralfs. Boulder County: north face of Longs Peak, 14,000 feet; alpine; growing with *Schizogonium* on wet, siliceous rock-ledges, July 25, 1933, *167*.

Vaucheriaceae

Vaucheria sessilis (Vauch.) DC. Boulder County: Chasm Gorge, 12,200 feet; alpine; floating in cold streamlet, September 2, 1933, *134*, *135*. Larimer County: Mount Lady Washington, 12,000 feet; alpine; bottom of dried-up streamlet, July 31, 1936, *4435*; Alpine Brook on Longs Peak, 9100 feet; montane; wet bank, August 10, 1935, *4948*.

Zygnemataceae

Zygnema insigne (Hass.) Kütz. Boulder County: Thunder Lake, 10,520 feet; subalpine; floating in shallow water at edge of Lake, August 27, 1931, *103*.

Zygnema pectinatum var. anomalum (Ralphs) Kirchner. Larimer County: Boulder Field, 12,560 feet; alpine; shallow streamlet, August 22, 1933, *155*.

Zygogonium ericetorum Kütz. Boulder County: Chasm Lake, 11,800 feet; subalpine; on wet, siliceous rock-cliff, September 18, 1934, *1290*.

Mesotaeniaceae

Cylindrocystis Brebissonii Menegh. Boulder County: near summit of Longs Peak, 14,000 feet; alpine; with *Schizogonium* over moss on wet, siliceous rock, July 22, 1932, *111;* east face of Longs Peak, 12,500 feet; alpine; over lichen squamules on wet, siliceous rock-ledges, August 9, 1936, *3866*.

Desmidiaceae

Hyalotheca dissiliens (Smith) Breb. Boulder County: Sandbeach Lake, 10,350 feet; subalpine; shallow water of outlet, September 12, 1937, *5595*.

Desmids were generally not absent in the collections, particularly those made from the alpine zone, but were never abundant enough for separate determinations.

Characeae

Chara contraria A. Br. Larimer County: Marys Lake, 8000 feet; montane; on bottom in shallow water, August 3, 1930, *2278*. Determined by R. D. Wood.

Game, Forestation and Parks Commission, State of Nebraska,
and
Conservation and Survey Division, University of Nebraska, Lincoln.

REVIEW

Las Pináceas Mexicanas. By Maximino Martínez. Instituto de Biologia, Mexico, D. F., 1945. 345 pp. + 6 pp. index, 300 figs. (180 line drawings, 120 half tones), paper cover. Published also as: Tom. 16, Anales del Instituto de Biologia de la Universidad Nacional de Mexico. 1945.

This book is the result of years of meticulous work by Professor Martínez and is comprehensive in its taxonomic treatment of the genus *Pinus* in Mexico. It contains an extensive discussion of the genus, based on the pines of the New World, under such headings as seed, germination, trunk, bark, buds, branchlets, needles, leaf-sheaths, cones, and several other categories dealing with subheadings under some of the above.

Discussions of damaging insects, fungi, and other pests, of methods used to protect pine lumber, of turpentining methods, and of production and export of resins and other naval stores take up the remainder of the first fifty-two pages. Immediately following is a series of lists, each one giving the species, varieties and forms known to grow in one of the twenty-six states and territories covered. Jalisco and Mexico share honors with seventeen named entities credited to each.

On page fifty-six Professor Martínez begins his discussion of the classification of the pines of Mexico with a brief account of the history of the subject. The taxonomy of *Pinus* in Mexico began in 1832 when Zuccarini described *Pinus cembroides*. Additional species were soon described by authors in Europe and the United States. Gordon, for the first time, brought all available information together in his "Pinetum" in 1858. The next notable works covering the region were those of Shaw, "The Pines of Mexico" in 1909, and his monograph, "The Genus Pinus," published in 1914. Professor Martínez then decries Shaw's ultra conservatism by saying that Shaw followed an exaggerated tendency toward reducing species when he recognized only eighteen species and seventeen varieties of pines in Mexico. The author of this paper, after years of careful study, during which he examined more than 6,000 specimens and travelled extensively in the field, recognizes thirty-nine species, sixteen varieties, and ten formas. These he groups into nine sections. The ninth of the sections, the "Coulteri," contains only the single species, *P. Coulteri* Don. The largest section is the sixth, the "Montezumae," which consists of seven species, four varieties, and four formas. The other sections range between these two extremes in the number of entities included in each. Professor Martínez seems to have toyed with the idea of reducing *P. monophylla* and *P. quadrifolia* to varietal rank under *P. cembroides,* but retained them in specific rank. *P. edulis,* however, is reduced to a variety of *P. cembroides.* The reviewer once wrote to Professor Martínez that, ". . . perhaps *edulis* can be regarded best as a good variety or subspecies of *cembroides,* and that possibly all of that piñon pine group, *cembroides, edulis, monophylla,* and *quadrifolia* are just geographical expressions of one specific complex." This comment undoubtedly was the basis for the statement that "It is the opinion of the last author [Wiggins] that all of the piñons cited are geographical expressions of one specific complex" (p. 80). Obviously the qualifying "perhaps" was overlooked or misinterpreted, for the next sentence in my letter said that I had not studied *cembroides* nor *edulis* in the field, implying thereby that I placed no great weight upon that casual comment. In general, however, the quotations from communications and papers of other workers are well chosen and bolster the conclusions of the author.

A key to the species, which is mainly dichotomous but at places presents three or four parallel choices, is included. In this key use is made of cone shape and size, character of the umbo and apophysis, persistence or caducousness of scales, number, diameter and length of the needles, and a number of lesser characters in differentiating the species. In general the key appears quite workable, but it is doubtful if *P. radiata* and *P. attenuata* could be separated consistently by "Cone oblique, reflexed" (*P. attenuata*) and "Cone almost symmetrical, ovoid, spreading" (*P. radiata*). The key is so constructed that those species possessing the same number of needles in a fascicle fall into the same groups, even though the number of needles is not used as a key-character to the groups.

The description of each species is very complete and is written in a narrative style instead of in the manner followed by botanists in the United States and Europe, who generally omit verbs. The species are not numbered in the key nor in the text. Synonomy is not given for most of the combinations accepted. The reference to the original publication of a species is given in bold face type immediately following or just below the binomial and the author's name, these appearing in capitals but not in bold face. Distribution maps accompany some species while for others a general statement of range suffices, and in still other instances individual listing of localities may supplement or take the place of the general statement of range. Names of the collectors are rarely given, and one is not sure whether the other localities represent those spots where Professor Martínez personally observed the entity or only localities at which others collected or reported the particular pine. In some few cases the statement of range is based upon published comments of earlier writers and is sometimes open to question, e.g., the presence of *P. flexilis* in Baja California (p. 102).

A tabulation of novelties and new combinations reveals one new species, ***Pinus lutea,*** published by Sr. Ing. Cenobio E. Blanco (p. 233), seven new varieties, seven new formas, two new combinations and two new names. One of the new names is designated "new combination," but the varietal name applied is proposed to take the place of an earlier (and in the author's opinion, untenable) name. The new name, "var. *oaxacana*" under *P. pseudostrobus,* had not previously been used for the entity under consideration (p. 195). The ambiguity too often evident in the "International Rules of Botanical Nomenclature" may well account for the relegation of *P. pseudostrobus* var. *apulcensis* Shaw to synonomy under *P. pseudostrobus* var. *oaxacana* Martínez and the proposal of *P. pseudostrobus* var. *apulcensis* Martínez, not Shaw, for the material from Hidalgo. As I interpret the rules this course is not permissible and Shaw's combination must stand for the entity "*P. pseudostrobus* var. *apulcensis* (Lindley) Shaw," even though Shaw misidentified the material from Oaxaca as Lindley's *P. apulcensis.* (The last named pine came from Hidalgo.) Thus *P. pseudostrobus* var. *oaxacana* may miss being considered a new variety instead of a new combination only because it is not accompanied by a Latin diagnosis. Latin descriptions are provided for all the new varieties and for *P. lutea* Blanco, but are omitted following the denomination of the new formas.

In spite of the criticisms mentioned above, I consider the book a credit to its author and deserving of a place in the libraries and on the desks of all botanists who are interested in the pines of the Western Hemisphere. The detailed descriptions will prove of tremendous value to anyone needing to identify a pine from Mexico. The halftones of cones, bark, needles and general habit, mostly made from photographs taken by the author, help one greatly in visualizing the character of the trees about which Professor Martínez writes lucidly. Of high value, also, are the line drawings and distribution maps. Even though the number of resin canals in a given needle may vary between base and apex, the cross sections of needles are valuable in showing the general pattern of the tissues and cells in the needle of each species so illustrated. Personally, I am glad that he included them and congratulate Professor Martínez upon having secured the services of Sr. Manuel Ornelas C. to make the drawings of these sections and of needles, cones, and seeds.

The typography is good and the use of glazed paper did much to enhance the clearness and quality of reproduction of the figures. Typographical errors are commendably few. In my estimation, this book deserves praise and lots of use. May more such works come from the workers in botany in Mexico!—IRA L. WIGGINS, Stanford University, California.

NOTES AND NEWS

TYPE LOCALITIES AND MAN-MADE LAKES. It is reported that plans have been approved for the construction of several additional dams in California. Of these, the one of greatest concern to botanists is the proposed dam at Isabella in the southern Sierra Nevada. It is said that the high water level of the lake will follow the 2605-foot contour. This will form a lake flooding the Kern River Valley east to Weldon and north along the course of the main fork of the Kern River to the vicinity of Kernville. The Weldon arm of the lake will be approximately ten miles long and the Kernville arm, six miles long. Walker Pass and the Kern River Valley lie along one of the main migration routes into California and many plants were first collected and described from this area. In July of 1891, Coville and Funston, of the Death Valley Expedition, collected here. Later, the Brandegees and Alice Eastwood collected and subsequently described as new many of the plants they found in this region. Other botanists—principally Greene, Purpus, Heller, Marcus Jones—published a number of new species based upon Kern River Valley material. Much of this collecting was done during the spring and early summer months.

With the flooding of this vast area, all of these type localities will be lost to science, and some of the species may be lost with them. Intensive collecting in this area is urged before construction begins. In addition to yielding valuable topotype material, a thorough study of this area will give us a better basis for evaluating the vegetational changes that will take place after the establishment of the permanent lake.—ANNETTA CARTER, Department of Botany, University of California, Berkeley.

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BIBLIOGRAPHIC NOTES ON ABIES BRACTEATA AND PINUS COULTERI

David D. Keck

One of the publications that has proved to be a continual source of trouble to bibliographers is Aylmer Bourke Lambert's "A Description of the Genus Pinus," which appeared in five editions over the period from 1803 to 1842. The confusion aroused by this work has been due not only to the long period of years over which it was published, but also to the fact that copies of the same edition do not always agree in contents and arrangement. These editions have been described in detail by Renkema and Ardagh (2).

Now attention has been called again by Little (1) to certain names of conifers first published on extra pages in the 1832 edition. These names are familiar from later publication in other places. In this 1832 edition, also known as "editio minor," or the third edition, there seem to have been inserted in volume two between pages 144 and 145 such extra pages as the printer and engraver had ready at the time. The copies of this volume differ as to the number of extra pages that are included, which, so far as known, vary from none to a potential twenty. Renkema and Ardagh apparently were acquainted with six or seven copies of this rare edition, and Little examined four more. I have looked at the copy at Stanford University and the one at the University of California, Berkeley, both of which appear to be in original bindings.

This edition is always cited as appearing in 1832, and Little points out that it was available to Lindley before the latter's article on *Abies* appeared in the Penny Cyclopedia in 1833. The text for the "editio minor" was printed for an imperial octavo, but the plates were of the folio size common to the other four editions. Consequently, some copies appear as folios, with the text sheets pasted on larger pages of folio size, as those at the University of California, the New York Botanical Garden, and Kew, but in other copies, as the ones at Stanford and Arnold Arboretum, the beautiful plates have been either folded in or closely trimmed to fit the large octavo text.

The species of conifers listed by Renkema and Ardagh as occurring on the unnumbered pages between pages 144 and 145 of volume two are ***Pinus Gerardiana, P. Sabiniana, P. monticola, P. grandis*** (=*Abies grandis*), ***P. nobilis*** (=*Abies nobilis*), ***P. Menziesii*** (=***Picea sitchensis***), ***P. Douglasii*** (=***Pseudotsuga taxifolia***), and ***P. dumosa.*** All but the first and last of these are conifers of the United States. The other unnumbered pages contain notes on

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Corrected date line: Madroño, Vol. 8, pp. 145–176. January 28, 1946.
Madroño, Vol. 8, pp. 177–208. May 2, 1946.

Australian and New Zealand conifers. Little made no additions to this list from the copies of the 1832 edition that he examined, but two more species are found in both of the California copies. The Stanford copy contains the extra pages for the species mentioned above except *Pinus Gerardiana,* and in addition contains *Pinus Coulteri* and *P. bracteata* (= *Abies bracteata*). The two latter species are also found in the copy at Berkeley, but of the above list it lacks the extra pages for *Pinus dumosa* and *P. Douglasii.* Several species described on the extra pages, including *Pinus Coulteri* and *P. bracteata,* are accompanied by the colored plates used also in the subsequent editions.

Authors have hitherto dated the publication of the Coulter Pine from the following: *Pinus Coulteri* D. Don, Trans. Linn. Soc. 17: 440, 1837, but now it may be given as *Pinus Coulteri* D. Don in Lamb., Descr. Genus Pinus ed. 3 (8°), 2: unnumbered p. betw. pp. 144 and 145, 1832. Fortunately no name change for this tree is involved.

The Santa Lucia Fir, however, must again take the name by which it commonly went prior to 1889 when Sargent called it *Abies venusta* (Dougl.) K. Koch, believing that this specific name, published in 1836, had priority over *Abies bracteata* (D. Don) Nutt., the specific name of which he thought was published in 1837. Little (*l.c.*) showed that both names were known in 1836, but did not decide which one was published earlier. Now the name and synonymy of this tree become as follows:

ABIES BRACTEATA (D. Don) Nutt., N. Am. Sylva 3: 137, pl. 118, 1849. *Pinus bracteata* D. Don in Lamb., Descr. Genus Pinus ed. 3 (8°), 2: unnumbered p. betw. pp. 144 and 145, 1832. *Pinus venusta* Dougl., Comp. Bot. Mag. 2: 152, 1836. *Picea bracteata* Loudon, Arb. Frut. Brit. 4: 2348, fig. 2256, 1838. *Abies venusta* K. Koch, Dendrol. 2(2): 210, 1873.

Several additional plates are found between pages 144 and 145 in the Stanford copy that deserve mention. These all occur without accompanying text. As in the case of the other plates in this work, the binomials beneath the plates lack the authority, so one does not know at a glance which names are published for the first time. These plates, some of which have numbers, are: *Abies Smithiana* (usually accredited as *A. Smithiana* Lindl., 1833 = *Picea Morinda* Link, 1841), *Pinus Llaveana* (usually accredited as *P. Llaveana* Schiede, 1838 = *P. cembroides* Zucc., 1832), *Pinus Brutia* (? = *P. bruttia* Tenore, 1826), *Araucaria Cunninghamii* (= *A. Cunninghamii* Sweet, 1830), *Juniperus chinensis* (? = *J. chinensis* L., 1767), *Juniperus excelsa* (not further identified), *Cupressus horizontalis* (= *C. horizontalis* Mill., 1768, which = *C. sempervirens* L., 1753), *Taxus Harringtonia* (usually accredited as *T. Harringtonia* Knight ex Forbes, 1839 = *Cephalotaxus Harringtonia* K. Koch, 1873). The last four of these, viz., *Juniperus chinensis, J. excelsa, Cupressus horizontalis,* and *Taxus Harringtonia,* do not occur in Renkema and

Ardagh's list of plates for any of the editions of Lambert. I have not had access to the later editions to determine whether these appeared there under other names. Possibly *Abies Smithiana* Lamb., *Pinus Llaveana* Lamb., and *Taxus Harringtonia* Lamb. are properly published in this Stanford copy under article 44 of the International Rules. It is indeed fortunate, however, that no name changing of an established species appears to be involved.

The above plates were of the usual engraved type common to the work. An additional engraved plate of an *Abies* cone-bearing twig without name or number has the name "Pindrow" penciled below it, probably much later. The first regular appearance of a plate of this species in Lambert was in 1837.

Finally, in the Stanford copy also are unlabelled colored drawings readily recognized as *Pinus tuberculata* Gord. not D. Don (two cones on two pages), *P. muricata* D. Don (two cones on one page), and *P. radiata* D. Don (two cones on two pages). These drawings apparently were originals made for the use of the engraver. These species were all legitimately published some years later in various works.

Grateful acknowledgement is made of suggestions received from Mr. Alfred Rehder of the Arnold Arboretum in the preparation of these notes.

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Literature Cited

1. Little, E. L., Jr. Notes on Nomenclature in Pinaceae. Am. Jour. Bot. 31: 587–596. 1944.
2. Renkema, H. W., and J. Ardagh. Aylmer Bourke Lambert and his "Description of the Genus Pinus." Jour. Linn. Soc. Lond., Bot. 48: 439–466. 1930.

A NEW NOLINA FROM SOUTHERN CALIFORNIA

Howard Scott Gentry

While visiting at the San Diego Museum of Natural History during the summer of 1945, my attention was called by the curator, Mrs. E. B. Higgins, to a *Nolina* that she and Mr. Harbison, entomologist of the same institution, had recently discovered near the Dehesa School. This locality is about eight miles east of El Cajon, San Diego County, California, and some fifteen miles north of the Mexican border in the bold, granitic mountains so characteristic of that region. Fire had swept the chaparral one or two years previous to our visit. The *Nolina* grew on the margins of what had been a chaparral slope and showed a marked preference for granitic outcrops and the coarse detrital edges of steep-sided gulleys, indicating that it had not been a close component of chaparral, but rather an associate in the more open margins in the poorer, immature, arid soils.

Most remarkable was the discovery that what had appeared to be acaulescent, individual plants of *Nolina* were in reality flowering shoots from a horizontal, trunk-like rhizome buried below the soil surface. Recent gulley erosion had partially exca-

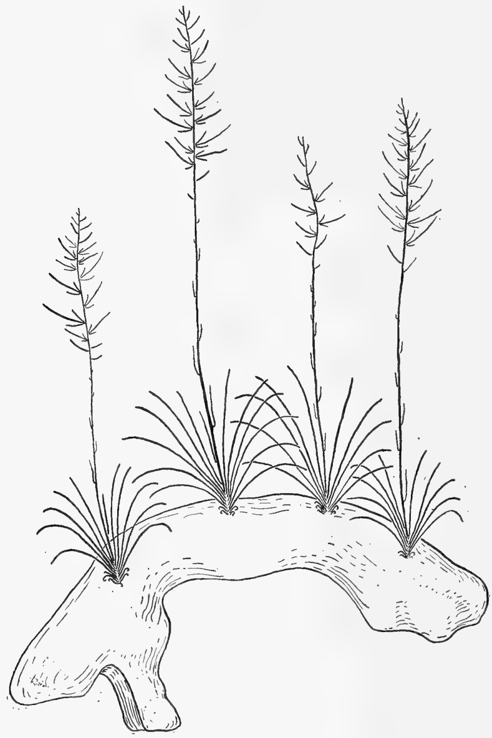

Fig. 1. Habit sketch of *Nolina interrata*.

vated several plants and had disclosed large, branching rhizomes 6 to 10 feet long and 8 to 12 inches or more in diameter, which bore small roots along the ventral side (text fig. 1). Some of the trunks showed partial burning with bark reduced nearly to charcoal. The aerial portions of the plants consisted wholly of growth made since the fire.

Specimens of *Nolina* were borrowed from the following institutions: University of California, Berkeley; California Academy of Sciences, San Francisco; University of Arizona, Tucson; University of Michigan, Ann Arbor. The author expresses appreciation to the curators of the herbaria at the above institutions.

Nolina interrata sp. nov. Lignosa rhizoma ferente rosulas subsessiles; cortice crasse reticulato, areolis truncate pyramidalibus, irregulariter pentagonis ca. 1 cm. latis et 5 mm. crassis; rosulis sessilibus typice 10–20-foliatis; foliis glaucis 70–90 cm. longis, 8–15 mm. latis, in apicem tenuem brunneolum efiliferum desinentibus, margine haud filiferis, denticulis biformibus alteris compositis 1–3-apiculatis inter se 0.5 mm. distantibus alternantibus cum alteris parvioribus simplicibusque; costis scabris, crassiuscule, denticuliferis; canaliculis intercostalibus profundis, apertis; panicula composita, laxa, 1.5–2 m. longa, internodiis 5–12 cm. longis, bracteiferis, bracteis foliaceis 20–40 cm. longis; pedunculis (terminalibus exceptis) ternis, centrali 12–16 cm. longo, lateralibus dimidio brevioribus, omnibus bracteolis scariosis dilaceratis vel truncatis vel varie imperfectis bases pedicellorum includentibus praeditis; pedicellis supra mediam articulatis, fasciculatis; floribus pistillatis staminodia ferentibus in perianthii segmenta; fructibus latioribus quam longioribus, 12–15 mm. crassis; seminibus viridiusculis, rugosis, 5 mm. longis, 4 mm. in diametro.

Plant with subterranean rhizome and aerial rosettes bearing flowering stalks, the bark coarsely reticulated into pyramidal pentagons 1 cm. or more broad and about 5 mm. thick; rosettes subsessile, (6) 10–20 (or more)-leaved, the bases of desiccated leaves persisting as brownish vestiges with decurved ends; leaves glaucous, 70–90(100) cm. long, 8–15 mm. wide near the bases, tapering to slender, dry, non-filiferous tips; margins fixed, armed with denticles of two sizes, the larger about 0.5 mm. apart and often compounded into two or three points; vascular costae scabrous with denticles discernible between the deep open intercostal sinuses; inflorescence an open compound panicle 1.5–2 m. long; scape internodes 5–12 cm. long with narrow leaf-like bracts 20–40 cm. long; peduncles, except the teminal, 3 from each node, the central one 12–16 cm. long, about twice the length of the two lateral ones, all with scarious, lacerate, long-acuminate bractlets 3–4 mm. long enclosing the pedicel bases, bractlets rupturing transversely in age to leave a truncate vestige; pedicels 1–3, fasciculate, jointed above the middle, the pistillate flowers with staminodes inserted on the perianth segments; fruits large, broader than long, 12–15 mm. wide; seeds yellowish, wrinkled, asymmetrical by the rather straight raphe, 5 mm. in long diameter, 4 mm. in transverse diameter, the hilum suprabasal with a conic caruncle which is more broadly and roundly duplicated at the axial apex.

Type. Slope west of Dehesa School, San Diego County, California, August 5, 1945, *Howard Scott Gentry 7330* (San Diego Museum of Natural History; isotypes, University of California, California Academy of Sciences, University of Arizona, University of Michigan).

The following additional collections from the type locality have been studied: *Gentry 7330a, 7330b, 7330c, 7330d* (representing depauperate and robust extremes); *Gentry 7330e* (mature staminate inflorescence); *Higgins 25472,* June 14, 1939 (immature staminate inflorescence); *Gander 7695,* July, 1939 (fruiting). Mature seeds were collected by Mrs. Higgins on November 15, 1945. The species may also be found in Baja California inasmuch as similar habitats occur south of the border.

Nolina interrata resembles *N. Palmeri* in its foliage, but it differs from that species in its larger fruits, which do not dehisce to expose a persistent seed. Because of its well-developed rhizome (trunk), broad leaves, and large fruits, *N. interrata* belongs to the section Arborescentes of Trelease (The Desert Group Nolinae, Proc. Am. Phil. Soc. 50: 405–423, 1911). It appears most closely related to the *N. Beldingii* group, from which it is distinguished by its more glaucous, narrower leaves with more numerous marginal teeth of two sizes, with open denticulate intercostal sinuses (closed in *N. Beldingii*), and by the larger seeds. The glaucous leaf with coarse armature sets it apart from other known species of *Nolina.* The horizontal subterranean trunk or rhizome is especially noteworthy and suggests that this structure may be present in other members of the genus heretofore assumed to be acaulescent. This feature, which may readily be over-looked, would not have been discovered in this case had not erosion exposed portions of the rhizome.

A review of the literature and collections convinces me that the genus *Nolina* is not well understood. It possesses few striking morphological characters: the flowers are monotonously similar, and the fruits vary only as regards size and dehiscence. The seeds show differences in surface structure and color, but they are often absent in collections. The leaves are superficially alike, but they do differ somewhat in form of keeling, thickness, width, and marginal armor. The latter character and the microscopic rugosities of the ribbing, when combined with gross features, offer an approach to the problems of speciation. The nature of the minute denticles of the vascular ribs can be determined only by 20–30 × magnification. On the whole, the leaf appears to be the most satisfactory organ for determining the status of closely related entities.

Under *Nolina microcarpa* and *N. Bigelovii* are grouped complex series of variants. Under *N. microcarpa* on the basis of fairly uniform inflorescences have been lumped numerous leaf variants. Similarly, numerous leaf variants have been gathered under *N. Bigelovii* because of exfoliating leaf margins. Close inspection of leaf structure, however, shows that actually these broad specific groupings cover several variants that appear to have genetic consistency. Such species are based upon a few conspicuous characters maintained rather for taxonomic convenience than for taxonomic adequacy. The minutiae of leaf and bract may be more

PLATE 19. NOLINA INTERRATA. Fig. *a*, base of rosette showing old persistent leaf bases and reticulate bark, $\times \frac{2}{3}$; fig. *b*, peduncles with bract and bractlets, $\times 1\frac{1}{2}$; fig. *c*, bractlets and pedicels, $\times 6$; fig. *d*, fruit, $\times 1$; fig. *e*, marginal section of leaf, $\times 15$.

expressive of genetic relationships, since greater differences between populations can be ascertained by their study. A fine series of California *Nolina* was gathered by Carl Wolf and put into cultivation at the Rancho Santa Ana Botanical Garden. One has only to examine casually this young live collection, with its several distinctive variants, to appreciate that only two names for California *Nolina* are insufficient. Not until close work on distribution with thorough collecting of populations is done can the Nolinae be understood.

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KATHERINE DAVIES JONES

1860–1943

Katherine Davies Jones, the fourth of seven children, was born of Welch parents in 1860 in a log cabin in Berlin, Wisconsin. In Wales, her father had been a singing master and her mother, daughter of the schoolmaster, was a singer of reputation. In this country, her father was first a colporter, selling Bibles and singing throughout the country, but soon he became a Congregationalist minister and was sent out to build and establish churches in rural communities, always moving westward. The children raised the family's food, were clothed by the occasional missionary barrel, an exciting event, and attended rural schools.

From the time she was sixteen until the family moved to Murphy's Camp, Calaveras County, California, in 1880, Katherine taught during the summers and attended school during the winters, going to Salem High School, then Normal School at Peru, Nebraska, and Latin School at Lincoln, Nebraska, followed by a year at the University of Nebraska. In Calaveras County, where her father's preaching station included six or seven churches, Katherine worked and saved until she was able to return to the University of Nebraska. After seven months, however, she was recalled to Murphy's Camp by the illness of her mother. Later that year the family moved to South Vallejo, California, where Katherine at first conducted a private school of her own and then taught for some six years in the public schools.

Through her aid, Guernsey, her younger brother, went to the University of California, where he graduated in 1891. Katherine sometimes visited her brother at Berkeley and attendance at some of Professor LeConte's lectures on zoology renewed her desire to return to college herself. She entered the University of California and graduated in 1896. For a year she taught biology and music at Hayward, but her health forced her to give up her teaching there and she returned to Berkeley. At first she assisted Professor Jepson in his botany class and Professors Ritter and Torrey in their zoology classes. She taught herself typing and stenography and in 1899 was working in Professor Hilgard's office under A. V. Stubenrauch. Then for a time she gave such valuable private assistance to Professor J. Burtt Davy in agrostology that he asked for her transfer to the Department of Agriculture. After changes in the department there she kept the records of the Botanic and Economic Gardens of the Department of Botany. This work under J. Burtt Davy and H. M. Hall influenced her career greatly and aroused her interest in exotics, but her special interest in acacias came from her effort to help Mr. Stubenrauch, who had returned to California in charge of the seven Experimental Stations of the Bureau of Plant Industry, United States Department of Agriculture. He had her appointed to carry on his office work, and, to help him with the bulletin on *Acacia* he had to prepare, she took up the study of the genus *Acacia* on her own time. When he was called back to the Washington office, Katherine was asked, on very short notice, to prepare the treatment of *Acacia* for L. H. Bailey's Cyclopedia of Horticulture. Later, when Professor Bailey was preparing a new edition, the one in current use, Professor Setchell declared that Miss Jones was the best, if not the only, person in the country capable of revising the section on *Acacia.*

In 1910 Professor E. B. Babcock needed someone in Agricultural Education to gather seeds to be sent to the schools of the state, and again Katherine was called upon as the one person available who had the necessary training for the work. This led, in the next year, to her academic appointment on Professor Babcock's staff to teach in Agricultural Education. That summer she went East to study and visit schools in order to prepare herself for the work. On her return, she first assisted in the classwork but later had full charge of the courses.

The Department of Landscape Gardening was organized in 1913 under the direction of Professor Gregg, and, as he had just come from the East, he found Katherine's wide knowledge of our exotic flora of great value. A course in Plant Materials was to be given by Mr. R. T. Stevens who was in Europe; so Katherine started the course and after Mr. Stevens returned she continued to assist with the botanical aspects. When Mr. Stevens resigned in 1917, Katherine found herself teaching five classes, including all of the Plant Materials. As there were no adequate textbooks in this field, she organized the work herself, prepared keys to the plants as well as descriptions emphasizing the aspects of the plants that pertained to landscaping. She was thorough, conscientious, and inspiring to her students, and through them, her work became widely known and praised. At Harvard students were told that if they had passed her work satisfactorily, no further examination would be required of them for entrance to the Plant

Material classes there. Her students tell how they would follow the spry, tireless figure, like a flock of chickens, from one tree or shrub to another during an hour of each laboratory period while she told them of origin, habitat and uses; then they would return to the laboratory and study in detail specimens of these same plants, making leaf prints and writing descriptions, and she would drill them intensively in the subject matter. Such methods as these may seem elementary, but to this day, many of her former students admit that when confronted with a plant their immediate reaction is "botanical name, common name, origin." Katherine always maintained an interest in her pupils and liked to keep track of them, especially when they continued in fields that made use of the training that she had given to them, and her pupils, in turn, thought much of her and through the years kept in touch with her. A never-ending source of joy to her were the greeting cards that arrived from former students each holiday season.

In addition to her teaching, Katherine carried on a time-consuming and extensive correspondence with the general public, giving help whenever asked. When she retired from the University in 1930, she turned to private teaching, to writing, and to the furthering of more accurate nomenclature and botanical information among the nurserymen, the garden clubs and the general public. The California Horticultural Society and California Garden Clubs, Inc., honored her, and she stands as one of the notable women of California in the advancement of the botanical and landscape side of horticulture. Her herbarium, collected over a period of nearly forty years and especially rich in specimens of *Acacia* has been given to the University of California.—Mabel Symmes.

Bibliography

The following list contains most of the articles published by Miss Jones.

Acacia, in L. H. Bailey, Standard Cyclopedia of Horticulture. pp. 178–190. 1914.

Vines for California, with John W. Gregg and R. T. Stevens in L. H. Bailey, Standard Cyclopedia of Horticulture. pp. 2705–2706. 1916.

Plant materials for school grounds in California, with R. T. Stevens in J. W. Gregg, The landscape improvement of rural school grounds. Calif. State Board of Education, Bull. no. 20: 1–52. 1917.

Review of Genetics in Relation to Agriculture by E. B. Babcock and R. E. Clausen. Jour. International Garden Club 2: 608. 1918.

Berried shrubs. Bull. Garden Club of Alameda County. 1921.

Color list of border plants, in Stephen Child, Landscape architecture, a series of letters. Stanford University Press, California. 1927.

Acacias in California. National Horticultural Magazine 12: 1–44. 1933.

Strelitzia Reginae. Golden Gardens 2(11): 1–2. 1934.

Deciduous shrubs for the San Joaquin Valley. Golden Gardens 2(12): 3. 1934.

Plants for the San Joaquin Valley. II. Evergreen shrubs. Golden Gardens 3(2): 3–4. 1934.

Plants for the San Joaquin Valley. III. Drought tolerant shrubs. IV. Drought tolerant herbaceous plants. Golden Gardens 3(4): 2. 1935.

Plants for the San Joaquin Valley. V. Shrubs for ground covers. Golden Gardens 3(7): 2. 1935.

The gay Abutilon. Golden Gardens 3(3): 1–2. 1934.
Plants of New Zealand grown in California. National Horticultural Magazine 14: 1–58. 1935.
Thirty important vines for California. National Horticultural Magazine 15: 1–65. 1936.
Acacia retinodes—water wattle. Golden Gardens 4(11): 3. 1936.
Thirty more climbers for California. National Horticultural Magazine 16: 1–57. 1937.
Thirty more climbers for California. National Horticultural Magazine 17: 13–58. 1938.
A study of climbers. I–X. Golden Gardens. 6(8): 1, 1938; 6(9): 2, 1938; 6(10): 5, 8, 1938; 6(11): 4, 8, 1938; 7(1): 7, 1938; 7(2): 4, 14, 1938; 7(3): 11–12, 1938; 7(4): 7–8, 1939; 7(5): 11–12, 1939; 7(9): 8–9, 1939.

ENNEAPOGON DESVAUXII AND PAPPOPHORUM WRIGHTII, AN AGROSTOLOGICAL DETECTIVE STORY

Agnes Chase

Enneapogon Desv., recognized either as a subgenus of *Pappophorum* Schreb. or as a distinct genus, has always been a puzzle because, though several species are well known, the type species could not be ascertained. The genus was described by Beauvois (Ess. Agrost. 81. 1812), who ascribed it to Desvaux. One species, *Enneapogon Desvauxii,* is figured (loc. cit., pl. 16, fig. 11) but not described, and four Australian species of *Pappophorum* described by Robert Brown are cited but not transferred. The figure, showing a dense panicle, the characteristic spikelet, and the lemma with nine feathered awns, is unmistakable as to the genus. Desvaux (Jour. de Bot. 1: 70. 1813) transferred Brown's species of *Pappophorum* to *Enneapogon,* preceded by the statement that he had examined a plant from "iles Manilles" that proved to be a distinct genus, close to the well-known genus *Pappophorum,* and in the same paper he cited *Enneapogon Desvauxii* as a synonym of *E. gracilis* (R. Br.) Desv. Later, because Beauvois had failed to do so, Desvaux described *Enneapogon Desvauxii,* "Habitat in Manilia" [sic] (Opusc. 98. 1831) and excluded it from the synonymy of *E. gracilis.* No species of *Enneapogon,* however, has ever been found in any of the Pacific Islands until recently in Maui, Hawaii, where it probably was introduced.

Because *Pappophorum Wrightii* S. Wats. [*Enneapogon Wrightii* (S. Wats.) C. E. Hubb.], belonging to the genus or subgenus *Enneapogon,* occurs in the southwestern United States from Texas to California as well as in Mexico and Argentina, the problem is of interest to us. In an attempt to identify the type of the genus, the writer searched in vain for *Enneapogon Desvauxii* in the Delessert Herbarium in Geneva, Switzerland, where a few of the Beauvois specimens were found, and in the herbarium of the Museum d'Histoire Naturelle in Paris.

Recently, Nancy Tyson Burbidge of the University of Adelaide, Australia, published "A Revision of the Australian Species of Enneapogon Desv." [Proc. Linn. Soc. London 153 Sess. (1940–41): 52–91, fig. 1–5. 1941]. Her revision was based on material in Kew Herbarium and on collections on loan there. Miss Burbidge states (op. cit., p. 53): "The war was responsible for the evacuation of Robert Brown's type material from the British Museum before it had been properly studied. . . . References made to his material are founded on the portions of his types which are at Kew." And (op. cit., p. 57) "In the British Museum there is a specimen labelled 'Enneapogon, Manilla, Herb. D. Desvaux,' in Robert Brown's writing, which indicates that the two authors were in communication at some period. This specimen, which is here accepted as a portion of the type, consists of an inflorescence with a culm bearing three leaves. In the axil of the uppermost is a small axillary inflorescence. It agrees in spikelet character and general habit with *Pappophorum Wrightii* S. Wats. (Proc. Amer. Acad. 18: 178. 1883), which therefore, lapses into synonymy." Comparison of the figure of *Enneapogon Desvauxii* in Beauvois (loc. cit.) with our American *Pappophorum Wrightii* shows that the two agree and further substantiates Miss Burbidge's conclusion.

The specific identity of the type is thus settled, but where was it collected and by whom? Experience in tracing the sources of Desvaux's species has shown that his cited localities are often erroneous. (*Panicum aciculare* Desv. of the eastern United States and the West Indies, in which the locality was given as "Indies orientales," is a good example). Because our southwestern states, where the species is frequent, were not explored botanically before 1830 and because *Enneapogon Desvauxii* was described in 1812, it seemed probable that the specimen came from Mexico. We learn from Leségue (Musée Bot. Delessert, p. 347. 1845) that Née, one of the botanists who collected in the Americas at an early date, crossed from Acapulco to Mexico City before he joined Haenke on the Malaspina Expedition. Née's collections were sent to Madrid where his herbarium is now preserved (op. cit., p. 451), and Lagasca, who was in charge of the herbarium there, was in communication with the French botanists. Sessé also collected in Mexico and sent his collections to Madrid, but there seemed less probability that his specimens would have been labelled "Manilla." These surmises were communicated to Dr. L. R. Parodi, of Argentina, who replied that in 1935 he had examined, in the herbarium in Madrid, a specimen "Ex Chile, Née iter," which was the same as *Pappophorum Wrightii.* Dr. Parodi had found that many of Née's collections in the herbarium at Madrid bore doubtful localities and he believed that since Née passed by Mendoza, Argentina, on his return from Chile, he might well have collected the *Enneapogon* at Villa Vicencio, on the eastern slope of the

Cordillera (i.e., in Argentina), where this species is still fairly common. Dr. Parodi thought that the specimens sent to Desvaux and shared by him with Robert Brown had probably come from the herbarium of Zea and were doubtless part of the collection in Madrid. Therefore, in spite of errors in data, the type has been located and identified and the very probable source of the specimen has been discovered. Our *Pappophorum Wrightii* Wats. thus becomes a synonym of *Enneapogon Desvauxii* Beauv.

With the removal of *Pappophorum Wrightii* from it, the genus *Pappophorum* can be limited to plants having one-nerved glumes and lemmas that are dissected into an indefinite number (ten to many) of fine, unequal, scaberulous awns. So limited, *Pappophorum* is confined to the Americas. *Enneapogon,* on the other hand, with seven- to many-nerved glumes and lemmas that are crowned with nine flat, usually plumose awns that are equal (or subequal) in length, is widely distributed. There are nineteen species in Australia, ten or more in Africa, and five or six in Asia, one of which, *E. borealis* (Griseb.) Honda, closely resembles the only American species, *E. Desvauxii.* In two of the African species of *Enneapogon,* the nine flat awns are not plumose. In *E. Desvauxii,* cleistogamous spikelets are produced in the lower sheaths; Miss Burbidge found cleistogenes in four Australian species, and the writer found them in one Asiatic and in two African species of *Enneapogon.*

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TWO SPECIES OF MICONIA FROM SALVADOR

H. A. Gleason

In most of the Melastomataceae the style, even in bud, is elongate and lengthens further during anthesis so that it is usually about as long as the filaments. How then shall we interpret a few "species" in which the style is permanently short or nearly aborted? Is this a specific character or merely a teratological condition? Within the section Cremanium of the genus *Miconia* there are five such species, all known from a few specimens only: *M. hemenostigma* Naud. (1851), "stylus fere nullus in umbilico ovarii inclusus," *M. biperulifera* Cogn. (1891), "stylo nullo," *M. purulensis* Donn. Sm. (1908), "stylus in floribus perscrutatis nullus," *M. minuta* Gl. (1925), "style 0.7 mm. long," and *M. brachygyna* Gl. (1930), "style 0.5 mm. long." The last three seem to be closely related and the short style may there be a group character; possibly the first should be included with them. But the second is quite different, and now I find a sixth in which the whole pistil is completely lacking.

Miconia sterilis sp. nov. Sect. Cremanium. Frutex bimetralis, caulibus juvenilibus 4-sulcatis densissime hirsutis denique glabrescentibus, pilis 1–2 mm. longis. Petioli 2–4 cm. longi, inferne glabri, superne sparse hirsuti. Laminae tenues, anguste oblongo-obovatae, usque ad 15 cm. longae 5.5 cm. latae, breviter acuminatae, integrae et ciliatae, basi obtusae, 5-pli-nerviae, supra glabrae, subtus ad venas primarias et secundarias sparse breviterque hirsutae; venae exteriores submarginales, secundariae sub angulo 70° orientes supra medium curvatae, cum venulis supra subplanae subtus vix elevatae. Panicula pyramidalis 8 cm. longa a basi ramosa, fere glabra, cymulis saepe 5-floris. Flores 5-meri. Hypanthium urceolato-globosum, ad torum 1.9 mm. longum, extus glabrum minute rubro-punctatum, parietibus crassis. Calycis tubus 0.3 mm. longus; sepala late depresso-semicircularia e sinibus rotundatis, 0.3 mm. longa; dentes exteriores minuti, adpressi, triangulari-acuminati. Petala alba, late obovata, fere equilatera, leviter retusa, 1.5 mm. longa, 1.7 mm. lata. Stamina isomorpha; filamenta complanata, 1.5 mm. longa, supra medium geniculata; antherae obovato-oblongae, 1.8 mm. longae, a basi ad medium 4-loculares, poris 2 latis dehiscentes; connectivum infra thecas subteres, ca. 0.5 mm. productum. Ovarium nullum.

Type. East side of Los Esesmiles, Department of Chalatenango, El Salvador, altitude 2200 meters, *Tucker 1100* (Herbarium of the University of California no. 693856). In general facies and structure of the anthers the species is strongly suggestive of the well known *M. theaezans* (Bonpl.) Cogn. It differs in its pubescence of simple hairs, its pli-nerved leaves, its 2-pored anthers, and the complete absence of the pistil. It may be more closely related to *M. biperulifera,* the anthers of which I have not examined. It is, of course, difficult to imagine a species in which all individuals lack a necessary reproductive organ. There is no present evidence to show whether this is a staminate portion of a dioecious or monoecious plant or merely a teratological specimen.

Miconia Tuckeri sp. nov. Sect. Cremanium. Frutex bimetralis, ramis juvenilibus tenuiter stellato-floccosis, denique fere glabris. Petioli 2–5 cm. longi, dense floccosi et supra sparse hirtelli. Laminae firmulae, anguste oblongo-ovatae, usque ad 15 cm. longae, 5 cm. latae, acuminatae, minutissime denticulatae, dentibus incurvis callosis, basi rotundatae, 5-nerviae, supra juventute minutissime furfuraceae mox glabrae, subtus ad venas minute furfuraceae et sparse hirtellae, pilis ca. 1 mm. longis; venae supra planae, subtus elevatae, secundariae fere transversae. Panicula pedunculata pyramidalis ramosa, 1 dm. longa, sparse furfuracea. Flores 5-meri. Hypanthium subglobosum, ad torum 3 mm. longum, minutissime rubro-punctatum. Calycis tubus 0.5 mm. longus; sepala rotundata a sinibus latis, 0.5 mm. longa; dentes exteriores triangulares, sepala aequantia. Petala alba, obovata, 2 mm. longa.

Stamina isomorpha; filamenta complanata, 2.4 mm. longa, supra medium geniculata; antherae oblongae, 2.4 mm. longae, 2-loculares, poro lato dehiscentes; connectivo ad basin dilatatum, brevissime productum, et infra thecas in lobos 2 laterales rotundatos deflexum. Ovarium semi-inferum, 3-loculare; stylus glaber, 4 mm. longus, superne incrassatus; stigma vix capitatum.

Type. Cloud-forest, east side of Los Esesmiles, Department of Chalatenango, El Salvador, altitude 2300 meters, *Tucker 998* (Herbarium of the University of California no. 693855). The plant resembles *M. purulensis* Donn. Sm. and *M. hemenostigma* Naud. in general aspect, but differs from both in its well developed style and considerably larger flowers.

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THE INTRODUCTION OF VIOLA LANCEOLATA INTO THE PACIFIC NORTHWEST

J. H. Schultz

Viola lanceolata L. is an abundant and conspicuous plant in several localized marshy areas in western Washington. The unexpected occurrence of this eastern species in this region has prompted much interest. Jones (5) held that it could be adventive here, but that on the basis of ecological evidence this was highly improbable. He thought, rather, that it was a relictual species which had been missed by previous collectors. Baker (2) speculated that seeds of this species had been carried in mud adhering to the feet of migrating water fowl from Venezuela, where it is known to occur. Baird (1) also has commented on the occurrence of this violet in western Washington, but she offered no explanation. Since *V. lanceolata* was previously not known from west of Minnesota, it is little wonder that its occurrence in the Pacific Northwest has invited comment.

Although many of the areas in which *V. lanceolata* now appears to be indigenous were intensively botanized many years ago this species was not collected. For example, Douglas (4) collected for many days near the mouth of the Columbia and on the Long Beach Peninsula in Pacific County, Washington. The writer is personally well acquainted in this area and has been able to locate specific spots in which Douglas collected on the Long Beach Peninsula from 1825 to 1827. Since Douglas collected species of violets and other plants which still grow there, it seems improbable that so keen a collector would have missed *V. lanceolata* if it occurred in the area at that time.

There appears to be a more logical explanation for the occurrence of this violet in the Pacific Northwest. *Viola lanceolata* is a common species in many cranberry (*Vaccinium macrocarpon* Ait.)

bogs in the Atlantic Coast and the Wisconsin cranberry districts. When the cultivated cranberry was first introduced into Washington late in the nineteenth century introductions were on a small scale and were limited to cuttings for propagation. However, from about 1909 to 1916 (3) the cranberry industry in Washington expanded rapidly and made extremely heavy importations of vines for propagation. These came chiefly from the Cape Cod and Wisconsin cranberry areas, in both of which *V. lanceolata* is common. Cranberry vines for propagation were purchased by the ton, and it was a common practice to mow parts of a bog and ship everything, cranberry vines and weeds alike, to the Pacific Coast in order to meet the demand for propagating material. It was undoubtedly in this manner that *V. lanceolata* was introduced into Washington and Oregon.

On the Long Beach Peninsula in southwestern Washington *V. lanceolata* is no longer restricted to the cranberry bogs but is common in low pastures and marshy areas, giving it the appearance of an indigenous species. That this is caused by the annual winter flooding and drainage practices followed in cranberry culture in that area is scarcely open to question. This violet is also a common weed in the cranberry bogs in the Grayland area, adjacent to the ocean near the Pacific County-Grays Harbor County line. Its occurrence at the south end of Puget Sound, where first detected by Jones (5), may be explained in the same manner. There have been periodic attempts to grow cranberries in this area, several bogs being cultivated there at the present time. Its occurrence in several widely separated localities, as noted by Jones, is thus accounted for. This is apparently the first report of its occurrence in Oregon, where the writer has seen it as a common weed in cranberry bogs near Seaside, Clatsop County. No specimens were taken.

Viola lanceolata is quite noticeable as a rather small herb with attractive white blossoms in April or May. At that season the plant is too small to be considered a weed of economic importance in cranberry bogs. However, in August and September when at the height of the cleistogamous flowering season, the plants are large and dense with foliage twenty to thirty centimeters high. It is at this season that the cranberries are ripening, and considerable economic loss frequently results from the shading and crowding caused by the dense growth of the violets.

The following specimens of *Viola lanceolata* have been deposited in the Herbarium of the State College of Washington, Pullman: cranberry bog, one mile north of Long Beach, Pacific County, Washington, May 28, 1944, *Schultz 4435* (vernal flowering condition); August 28, 1941, *Schultz 4121* (cleistogamous flowering condition).

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LITERATURE CITED

1. BAIRD, VIOLA BRAINERD. Wild Violets of North America. University of California Press. 1942.
2. BAKER, MILO S. Studies in Western Violets—III. Madroño 5: 218–231. 1940.
3. CROWLEY, D. J. The cultivated cranberry in Washington. Washington Agri. Exp. Sta. Bul. No. 349. 1937.
4. DOUGLAS, DAVID. Journal kept by David Douglas during his travels in North America 1823–1827. Published under the direction of the Royal Horticultural Society, London. W. Wesley & Son. 1914.
5. JONES, GEORGE N. New records of vascular plants in Washington. Madroño 4: 34–37. 1937.

HERBERT JOHN WEBBER

While gathering oranges in his yard from a tree which he had planted and raised, Dr. Webber suffered a heart attack which was followed by his death on January 18, 1946, shortly after he had reached his eightieth birthday. That his last activity should have been concerned with a fruit which he had studied in one way and another for half a century seems eminently fitting to those who knew him well.

Affable, genial, unselfish, alert, energetic and optimistic, he merited that esteem of colleagues and students which he received. A charter member of the California Botanical Society, he was an enthusiastic and loyal member of the organization. Prominent also in the founding and work of the Botanical Society of America and of the American Genetic Association, his cooperation was freely given to promote welfare of science.

His never-tiring interest in plants endeared him to his teacher, Bessey, at the University of Nebraska, who inspired him with the active scientific spirit which dominated his subsequent life. Webber received the degree of B.S. in 1889 and A.M. in 1890 at the University of Nebraska. He did graduate work at Washington University, obtaining the degree of Ph.D. in 1901. The scientific study of living plants in the out-of-doors became a passion with him when, in 1892, he went to Eustis, Florida, in the service of the United States Department of Agriculture to investigate problems connected with the citrus industry, in association with Walter T. Swingle. At once Webber was fascinated with the new problems in botany in that subtropical region. Writing to Bessey, he waxed enthusiastic about the unique distribution of plants in the hammocks and sandy plains, was excited by the discovery of plants like *Zamia* and *Casuarina,* and the alluring field of citrus culture. In view of his later importance in that field, his remark in a letter to Bessey had singular significance. "Orange studying I find a delight. Hope I may continue to like it as well."

The primitive spermatophyte, *Zamia,* so aroused his scientific curiosity that he somehow found time, aside from his regular duties, to study it. His first paper, entitled "Peculiar Structures Occurring in the Pollen Tube of Zamia," published in the Botanical Gazette in June, 1897, announced that the male gametophyte produces motile antherozoids. Two more papers followed in rapid succession, establishing this novel discovery. When he read a paper containing the results of his researches at the meeting of the Botanical Society of America at Toronto in that year, he knew that it would be difficult to convince his audience that a seed-plant has motile antherozoids, therefore he showed slides representing all the important stages. Fortunately for him the mature antherozoids of *Zamia* are probably the largest male gametes known in the plant kingdom, being plainly visible to the naked eye. Still, there was incredulity in the minds of many botanists. Rodgers says, "Some went so far as to believe that Webber's sanity had been affected by the warm climate of Florida." The following year Webber read a paper at the Boston meeting of the American Association for the Advancement of Science in which he described the formation of the cilia-bearing membrane of the antherozoid. In 1901 Webber's work on *Zamia* was culminated with the publication of his researches by the United States Department of Agriculture in a ninety-two page, fully illustrated paper.

His discovery of motile antherozoids in *Zamia,* his cooperation with W. T. Swingle in producing the first interspecific hybrids in *Citrus* having resistance to low temperatures, his influence on the development of genetics in the Department of Agriculture in Washington and at Cornell, established Webber's scientific abilities at home and abroad while he was still a young man.

His hybridization of species and varieties of citrus led him to ponder the principles of heredity and he was alert to the new possibilities in the laws of Mendel, rediscovered in 1900 by DeVries and Correns, and in DeVries' theory of mutation published in the same year. For the next quarter of a century Webber's name was linked to studies on the breeding of oranges, cotton, corn, pineapples, timothy and potatoes. He was appointed in 1900 to be "Physiologist in Charge of the Laboratory of Plant Breeding" in the United States Department of Agriculture where he was successful in introducing scientific principles into the agricultural work in this and other countries.

In 1907 Webber was called to a professorship of experimental plant biology at Cornell University where he worked for five years, resigning to take the directorship of the newly founded University of California Citrus Experiment Station and Graduate School of Tropical Agriculture. He arrived in Riverside in July, 1913, and threw himself into the tasks concerned with organizing the new institution, building up an Experiment Station which now has an international reputation for its researches in subtropical horticulture and related problems.

At the invitation of the department of agriculture of the Union of South Africa, he spent the year 1924–25 in studying the citrus industry in that country and advising the government on the organization of agricultural education and research. Thence he visited various citrus growing regions in the Orient and completed a journey around the world.

Dr. Webber was appointed chairman of the Division of Subtropical Horticulture in the College of Agriculture, University of California, in 1921 and took up residence at Berkeley; served as acting dean of the College and Director of the Experiment Station in 1923–24; returned in 1926 to Riverside to resume his former position as Director of the Citrus Experiment Station; became professor emeritus in 1936. He knew no such a thing as retirement however, going daily to his quarters in the building or making studies in the orchards, or discussing horticultural matters with members of the staff.

One of his first accomplishments in 1913 at Riverside was the formation of the Synapsis Club, an informal seminar, debating society, colloquium, which has afforded the opportunity for the workers in the sciences connected with horticulture to report on their researches and, more important, to get the criticisms of their comrades in science. Membership in the Synapsis Club was composed of staff members of the Citrus Experiment Station and of the branches of the United States Department of Agriculture stationed in southern California, but interested citrus growers were welcome at the meetings. That this Club has carried on for more than thirty years is strong evidence of the foresight and wisdom of the founder.

This is not the place to review Dr. Webber's voluminous scientific writings which were published for the benefit of botanical and agricultural workers at home and abroad, but reference must be made of his crowning success in planning and producing, in collaboration with Dr. L. D. Batchelor, of the great work entitled "The Citrus Industry" in three volumes. The first volume was published by the University of California Press in 1943, and the second will be ready shortly. In scope and wealth of information it far surpasses anything of the sort ever attempted. In addition to editing the work, Dr. Webber wrote over 300 pages of the first volume, including a comprehensive chapter on the cultivated varieties of *Citrus*. The second volume will be devoted to matters concerned with the production of the crops, to which Dr. Webber has contributed two chapters: "Nursery Methods" and "Citrus Rootstocks; Their Characters and Reactions."

Dr. Webber married on September 8, 1890, Lucene Anna Hardin (deceased August 16, 1936). Their children were Mrs. Eugene Frances (Webber) Morrison, Mrs. Fera Ella (Webber) Shear, Herbert Earl Webber and John Milton Webber.—Howard S. Reed, Department of Botany, University of California, Berkeley.

FIVE NEW SPECIES OF NAVARRETIA

Herbert L. Mason

In preparing the manuscript of the Polemoniaceae for Abram's Illustrated Flora of the Pacific Coast States, the following five species of *Navarretia* were found to be undescribed. All species will be illustrated in that work.

Under the name, *Navarretia Bowmanae,* Miss Eastwood described a plant from Anderson's Ranch, Lake County, California. In the discussion accompanying the description, she called attention to its relationship to *N. cotulaefolia* and hazarded the opinion that it may be "too closely allied" to that species. In this opinion we concur. Jepson (Flora of California, p. 152, 1943), concluded that the plant described by Miss Eastwood had blue or possibly white flowers which had changed to yellow on drying. On the basis of this decision, Jepson re-diagnosed *N. Bowmanae* and tentatively referred to that name a group of specimens unlike the type specimen described by Miss Eastwood. The individuals in the large colony of yellow-flowered plants seen by the writer at the type locality, however, do agree with Miss Eastwood's description. The plants placed under *N. Bowmanae* by Jepson, on the other hand, fall into two groups representing two distinct entities, both of which are undescribed. One centers in the Sierra Nevada foothills and adjacent plains from Calaveras County to Eldorado County and adjacent Sacramento County with an outlying occurrence in Solano County. The other occurs in Tehama and Lake counties, thus centering on the north and west sides of the Great Valley. Both entities appear to occur in soils rich in ferro-magnesian metals.

Navarretia eriocephala sp. nov. Annua erecta, 5–35 cm. alta, simplex vel racemosa-ramosa; folia rache crasso, lato vel tenui, 1–5 mm. longa, bipinnate seccata; bracteae rigidae-coriaceae rache lato, bipinnate seccata, subter dense albae-villosae; flores in capitibus; calyx inaequaliter seccatum, 2–3 lobae integrae, aliae dentibus, 6–8 mm. longae; corolla 5-mera infundibuliformis, 8–12 mm. longa, lutea saepe purpurea-maculosa; stamina ad faucium aequaliter affixa, filamenta inaequaliter, 1–3 mm. longi, illorum maximi exserti; stigma 2-lobatum; capsula obovoidea, valvi 4, semina 1.

Erect annual, 5–35 cm. high, stems tan to reddish brown, simple or racemosely branched, densely white canescent with retrorse hairs; leaves bipinnately dissected, often with a stout broad rachis or the rachis narrow, 1–5 mm. long, puberulent; bracts stiff-coriaceous, bipinnately dissected into linear, acerose lobes, the rachis expanded below, densely white villous below; flowers in heads, 5-merous; calyx unequally cleft, some lobes entire, others 3-lobed or toothed, 6–8 mm. long, densely white coarse villous above, glabrate below; corolla funnelform, 8–12 mm. long, cream yellow and often spotted or marked with purple, tube 6 mm., throat 3 mm., lobes 3 mm. long; stamens equally inserted on the throat, filaments unequal in length, 1–3 mm. long, exserted from throat; stigma exserted, 2-lobed, lobes 0.5 mm. long; capsule obovoid, 4-valved, 1-celled, 1-seeded, seed brown, smooth or slightly furrowed.

Type. Folsom, Sacramento County, California, July, 1910, *K. Brandegee* (Herbarium of the University of California no. 142954). Other collections. Copperopolis, Calaveras County, *J. Burt Davy 1377;* between Pilot Hill and Cool, Eldorado County, June 3, 1908, *K. Brandegee;* west side Brown's Valley, Solano County, May 2–6, 1891, *W. L. Jepson.*

Range. Foothills of the northern Sierra Nevada, Calaveras to Eldorado and Sacramento counties; Solano County, California.

Navarretia heterandra sp. nov. Plantae simplices vel basi ramosae, 3–20 cm. altae; folia bipinnata-dissecta, inferiora molliter herbacea, superiora rigidentia acerbaque; bracteae divaricate pinnatifidae, infra crasse albae-villosae; flores in capitibus; calyx inaequaliter scissum, lobae inaequales, 2–3 integrae, 2 dentibus duobus vel lobis, membrana sinus inaequaliter, tubus glabratus, lobae albae-villosae; corolla 4-, aliquando 5-mera, caerulea vel alba, calyx inaequalis, 5–7 mm. longum, tubus aliquando pubescens; stamina inaequaliter affixa, 0.5–1 mm. longitudine, inclusa, filamentes inaequales; stigma 2-lobatum, inclusum; capsula obovoidea, valvi 4, semina 1.

Plants simple or branched from the base, erect or radiately spreading, 3–20 cm. high; stems densely white canescent with minute, retrorse hairs; leaves bipinnately dissected, the lobes and rachis slender, lobes of the lower leaves soft-herbaceous becoming pungent and rigid on upper leaves; bracts divaricately pinnatifid with rigid, acerose lobes, densely white villous below with coarse white hairs; flowers sessile in clusters, these aggregated into heads, 4-merous or occasionally one or two 5-merous in the same head; calyx unequally cleft, some to the base, others only two-thirds to base, lobes unequal, usually 3 entire and 2 with lateral teeth or short lobes; sinus membranes unequal, calyx tube white villous above, glabrate on lower half; corolla subequal, longest sepals, 5–7 mm. long, white or blue, tube 4–5 mm. long, sometimes pubescent, throat 1 mm. long, lobes 1 mm. long; stamens unequally inserted on the throat, 0.5–1 mm. long, filaments unequal, anther 0.5 mm. long, included; stigma 2-lobed, included; capsule 4-valved, 1-celled, 1-seeded, seed brown, smooth or slightly furrowed.

Type. "Near Cottonwood, Tehama Co." [Shasta County], June 17, 1934, *J. T. Howell 12223* (Herbarium University of California no. 526143). Other collections. Three miles southeast of Redding, June, 1945, *G. L. Stebbins;* Kelseyville, *K. Brandegee* (?).

The literature of the Polemoniaceae makes repeated references to *Navarretia minima* as occurring in the Coast Ranges of California. The writer has thus far been unable to verify any such record. There are, instead, three inhabitants of vernal pools in Lake County which would key to *N. minima* in the literature, but which differ sufficiently from that species and from each other to warrant separate treatment. Field studies of these species suggest that their differences are related to the edaphic conditions to which they must be genetically adapted. One occurs in a pool in adobe soil, surrounded by white oak savanna; another occupies a pool on volcanic ash-obsidian rubble, surrounded by chaparral; and the third is on the margin of a bog actively building up a peat deposit and is surrounded by a forest of Douglas fir. In all these sites the plants are submerged during the period of germination of the seeds and establishment of the seedlings; they thus begin their life as aquatics. The details of floral morphology are strikingly alike and indicate close interrelationship. However, the great differences in habitat, indicative of considerable physiological differentiation, and the great difference in habit, produced by differences in the vegetative organs, is very striking and warrants specific segregation. These three species with their stamens inserted in the sinuses of the corolla lobes seem more closely related to *N. prostrata* of southern California which has a similar insertion of the stamens than to the northern *N. leucocephala* and *N. minima* in which the stamens are inserted midway on the corolla throat.

Navarretia Bakeri sp. nov. Annua erecta vel expansa, 2–5 cm. alta; caules 0.5–1.4 mm. crassitudine; folia infera simplices lineares vel dentibus raris vel pinnatifidis, supera pinnate seccata lobis raris divaricatis vel proliferatis, subter glabrata, super pilis brevibus crispisque; bracteae foliosae pinnatae, super paribus dentium subter paribus lobarum saepe aut lobis proliferis ad basim aut ex partibus dorsalibus rachis; flores in capitibus; calyx cum membrana ampla ad basim infra sinibus, margo solutus ciliatus, lobae tenues, aristatae; corolla 5–7 mm. longa, alba; stamina in sinibus affixa, exserta; stigma minutum, 2-lobatum, exsertum; capsula 2 mm. longa; semina pauca.

Erect spreading annual, 2–5 cm. high; stems racemosely branched, 0.5–1.5 mm. thick, densely clothed with retrorse crisped hairs; lower leaves linear, entire to few toothed or pinnatifid, upper dissected, lobes often proliferating, glabrate below, pilose with short, crisped hairs above; outer bracts foliaceous, pinnatifid with highly dissected proliferations; bracts within head pinnate with 1–2 pair of teeth in upper third and 1 pair of lobes below middle with proliferating lobes from their bases or from the dorsal surface of the rachis; flowers in heads; calyx lobes unequal, the longest lobes 5.5 mm., slender aristate, with a few weak hairs, membranous to base in sinuses, free margin of membrane ciliate; corolla white, 5–7 mm. long, tube 4 mm., throat 0.5–1 mm., lobes 1–1.5 mm. long; stamens inserted in the sinuses of corolla lobes, 2.5 mm. long, exserted from throat; style exserted, stigma minutely 2-lobed; capsule about 2 mm. long, the somewhat thickened top breaking away irregularly circumscissily from the membranous base; seeds few, minutely pitted, reddish brown.

Type. In vernal pool in adobe soil surrounded by oak savanna, 1.5 miles southwest of Lower Lake, Lake County, California, June 28, 1945, *H. L. Mason 12599* (Herbarium of the University of California no. 700272). Other collections. 1.5 miles west of Lower Lake, Lake County, (topotype) *Baker 11070;* Sherwood Valley, Mendocino County, *Davy* and *Blasdale 5162;* Trinity County, *Manning 99.*

Range. Vernal pools in meadows of the inner north Coast Ranges from Lake County to Trinity County, California.

Navarretia plieantha sp. nov. Annua prostrata lata 5–20 cm.; caules 0.8–1.4 mm. crassitudine, epidermis saepe exfolians; folia 3–4 cm. longa, integra vel paucis lobis filiformibus remotis risque; bracteae foliosae 3–4 capite quoque, 1–2 capites longitudine, pinnatae, lobae 1–2 proliferatae, rachis membranis ciliatis ab utroque latere; capita lata 1–2 cm., 20–50 floribus; calyx 4–5 mm. longum, membrana ciliata-marginata truncata in sinibus, lobae acerosae, subaequales; corolla 5–6 mm. longa, caerulea; stamina in sinibus lobarum corollarum affixa, exserta; stigma aut 2-scissum aut 2-lobatum aut integrum; capsula irregulariter dehiscens, pars summa nonnihil crassa ab lateribus membranosis cum humida frangens; semina 1–3.

Prostrate annuals forming a mat 5–20 cm. broad with several stout branches but not proliferating from below a central head, the main axis often with crisped retrorse hairs, lateral stems glabrate, the epidermis often exfoliating as a white membrane-like tissue; leaves 3–4 cm. long, linear and entire or pinnate with a few remote filiform lobes; outer bracts foliaceous, 3 or 4 to each head, 1–2 times the head, pinnate, the lobes often 2–4 times proliferated or the bract simple pinnate, rachis flanked by a ciliate membrane below, bracts within the inflorescence with from 1 to several pairs of lobes below the middle, entire above or with a pair of acerose teeth; flowers in heads 1.5–2 cm. broad, heads 20–50 flowered; calyx somewhat constricted above, 4–5 mm. long, membranous throughout except for the herbaceous lobes and a line of herbaceous tissue immediately below the lobes, glabrous or with a few weak hairs except for the ciliate margin of the truncated membrane in the sinus of calyx lobes; corolla 5–6 mm. long, blue, funnelform, tube 3–3.5 mm. long, included in calyx tube, throat 0.5 mm., lobes 2 mm. long; stamens inserted in the sinuses of the corolla lobes, 2.5 mm. long; stigma exserted, 2-cleft to 2-lobed or entire; capsule not regularly dehiscent, the somewhat thickened top breaking away irregularly from the membranous walls when wetted, the seeds working out of the constricted orifice of the calyx and resting on top; seeds about 3 to each capsule, reddish brown and minutely pitted.

Type. In peaty soil of lake margin surrounded by a black oak, madrone, Douglas fir and yellow pine forest. Boggs Lake, northwest slope of Mount Hannah, Lake County, California, June 29, 1945, *H. L. Mason 12628* (Herbarium of the University of California no. 700273).

Navarretia pauciflora sp. nov. Annua prostrata 1–4 cm. alta; hypocotula cortice crassa spongiosaque; caulis filiformis crassus 0.2–0.5 mm.; folia 1–2.5 cm. longa, linearia integraque vel pinnate divisa, glabra; bracteae rarae foliosae, 1–3 capites longitudine paribus pluribus lobarum sub medio; flores 2–10 in capite quoque; calyx cylindricum, 4–5 mm. longum, lobis inaequalis acerosis vel cuspidatis, ad basim sine membrana, membrana truncata et supra ciliata; corolla 5–6 mm. longa, caerulea vel alba; stamina in sinibus lobarum corollarum affixa, aequalia, exserta; stigma bilobata; capsula irregulariter dehiscens, pars summa nonnihil crassa ab muris lateralibus sejuncta; semina 1–plures.

Prostrate annual, 1–4 cm. high and spreading 2–8 cm.; hypocotyl with a thick spongy cortex; stems slender, filiform, 0.2–0.5 mm. thick, white with streaks of purple, densely clothed with short white retrorse crisped hairs or almost glabrous; leaves 1–2.5 cm. long, linear and entire or pinnately parted into 1 or 2 pairs of linear cuspidate lobes each about 2 mm. long, glabrous; outer bracts foliaceous, few, 1.5–3 times the head, with several pairs of lobes below the middle, membranous winged below, those within the head little exceeding the calyx, membranes ciliate margined, lobes acerose to cuspidate; flowers sessile or subsessile in 2–10 flowered heads, heads 4–10 mm. broad; calyx cylindric, 4–5 mm. long, membranous except for the lobes and the narrow band of tissue below them, this often reduced to a single vascular strand, membrane in the sinus truncate across the top and ciliate on the upper margin, lobes pubescent within; corolla funnelform, 5–6 mm. long, blue or white, fading blue, tube 3 mm., throat 1.5 mm., lobes 1.5 mm. long; stamens inserted in the sinuses of corolla lobes, equal in length somewhat exceeding the petals and well exserted from throat; stigma exserted, 2-lobed, lobes minute; capsule irregularly dehiscent, the somewhat thickened top falling away irregularly from the membranous sidewalls, seeds 1–several, minutely pitted, reddish brown.

Type. Playa strewn with obsidion rubble and surrounded by chaparral, 5 miles north of Lower Lake, Lake County, California, *H. L. Mason 12583* (Herbarium of the University of California no. 700271).

Department of Botany,
University of California, Berkeley.

REVIEWS

Nevada Trees. By W. D. Billings. Agricultural Extension Service, University of Nevada, Reno, Bulletin 94, pp. 102, illustrated. June, 1945.

"Nevada Trees" is a popular guide to the native and exotic trees of Nevada. Of the 177 species and varieties, 75 are native and 102 are introduced. The introduced species are readily distinguished by an asterisk preceding the name. Kinds growing on the grounds of the University of Nevada are noted.

The author has followed a phylogenetic sequence rather than arranging the genera and species alphabetically as is, unfortunately, so often done in a popular treatment. The species are grouped by families, the common name being used for the latter. Both the scientific and common name is given for each species. A non-technical key to the genera makes use of vegetative characters. Its use is explained and a glossary of the few technical terms is appended. An index of the common names only is provided.

Thirty-three of the species of most importance or of general interest are described rather fully and are illustrated by photographs. The photographs are supplemented by clear line drawings of the leaves, or, for 16 conifers, by good half-tone reproductions of the cones. The salient characteristics of the other species are briefly described in one or two lines. As the same characters are not always described for the species in a genus and as there is no key to the species, it is sometimes difficult, if not impossible, to make the necessary comparisons to identify the specimen at hand. If, in another edition, keys to species were added, the difficulties with the larger genera such as spruces, willows, and elms would be eliminated. Inclusion of more actual measurements, rather than such phrases as "greater than," would also make identification easier and more precise.

Zonation of the native forest-types in different areas of the state is described in the introduction. An excellent feature is that the complete geographic range of the native species is given in addition to the detailed range in Nevada. A map of the counties is included and care has been taken, in speaking of particular mountain ranges, to refer them to their respective counties. The native home of introduced species is also stated.

The format is pleasing and the paper of better quality than in many war-time publications. Sewing, instead of stapling, would have added to the durability of the bulletin.—Mary L. Bowerman, Department of Botany, University of California, Berkeley.

Hayfever Plants: Their appearance, distribution, time of flowering, and their role in hayfever, with special reference to North America. By Roger P. Wodehouse. Pp. xix + 245, with 73 figs., and 10 tables. The Chronica Botanica Company, Waltham, Mass., 1945; J. W. Stacey, Inc., San Francisco, California. $4.75.

The appearance of the first book on the hayfever plants of North America is in itself an event worthy of note. When such a book is written by one who is a thoroughly trained botanist with long experience with hayfever plants and their pollen, and also has a thorough acquaintance with allergic problems, it bears the stamp of authority and deserves the attention of botanists as well as allergists. Although the book is written primarily for the benefit of practicing allergists, there is much of interest and value for botanists and others who are in any way concerned with the problems of allergy. The book is divided into four chapters: The Botany of Hayfever, The Hayfever Plants—Gymnosperms, The Hayfever Plants—Angiosperms, and Regional Surveys. A brief glossary and an extensive bibliography follow the text.

The chapter on the Botany of Hayfever includes information on the structure of flowers, distinction between entomophilous, anemophilous and amphiphilous flowers, toxicity of pollen, methods of collecting and the identification of atmospheric pollen, and a discussion of some of the botanical literature which will aid in the identification of plants in the various regions of the United States.

In the chapter dealing with the gymnospermous hayfever plants a brief discussion of gymnosperms in general is followed by information upon two families "of interest to students of Hayfever," the Ginkgoaceae and Coniferae. Of the six tribes mentioned in Coniferae, only the Abietineae and Cupressineae are presented in any detail. To those residing on the Pacific Coast, the failure to include *Pinus ponderosa* and *Pseudotsuga* with the discussion of pines, spruces, and firs, may seem a surprising omission. However, since the gymnosperms as a group are of such minor importance in causing hayfever this omission may be excused.

The chapter on the angiospermous hayfever plants includes not only those plants the pollens of which are known to cause hayfever, but most of the genera of wind-pollinated plants of North America. These plants comprise five families of monocotyledons (Typhaceae, Arecaceae, Gramineae, Cyperaceae, and Juncaceae) and twenty-two families of dicotyledons (Salicaceae, Betulaceae, Fagaceae, Casuarinaceae, Juglandaceae, Myricaceae, Ulmaceae, Moraceae, Cannabinaceae, Polygonaceae, Amaranthaceae, Chenopodiaceae, Rosaceae, Platanaceae, Mimosaceae, Fabaceae, Simarubaceae, Tiliaceae, Aceraceae, Oleaceae, Plantaginaceae, and Compositae). Short but effective descriptions, not overburdened with technical language, are given for the families and genera. The inclusion of pollinating dates, description of pollen grains, and the evaluation of the species as probable factors in causing hayfever are of the utmost importance to practicing allergists. The descriptions are supplemented by over sixty original drawings of flowers and other parts of the more important species of hayfever plants and by nearly as many drawings of their pollen grains.

The fourth and last chapter is largely a compilation of the numerous reports and surveys of hayfever plants throughout the United States. These surveys have been grouped into ten sections of the United States, chosen arbitrarily "for convenience of presentation," rather than being based upon political divisions or natural vegetational units. Tables giving the pollinating dates by weeks in the various sections, and references pertaining to these sections accompany the text. The lack of uniformity in the text of the treatment of the hayfever plants for the different sections is unfortunate, as this gives a wrong impression regarding the relative importance of the various groups of plants. In sections I, II, and IV the plants are presented under the three major hayfever seasons, namely, early spring (trees), late spring and early summer (grasses and plantains), and late summer (ragweeds and other weeds). In sections VI, IX, and X the plants are listed under trees, grasses, and weeds. Either one of these methods of presentation is satisfactory as there is much correlation between the major hayfever seasons and the three major groups of hayfever plants. The text in section III (Virginias and Carolinas) consists of brief discussions of the maples, elms, junipers, hickories, oaks, and poplars (all trees), and with only two lines on Bermuda grass and six lines on five weeds. This treatment overemphasizes the place of trees in causing hayfever. In the section on the Southern States (V) the treatment consists of using generic names as *Juniperus, Quercus,* and *Betula* instead of junipers, oaks and birches as in section III. Again, as in that section, one gains the impression that the grasses are of little importance. To botanists and allergists on the Pacific Coast, the text for sections VII (southern California) and VIII (The North Pacific States—northern California, Nevada, Oregon, and Washington) gives the impression that grasses are of little importance as hayfever plants in these two divisions. The text on southern California is comprised of a discussion of five weed-shrubs (*Artemisia, Atriplex, Ambrosia pumila, Franseria,* and *Hymenoclea Salsola*); no mention is made of grasses and trees. It is only after careful examination of table VII (hayfever plants of southern California) and of the references that one is aware of the place of grasses and trees as factors in causing hayfever in this division. In the section on the North Pacific States, thirteen tree groups and ten weed-shrub groups are discussed, but no mention is made of any grasses. However, in the table listing eighty plant groups (genera and species) twenty-three are grasses.

The inconsistent usage of common and generic names as headings and subheadings and the lack of uniformity in the treatment of the hayfever plants in the various regions included in chapter

IV are in direct contrast to the uniformity and excellent treatment of the plants in chapters II and III. Perhaps many of these inconsistencies could have been obviated by more careful editing on the part of the publisher. Whatever fault one may find in the method of treatment of material in chapter IV, it is more than compensated for by the tables of plants and their pollinating dates and in the discussion of the references following the text for each region.

Dr. Wodehouse is to be congratulated for the great service he has done to all practicing allergists in bringing together in this fine volume the great mass of botanical information applicable to the field of allergy.—H. E. McMinn, Mills College, California.

A Synopsis of the North American Species of Delphinium. By Joseph Ewan, University of Colorado Studies, Series D (Physical and Biological Sciences) 2(2): 55–244. f. 1–58. 1945. $1.00.

Like most of the larger genera of North American plants, *Delphinium* has been for many years in need of a thorough and comprehensive new treatment and of a complete re-study of its species. Although it is not possible for one unfamiliar with many of the species of a genus to make an adequate evaluation of a paper of this sort, the one by Joseph Ewan gives evidence of complete competence of workmanship, and many features give testimony of an unusually scholarly approach.

The author does not claim to have made a complete solution of the interrelationships of the major species groups, and he has not chosen names of formal standing to designate them. Consequently, the species are placed in series rather than in subsections, sections, or subgenera. Probably it is recognition of this limitation of the present state of knowledge of the group of plants which has led the author not to attempt to make a key to all the species or to the series recognized by English names. Consequently, he has given regional keys to the species occurring in such areas as, for example, "Washington and Idaho," "California," or "Colorado." It is to be hoped that in time, after further study of the genus it will be possible for the author to provide keys to segregate the major groupings, and to separate all the species according to relationships, rather than according to geography.

The treatment of each species, subspecies, and form is thorough, but the author has not gone to the extreme of detail of citing all of the specimens of common species. However, for all critical points he has backed up his interpretation by citation of specimens. Both the text and the introduction show the results of a long and critical study.

The writer is inclined to wonder about only one major point. In the introduction a list of characters considered as primitive is given. Opposite this there is another list of corresponding characters considered as advanced. It is obvious that some of the characters such as papillate or scaly seeds may represent specialization and probably, therefore, are indicative of advanced types. However, it is to be wondered whether such a character as relatively simple leaves is to be considered always as necessarily primitive within the genus and whether the corresponding character of more deeply lobed leaves is to be considered necessarily as advanced. The same question might be raised concerning such characters as the relative density of the inflorescence and hairiness of the herbage. The writer is ignorant of the situation in the genus *Delphinium,* and it is quite possible that the primativeness of the characters as described by Mr. Ewan is correct.—LYMAN BENSON, Department of Botany, Pomona College, Claremont, California.

Forest Tree Breeding and Genetics. By R. H. RICHENS, M.A. Imperial Agricultural Bureaux, Joint Publication No. 8. November, 1945.

This bulletin is the most comprehensive of the relatively few British publications in the field of forest tree breeding. Its content may be summarized briefly.

A short preface and table of contents precede the fitting foreword by the well-known forester H. G. Champion. The introduction is primarily an argument supporting the need for forest tree breeding in England, seemingly with the intent of overcoming indifference to such work on the part of His Majesty's Forest Commissioners. The next eleven pages are devoted to a generalized (and excellent) discussion of the principles and fundamentals of forest tree breeding. A detailed text of 41 pages follows. The bulletin ends with a glossary, a summary in four languages, and 613 citations to literature on the subject.

According to the preface, the objective of this publication was "to collate the literature on forest tree breeding that has appeared since 1930." This has been done by selecting for discussion 22 topics such as "natural variation," "quality," "selection," "hybridization." The literature on each of the 31 included genera of forest trees is systematically reviewed with relation to the 22 topics chosen.

The table of contents, a very ingenious device, permits ready reference to any one of the 22 topics as it relates to any of the 31 genera considered.

Careful study of the genera treated and the topics discussed reveals that very little recent literature on the subject of forest tree breeding would be excluded in the screening provided by the plan of the bulletin. While it is possible that some publications on the subject may have escaped the attention of the author, due to the war-torn condition of the world for the past few years, it is doubtful whether any considerable amount has thus been overlooked. Furthermore, frequent citations to unpublished material and ideas indicate that the author canvassed contemporary students of the field in an effort to bring his contribution strictly up to date.

After a study of the literature, the author selected for citation what he considered best. Many papers describing purely local work and papers that are repetitive have not been included. These may be exemplified by the numerous, but not too important, dialectics emanating from central Europe during the mid-thirties in which were debated the relative value of various criteria for distinguishing geographic races of trees.

In terse style the author summarizes the information available on each topic, citing the publications from which the information was extracted. It is difficult to find a phase of forest tree breeding which has been investigated that is not mentioned. Students can find no better guide to the literature on the subject for the time period covered than this bulletin. It will become a permanent point of reference in the literature of forest tree breeding.

I feel that there will be disappointment, however, on the part of the forester or tree breeder when he has finished perusing this pamphlet, not because of the way it is done but rather because it does not go further into the subject. The condensed treatment prevents the author from expanding the ideas presented and in some places the presentation itself suffers from brevity. Also, a critical comparison and evaluation, by Mr. Richens, of the literature on controversial issues has not been possible in the allotted space.—W. P. Stockwell, In Charge, Institute of Forest Genetics, California Forest and Range Experiment Station.

NOTES AND NEWS

Stipa arida in Nevada. In June of 1940 in Nevada, I collected an unusual *Stipa* growing with the rare *Blepharidachne Kingii* (S. Wats.) Hack. on extremely dry lava beds five miles southwest of Lockes, Nye County, Nevada (lat. 38° 28′ N., long. 115° 52′ W., *Pohl 2073*). Dr. F. J. Hermann of the National Arboretum Herbarium, Beltsville, Maryland, kindly identified the *Stipa* for me as *S. arida* M. E. Jones, a plant hitherto known only from Colorado, Utah and Arizona. The Nevada specimens correspond very closely in spikelet characters to material of the type number (*Jones 5377*) in the United States National Herbarium. They are considerably more mature than the Jones specimen, however, and show certain features of the fruit which are not well exhibited in the latter. The body of the fruit becomes a golden brown at maturity. The awn, while frequently merely somewhat flexuous, may at full maturity develop a definite geniculum about a centimeter above its base. The proximal portion of the awn, below this geniculum, becomes brown in color like the body of the fruit, and is banded with whitish stripes along the edges of the loose spiral into which it is twisted. The distal portion of the awn is not twisted and is whitish in color.—Richard W. Pohl, Department of Botany, University of Pennsylvania, Philadelphia.

Viola odorata in California. A violet having deep reddish violet flowers and long, leafy runners was found at an altitude of 5500 feet at Pinecrest, Tuolumne County, California, on February 24, 1945, by Mrs. Anita Hewick and was referred to me by Miss Elizabeth E. Morse of Berkeley, California, to whom it was sent. The plant is *Viola odorata* L., the Fragrant Violet or the English Violet and is a native of the old world where it occurs in England, on the continent of Europe, east in Asia to the Caucasus Mountains, and again in Northern Africa. It is probably the violet often mentioned by that earliest of botanical writers, the Greek philosopher, Theophrastus, who lived some three hundred years before Christ. An early introduction into American gardens, it has long been enjoyed for its color and fragrance. In some of our eastern and western states it has escaped from cultivation and when found away from a dwelling and growing "wild" it is natural to confuse it with our own native violets.

The only native violet with runners growing in the vicinity of Pinecrest is a small white violet (*V. Macloskeyi*). There is, however, a species with violet colored flowers, the Hooked Spur Violet (*V. adunca*) which later in the season has elongated stems, but these stems are not runners.

Viola odorata differs from any of our native North American violets in having a style in which the tip is bent downward like a hook. Also, the stem of the ripened seed pod bends downward and so more safely plants the cream-colored seeds. These characteristics, together with the color and fragrance of the flowers, and the long leafy runners make this violet readily recognizable.

The violets sold today in the florist shops have been made by crossing *Viola odorata* with one of our North American violets, the Meadow or Hooded Blue Violet, *V. papilionacea* (?). The result of this crossing is a bigger violet, but, unfortunately, much of the fragrance is lost.—Viola Brainerd Baird, Berkeley, California.

On March 23, 1946, the California Botanical Society held its first annual dinner meeting since Pearl Harbor at the Hotel Shattuck, Berkeley. Dr. C. Y. Chang, Professor of Botany, University of Peking, spoke on "Botany in War Time China" and told of the need for maintaining the Chinese universities during the war period and of the difficulties encountered. It was necessary to move the universities more than once, the students and faculty walking for as much as a thousand miles to reach the new locations. Furthermore, it was necessary for them to build their own living quarters and laboratories, to get along with very few microscopes and without up-to-date text books. Once during a Japanese bombing attack, the laboratories were destroyed and had to be completely rebuilt. Yet in spite of these many difficulties the classes continued to meet and the faculty, by devising substitute equipment, managed to carry on a research program and give vital scientific information to the government.

The annual meeting of the Pacific Division of the American Association for the Advancement of Science and affiliated societies will be held this summer from June 17 to 22 at the University of Nevada, Reno.

Dr. Rogers McVaugh, Acting Curator of the National Arboretum Herbarium, Bureau of Plant Industry, Beltsville, Maryland, has accepted the position of Curator of Phanerogams, University Museums, University of Michigan, Ann Arbor.

Dr. Philip A. Munz, now at the Bailey Hortoreum, Ithaca, New York, is returning to California as Botanist at the Rancho Santa Ana Botanic Garden, Anaheim, a position which has been vacant since Dr. Carl Wolf resigned a year ago to take over the management of extensive citrus holdings. Dr. Munz will assume his duties at the Garden August 1, 1946.

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A WEST AMERICAN JOURNAL OF BOTANY

Contents

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THE EDAPHIC FACTOR IN NARROW ENDEMISM. I. THE NATURE OF ENVIRONMENTAL INFLUENCES

Herbert L. Mason

There are three aspects to the dynamics of any problem involving the geographic distribution of plants. First there is the environment, represented by a series of intensity spans of the various environmental factors or by conditions or sequences of conditions of these factors. Secondly there are the physiological reactions of the individual plant that function within limits of tolerance for the conditions prevailing within the environment. Thirdly there are the genetic processes that operate to fix tolerance ranges of and give character to the individual, to control the variability of the population, and to give rise to new individuals preadapted to this environment or endowed with the potentiality for extending the area of the species. The interaction of these three forces determines the area occupied by any group of plants and no other force, except as it may influence either directly or indirectly the interaction of these three, can in any way affect the distributional pattern of the population.

The functioning of all plants is conditioned by environmental factors acting to control physiological processes. The relationship between environment and physiology in each individual case is probably genetically fixed as to the nature and span of the tolerances concerned. The fixation of tolerance spans may result from any of the isolating mechanisms of genetics that function to elaborate plants over the available habitats, each species or population being restricted to the area of the environmental conditions to which the tolerances of its component members are suited. These dynamics apply to all plants, hence all plants are restricted in range. Restriction in range is purely relative and is always related to environmental factors through physiological and genetic processes.

When the literature dealing with the subject of endemism is reviewed in the light of these ideas it becomes evident that there is much misunderstanding of the problems that relate to species of highly restricted range. Most of the difficulties result from an attempt to apply abstract ideas in the role of factors in cause-and-effect relationships. There are frequently encountered such terms as "age factor," meaning either age of species or age of land mass; "size factor," inferring size of land mass; "isolation," as a causal factor rather than as a term descriptive of a situation in which the real causes operate; and "historical factor," used in a vague sense to imply causal relationships bound often to unknown events of the past. I shall return later to a discussion of

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Corrected date line: Madroño, Vol. 8, pp. 177–208. May 15, 1946.
Madroño, Vol. 8, pp. 209–240. August 5, 1946.

these abstractions. For the present it will be sufficient to point out that none of these concepts can be applied with significance to problems of physiological reactions of the individuals of the population or to the genetic processes that control a population. They can therefore have no influence in the restriction of area of any species of plant. The many difficult problems relating to endemism can never be solved by continuing to apply abstract ideas toward their solution. Endemic species, like every other species of plant, are made up of individuals that are functioning organisms. Their physiological reactions operate under the influence of environmental conditions. Their precise nature is the result of genetic processes. The general dynamics applying to problems of their geographic distribution must therefore be the same as those applying to all plants. Since there is so much misunderstanding of these problems, I deem it pertinent, before entering upon my subject, to discuss very briefly what I presume to be the nature of the roles of the environment, of the physiology of the individual of the population, and of population genetics, as they operate in vegetation dynamics. Although certain aspects of broad endemism are herein discussed, it should be borne in mind that the main thesis of this paper is the highly restricted patterns of distribution.

The Nature of Environmental Relations

The geographic area occupied by any group of plants is controlled by definite intensity spans or rhythmic patterns of certain conditions of environmental factors. Climatic factors in any given region are most inclusive in their scope of control. They may function within a pattern laid down by diurnal and seasonal rhythm. The nature and sequence of this rhythm may at times be a limiting factor to the occurrence of certain species of plants and may be equal in significance to the extremes (8, 10) of the intensity span of any environmental factor in its function of determining and controlling the periphery of the area that any species can occupy. Practically the entire range of normal climatic situations over the surface of the earth provides suitable habitats for plant populations, given an adequate edaphic setting.

In any given region the various aspects of the edaphic factor operate wholly within the conditions superimposed by climate. They may be relatively stable in their occurrence and span of intensity, or they may fluctuate as a direct result of some chance climatic sequence of events or with the rhythm of climatic events, or their fluctuation may be imposed by biotic factors or diastrophic processes. Here again, where the fluctuation is rhythmic, the rhythm may function as a limiting factor much as does the rhythm of climatic events. An example of such a rhythm is the seasonal fluctuation in the position of the water table, or the seasonal fluctuation of the soil-moisture content in certain arid regions, or the seasonal sequence of salinity or of hydrogen-ion concentration in certain soil solutions. Almost the whole enormous range of edaphic situations provides suitable habitats for some plant populations.

The biotic factor, being the result of the functioning of organisms, is in itself subject to the whole gamut of environmental factors, hence its various aspects operate within conditions prescribed by climatic and edaphic factors. Often the precise biotic effect may result from the regular coincidence of one phase of a life cycle with a certain phase of the life cycle of another organism upon which it depends or which it may influence. The yucca moth must emerge at the time that the yucca is flowering or no pollination will result. Here is a case of the necessity for the coincidence of two ontogenetic rhythms to insure proper functioning. Any factor that disturbs either of these rhythmic sequences to the extent that these two ontogenetic phases no longer coincide, would cause the yucca to lose its capacity to reproduce. There are many biotic environments that possess their special floras; frequently they consist of populations of single species and they often involve various aspects of parasitism and hemiparasitism.

It will thus be clear that the problems of environmental factors in their conditioning reactions on physiological processes of plants are not always simple problems of presence or absence, nor are they always simple problems of intensity or the gradient between extremes. They may involve the coincidence of many rhythmic sequences of fluctuating presence and absence, or fluctuating intensities with fluctuating physiological demands, or rhythmic sequences in the ontogeny of the plant. Often they operate to condition one another and may, in so doing, alter the physiological response. Most significant to problems of plant geography is the fact that environmental conditions occupy area independently of whether any precise condition may or may not influence a particular organism.

The Physiology of the Individual

The response of the organism to the conditions of its environment may be expressed in terms of the principle of limiting factors (8), and the theory of tolerance (7) or the theory of physiological limits (3); such relationships, insofar as they are inherent within the species, are subject to the laws of evolution and genetics. Within the species or population, the range of variation of the capacity to tolerate various aspects of the environmental factors is the direct result of the genetic diversity of the species or population in question (9). The functioning of all plants, regardless of their degree of geographic restriction or the age of the species, is conditioned by environmental factors acting or interacting to control physiological processes. Just as there are rhythmic aspects in many types of environmental factors, there are rhythmic aspects in the diurnal and seasonal phases of the plant's physiology as well as in the seasonal aspects of its ontogeny. Each phase of the rhythm of ontogeny or the rhythm of physiology is controlled by its own span or sequence of environmental conditions, and one phase of the ontogeny or physiology may make different demands upon the environment than another. Thus, some plants require a significant drop in temperature at night; others require a reasonably sustained temperature. Some plants come into flower under the influence of a seasonal sequence of rising temperatures and sustained water supply, while others, such as the summer annuals of the California foothills, appear to require a seasonal sequence of rising temperatures and decreasing water supply. During the occasional season when water supply is sustained, these plants spend most of their energy in developing foliage, and they produce few flowers, or flowering may be seriously retarded seasonally. Owing to the great mortality of seedlings between germination and establishment in nature, one must conclude either that some physiological process has a very narrow span of tolerance for some factor of the environment, or that the coincidence of a physiological or ontogenetic rhythm with some aspect of seasonal rhythm of the environmental complex is under very fine adjustment. An example is the environmental condition that controls the establishment of seedlings of the highly restricted endemic Monterey cypress, *Cupressus macrocarpa* Don, in its native habitat. In a normal year the moisture content of the surface soil recedes very rapidly at the end of the rainy season. If the growth of the taproot of the seedling is able to keep pace with the recession of the soil moisture the seedling will become established. If not, the seedling dries up and dies. Here an essential coincidence between two rhythmic cycles is usually out of adjustment and normally results in no establishment of seedlings. It is only occasionally that conditions are favorable for the establishment of seedlings of this species in its native habitat. Favorable conditions may result from late rain or a cool spring, and during such occasional years the establishment of seedlings is abundant. It is well to point out here that this is a problem of the relation of a species to its environment involving the species as it is constituted genetically and physiologically today, meeting environmental conditions as they prevail today. Given a plant so constituted and an environment so characterized, the age and source of the species to which it belongs, or the incidents in the history of the species, have no bearing on the problem of how the plant reacts to the conditions of its environment except as conditions and incidents of the past, reacting on the developing species population, may have influenced the genetic processes responsible for the present constitution of the plant.

The physiological processes of the plant, whether they involve nutrition, respiration, growth or reproduction, operate under the influence or sanction of environmental conditions. The environment functions to control the physiological processes, and, because the conditions of the environment occupy area, they circumscribe the area in which the process can function. Thus the dynamics of the physiology of the individuals of a population become linked with the dynamics of the environment to control the area the population can occupy.

The Role of the Genetics of the Individual and of the Population

Genetics, by whatever mechanism it may operate, in each individual case functions to set the capacity of the plant to tolerate the conditions of the environment. Once the zygote is formed, the role of genetics, so far as the new individual and its characteristics are concerned, is ended. This however is not the case with the population. The population is continuous beyond the life span of the individual. Its continuity results from the reproductive process among individuals which inevitably sets in motion the mechanics of population genetics. Each of these aspects of genetics plays an important role in the dynamics of plant geography.

There is enough evidence now at hand to justify the general conclusion that the relationship between function and its conditioning environmental factors is genetically fixed within each individual plant. The tolerance span of the individual is but an increment of the total span of variation that characterizes the species or the population with respect to any particular function and its conditioning environmental factors. Furthermore, the fixing of the tolerance span of the individual, or of the population or of the species, may result from any of the isolating mechanisms operating in the genetics of plants. Out of the diverse mass of seed presented to it, the environment is able to select only those individuals that are preadapted by their tolerance spans to become established and survive under the conditions prevailing in the area into which the seeds chance to fall. This repeated selection, generation after generation, tends to fix the form and the physiological capacity of the individuals of the species and to control the range of genetic diversity of the population that may occupy an area characterized by any given set of environmental conditions. It is akin to what Turesson (14) termed a "genotypical response of the plant species to its habitat." It results in a genetic race thoroughly in adjustment with the pattern of interaction between the various factors of the environment and the physiological processes of the plant that govern germination, establishment, and the functioning of the mature individual. It is through these processes that the species is enabled to persist in a given environment through the normal fluctuation of habitat conditions. It is likewise through these processes of genetic variation that individuals develop that are capable of extending the population into new habitats. Only in this way can a species overcome the great environmental diversity that otherwise would serve as a barrier to its migration. Many aspects of the edaphic environment do not migrate with climatic changes; these, therefore, stand as either selective agents or barriers imposed across the path of a migrating flora. Thus, extensive migration, even though it accompany a definite climatic environment in its shift, will probably result in considerable ecotypic differentiation and speciation, as well as in some extermination at various points in its course. To our thesis it is most important that the seed destined to survive in the new environment arrives already preadapted to the new conditions through the genetic phenomena that are inherent in the reproductive process. The new environment plays no part in this preadaptation.

Because of the nature of the usual reproductive process, every problem involving the geographic distribution of such plants must of necessity be concerned with the genetics of populations. The mechanics of population genetics have inherent in them the potentialities for inducing or restricting morphological and physiological variation in the population, as well as for initiating and pursuing the various processes leading to speciation that may function to elaborate the population over the available habitats. These mechanics owe their amplitude in any given environment to such things as the genetic diversity of the population, the nature and rate of mutations, gene infiltration, and the chromosomal phenomena that may alter the nature, arrangement, and quantity of genic materials entering the zygote, as well as to the selective influences of the conditions of the environment. Any of these phenomena may function to alter form and physiological responses of the individuals of the population and thus give rise to habitat types adapted to the particular environmental complex or complexes prevailing in the area. The population may operate wholly within its own genetic influence and become stabilized through random fixation, or it may be subject to frequent mutation or to gene infiltration that will function to keep it in a relatively unstable condition genetically. Whatever the situation may be, for purposes of plant geography it must be constantly borne in mind that the genetic phenomena involving the individual of the population, as well as the population as a whole, concern the physiological responses of individuals to the conditions of the environment and therefore have an important bearing on problems involved in the area the population can occupy.

Genetic diversity within the population may be expressed in terms of biotype number. At any given time biotype number in the population is the result of the interaction of genetic and physiological processes and environmental factors. This being the case, so far as the environmental relations are concerned, the number of biotypes in an area is to be determined by environmental conditions and not by the size of the area. Aside from purely environmental relations, the number of biotypes in an area is subject to such genetic phenomena as chromosome aberrations, gene infiltration, and random fixation. Thus, when conditions are alike over a wide area and genetic phenomena relatively stable, one might find few biotypes over the entire area. When great environmental diversity prevails in a small area and genetic instability characterizes the population, there may be many biotypes in a small area. On the other hand we may have, as Stebbins (13) has pointed out, a definite correlation between restriction of species and biotype depauperization. Here, in all probability, there must also be a close relation between environmental condition and adjusted tolerances resulting from biotype depauperization of the population. It must, however, be pointed out that the phenomena reported by Stebbins may not always of necessity be reflected in reduced size of area. It will be so only when tolerance spans are reduced along with biotype reduction, and the conditions to which the adjustment is suited occupy smaller area.

This discussion of the relation of the organism and the species population to its environment is pertinent to my subject because it demonstrates that the variations possible in the interaction of an enormously complex series of environmental factors with the physiological mechanisms of plants under the influence of ordinary genetic processes are sufficiently great to give rise to a plant population with all of the peculiarities of minor speciation and distribution pattern known to us today. It should be clear that the populations of special environments result from genetic differentiation. This is essentially the mechanism behind floristic diversity, a condition that obviously is to be associated with environmental and genetic diversity in their effect on physiological processes. The key to the problem is diversity. The greater the environmental diversity the broader the selective powers of the environment. It must follow that the greater the genetic diversity, the more numerous will be the opportunities for the exercise of environmental selection. The precise outline of the geographic occurrence of a species will be determined by the outlines of one or more increments of the pattern of environmental diversity. The nature of the species will result from genetic processes under the influence of environmental selection.

Endemism, Area and Geographic Restriction

For these reasons all plants are restricted in their geographic area by environmental conditions, and, for these same reasons, all plants are, in a sense, endemics. The area of their occurrences is determined by precisely the same set of dynamics. It would appear that endemism results from forces operating to limit or restrict the area of all species, and that the nature of these forces is the interplay or interaction of environmental factors on physiological and genetic processes. The manifestation of restriction may be in the form of a response to climatic, edaphic, or biotic factors, or to any combination of these. There is evidence that all of these, singly or in various combinations, have been responsible for some aspect of endemism. Endemism should not be burdened with indefinable presumed freak distribution patterns, nor should it be confined to highly restricted patterns of distribution. When so treated it is set upon a plane where normal explanations seem not to apply. It should be constantly borne in mind that the dynamics of plant distribution are essentially the same or of the same order for all plants, and that these dynamics may serve as a pattern or framework upon which to build interpretations or explanations of the many problems of either usual or unusual distribution.

With this concept of endemism we have in no way altered the problem; we have altered only the point of view. We still have restricted endemism and broad endemism, old species and young species, and all stages in between. We still must seek explanations in terms of cause and effect. With this point of view, however, *area becomes subordinated to environmental condition. The area is incidental to the condition and is significant only because the condition occupies area.* Environmental diversity becomes the key to floristic diversity, and the more precise patterns of distribution must be involved with the more precise causes. In general, the larger the area occupied by a species the more apt is its periphery to be under the influence of a complex series of limiting factors. These may operate differently in the various segments of the periphery of the area of the species. The smaller the area occupied by the species the fewer will be the factors concerned with its restriction until, in certain highly restricted patterns of distribution, a single limiting factor may suffice. Although this relationship is in general true, it obviously cannot be absolute because it is perfectly possible for a single factor or a few factors to control fairly large areas or for small areas to be controlled by several series of factors.

The causes behind any particular pattern of geographic distribution of plants may be numerous and diverse. They must, however, be of the nature of conditioning factors to physiological processes. Since their chief manifestation is a pattern of geographic distribution within an area, it follows that the causes must be related to conditions that likewise occupy area independently of the fact that plant species may be restricted by them. Of the three aspects of the dynamics of plant geography, only that pertaining to the environment independently occupies area. Therefore we may conclude that causes behind any patterns of distribution are intimately linked with the environment, and that the distributional patterns are circumscribed by environmental conditions. It is the areal span of the environmental condition to which the plant is preadapted that determines the area that any species can occupy. If the condition is local, the potential area of the species will be local; if the condition is widespread, the potential area of the species will be broad. Likewise, if the area of the condition is continuous, the potential area of the species is continuous; if the condition is discontinuous, the potential area will be discontinuous. This does not mean that all plants occupy all of their potential area, but it does mean that all plants have a potential area characterized by a given set of environmental conditions occurring in a definite span of intensity and often in definite rhythmic sequences. The plant, having the capacity to tolerate a particular set of environmental conditions, will—unless effectual barriers exist—soon occupy all of its potential area through such agencies of regular and chance dispersal as may be available to it.

When we begin with the concept that all species owe their distributional patterns to various aspects of the same set of dynamics, we note that there are wide variations in the size and nature of the area occupied by the different members of the flora. We observe that there appear to be patterns of distribution that relate themselves to various sets of environmental conditions. Some species will appear to be under the influence of certain aspects of climate, such as temperature or moisture. Other species may seem to be under the influence of edaphic factors, such as the physical conditions of texture or of water-yielding capacity of soil or perhaps some local occurrence of a special metallic ion in the soil solution. In other cases some aspect of a biotic relationship may prevail. Were it possible to make a really adequate analysis of such problems we probably would find that almost every conceivable combination of environmental condition could be correlated with the distributional pattern of some species of plant. It must be emphasized that any environmental factor or combination of factors may be responsible for the restriction of area of some species of plant. In all probability the environmental relations of the distributional pattern in any given case involve complex interrelationships of several aspects of one or more categories of factors. Nevertheless, it is also highly probable that in other cases a single aspect of the environment may occur spatially in such a manner as to precisely circumscribe the periphery of the area, or a segment of the periphery of the area, that the species can occupy. Presumably this condition of the environment at this point spatially represents the limit of tolerance for a vital function, or marks the point where two or more coincident rhythmic cycles cease to be coincidental. It must be emphasized that the entire periphery of the area occupied by a species is not necessarily under the control of the same factor. An example may be cited in the case of the distributional pattern of *Sequoia sempervirens* (Lindl.) Dec. Its northward extension appears to be limited by low winter temperatures, particularly as these affect seedlings; its eastern boundary coincides with the boundary of the occurrence of almost daily summer fog; to the south some other aspect of water relations of soil or atmosphere, or possibly the oxygen content of the soil solution may be the limiting factor; to the west it is against the barrier of the Pacific Ocean; a thirty-mile gap in its range coincides with the occurrence of an extensive area of serpentine rock. At many points along its front any number of minor factors may control the situation locally. These are different categories of environmental factors, and for the most part they are critical at different seasons of the year. In the case of highly restricted patterns of distribution, however, it is more probable that the entire periphery may be, in most cases, under the control of a single environmental factor or a single complex of factors. This is especially true where the limiting factor may be edaphic.

The Edaphic Factor

When we consider the nature of environmental factors whose various conditions may occupy area independently of the occurrence of any species of plant, it seems probable, except for certain cases of special biotic restriction, that the edaphic factor occurs spatially in a manner that is most apt to be related to highly restricted patterns of distribution among plants. The edaphic factor pertains to the substratum in which plants grow and from which they derive their mineral nutrition and much of their water supply. It involves the physical and chemical nature of the substratum together with the effects of these on the various aspects of water relations and aeration of soils. Because of the great local variation that exists in the physical and chemical nature of the substratum and soils, the edaphic factor presents the possibility of enormous diversity of habitats in any given area. This diversity is expressive of conditions that may involve presence or absence, amount, degree of intensity, or rhythmic sequences of fluctuation of any aspect of the edaphic factor as it may vary from place to place and from season to season in the area. Because of the nature of various conditions of the edaphic factor, the geographic area of the condition is often very sharply delimited.

Edaphic diversity owes its nature to many causes and may express itself both physically and chemically. Without attempting to give a complete picture of the causes of this diversity, the nature of some of it may help to clarify certain aspects of the problems of highly restricted plants. Most obvious in the cause of edaphic diversity is variation in the position of the water table. Where it occurs above the ground level we have lakes, ponds, pools, and marshes. Its depth below the ground is no less significant as an ecological factor. The seasonal fluctuation in the position of the water table presents a rhythmic sequence that is very important floristically, especially in arid and semi-arid regions. Where these conditions coincide with particular soil types, special habitats of a highly selective nature are produced. Among these are the vernal pools of the Great Valley of California with their richly endemic floras.

Soils, soil building, and soil leaching provide other aspects of edaphic diversity; here are many forces at work that may produce very local conditions. Soil building and soil maturing, by bringing together and mixing many diverse sediments, tend in some cases to counteract some of the elements of diversity characteristic of certain of the more youthful, highly mineralized situations. Hence, greater floristic diversity sometimes occurs where soils are less mature. Of possible significance to our subject is the ability of certain plants to absorb certain rare earth minerals from the soil and concentrate them in the leaves. When these fall and decay the minerals are deposited in the surface layers of soil in unusual concentrations. It is now an established fact that yttrium is accumulated in unusual quantities in the surface layers of the soil by the disintegration of hickory and walnut leaves (11). Oak leaves from these same localities show no trace of yttrium.

Other causal factors of edaphic diversity are the forces responsible for both epeirogenic and orogenic diastrophism of the earth's crust. Here, through faulting and folding and subsequent wearing down and dissection of the uplifted segments, the various strata of rock become exposed, each with its own physical and chemical features and each producing its own effect on soils. The area and continuity of these outcrops will vary with the thickness of the strata, the length of the exposure, the degree of dissection, and the location of any overburden of soils or soil materials. In highly tilted or highly folded strata the area of some of the outcrops may be exceedingly small. Often all that may remain of a given stratum persists as a cap on the top of a mountain. The contact between strata often is a line of weakness through which water may seep and bring to the surface dissolved minerals, which it deposits in increasing concentration in the surface soils. Faulting and folding often disturb drainage conditions and the movement of water, altering the pattern of erosion and affecting problems of the water table.

The extent of edaphic diversity attendant upon the forces of vulcanism and other igneous agencies is enormous. On the slopes of a single volcano very diverse conditions may result from the nature of the activity and the chemical composition of the magma that wells up. Pyroclastics of various types may be thrown out and roughly sorted into different patterns over the surface, and these may become interbedded or intruded with lavas of various types. The speed of cooling will materially affect the nature of the resultant rock. Lavas filling fissures and forming dykes frequently cause contact metamorphism of the older rock. Superheated waters, often from great depths, come to the surface charged with compounds of metals or other minerals in solution, which they deposit at the surface. Fumeroles and other solfateric activity persist long after other activity ceases, adding new supplies of mineral substances to the surface layers. Molten lava often is a poor medium for rapid diffusion, and sometimes high concentrations of certain minerals remain local in the hardened lava, often in water-soluble form, resulting in a very diverse pattern of mineral concentration over the surface layer of such a lava flow. Of particular significance to our subject is the role of vulcanism and its attendant phenomena in bringing to the surface many minerals of types both useful and toxic to plants.

Still another cause of great edaphic diversity are the forces attendant upon geological metamorphism. Here significant physical and chemical change is wrought upon rock sometimes on a very wide scale and sometimes quite locally. Where these processes involve substitution, crystallization, and segregation of minerals, the infiltration of waters charged with minerals, and other attendant chemical changes under the influence of heat and pressure, situations are created that may result in very local geographic patterns of edaphic conditions when these rocks become exposed at the surface. Much of the concentration of metals in the earth's crust results from the forces of metamorphism. A great variety of rock type is the result of metamorphism, and it is significant that endemic species of plants are often associated with metamorphics. Outstanding among these rocks are the gneisses, schists, diorites, and serpentines.

Throughout this discussion of the edaphic factor there has been frequent reference to the concentration of minerals and metals in the surface layers of the earth's crust. This aspect of the environment will stand out as very important to anyone studying the problems of restricted distributions of plants, but, unfortunately, there is as yet very little information of a precise nature to enable the subject to be put into clear terms of cause and effect. From the nature of the areas where great concentrations of highly restricted species occur, it appears almost certain that some soil chemicals possess an inordinately high selective value on vegetation. One must not rule out the possibility that they might, in some instances, affect mutation and mutation rate or induce other chromosomal disturbances. Large numbers of restricted species occur on ultrabasic igneous rock and on metamorphics containing metals of the ferro-magnesian complex including in the soil solution (in concentrations often lethal to crop plants) such metals as the ferric irons, magnesium, manganese, chromium, nickel, cobalt, mercury, and most of the other basic heavy metals. Highly restricted endemism on serpentines and serpentinized rock almost the world over provides excellent examples. Here are variable high concentrations of iron and magnesium and, in some areas, local concentrations of chromium, manganese, nickel, cobalt, and mercury. In some of these areas the sparsity of the flora suggests high toxicity for most of the species readily available to them. The taxonomic peculiarity of the species that do tolerate these conditions suggests that these species, through genetic processes, have been preadapted to these conditions and, hence, that the seed from whence they sprang reached a habitat favorable for them to become successfully established. Gordon and Lipman (4) maintain that the peculiarities of serpentine soils are not due to toxic effects of magnesium, but rather to the unavailability of necessary mineral ions, to high hydrogen-ion concentrations, and to low concentrations of potassium, nitrogen, and phosphorus. Robinson, Edgington, and Byers (12) point to the high toxicity of such substances as chromium, nickel and cobalt, elements which are frequently found in serpentine soils in high concentrations, and attribute to these substances the usual sterility of serpentine soils. Certainly either of these ideas could well account for absence on serpentine soils, but to our subject it is more important that we account for the presence of species that tolerate these substances in such high concentrations. It is these species that make up the endemic element of the floras of such areas.

Foster and San Pedro (2) speculate on the rarity and lack of establishment of seedlings of *Microcycas calocoma* A. DC. in Cuba. It might be relevant to this problem to mention that *Microcycas* occurs in a region where some of the soils derived from chlorite contain the highest concentrations of chromium known in soils (12). Concentrations of from 3.18 to 5.23 per cent of chromic oxide occur locally. This substance is toxic to most plants in concentrations of about 0.1 per cent. Obviously, such soils would be highly sterile to most crop plants and such plants as do occur there can do so only by genetic adjustment of tolerances. Other minerals that seem related to problems of endemism are gypsum (6), diorite, quartzite, and some forms of calcium carbonate. In some instances the effect may be the result of associated minerals or metals not evident to the field observer.

It appears almost certain that some relationship exists between the highly mineralized nature of the substratum and the peculiarities possessed by the floras in such areas, but as yet we are not in a position to state just what that relationship might be. It is a subject that, through newly developed techniques, lends itself to experimental investigation; it is to be hoped that within the near future enough studies of this will be undertaken so that the problem at least can be narrowed down if not solved.

From the standpoint of highly restricted distributional patterns in plants it is important that of all of the environmental influences, the edaphic factor most frequently occurs in sharply defined patterns and often occupies very small areas. It is also important that the toxic substances possessed by certain soils or soil materials may, through restriction or special selection, produce striking vegetational results.

The Misuse of Abstractions

To round out this discussion of the environmental relations of endemism it is desirable to review certain features of previously suggested explanations of the problems of endemism that, to the writer, appear to be based upon fallacious reasoning. Since the time of Engler (1), it has been customary to regard endemics as being of two kinds: first, new species that have not as yet achieved their potential area, and second, relict species that are reduced from a former widespread area. These are two aspects of a single problem, age. Even though a species does possess age as one of its attributes, and even though its distributional pattern does fluctuate through time, no species ever owed its distributional pattern for very long to its age. Old species may be widespread or they may be restricted, they may be abundant or they may be rare. The same may be said of new species after the very brief interval necessary for them to achieve or occupy that portion of their potential area not denied to them by the existence of barriers. In general, each species will occupy locally the same size and configuration of area as do the conditions of the environment to which it is adapted. Age has nothing to do with this. To be sure, the processes that elaborate a species over the available habitats require time, and the longer the species has been in the area the more opportunities it will have had to become genetically elaborated, but it does not necessarily follow that this will happen. Likewise, environmental fluctuation that may serve to restrict or to reduce genetic diversity will vary in rapidity in different areas and in its effect on different species. These processes of distribution and change all require time, but time is not their cause. They may be rapid with one species or infinitely slow or non-existent with others. They may be rapid under one set of conditions and slow under others. These would appear to be individual problems under individual conditions. There is little in this situation to permit generalization as to age, time involved in expanding or receding area, or speed of evolution. Hence, both restricted and widespread species may well be of any age. Age is, therefore, not necessarily a significant attribute of any restricted endemic. Age is sometimes expressible in terms of biotype depauperization, but this need not necessarily imply that the area will be highly restricted or even small. The area that any species of plants may occupy stands as a fact apart from details of its age, so far as cause and effect are concerned.

The phrase "historical factor" is often applied to problems of restricted distribution. This is a vague way of implying that age is a significant factor or attribute of endemism, as well as being a phrase with which one may confuse facts attendant upon migration and establishment with facts pertaining to restriction of range. There is no doubt that species are characterized by age and that they have had a history. The history of a plant species may tell the very important story of *how* it arrived in any given place and *where* it came from, but it does not explain its persistence nor the precise pattern of the area occupied in the new environment. The facts pertaining to the pattern of area are tied up with the individual plants as they are constituted today and with the environmental conditions as they prevail today. Such facts are no doubt related to the past, but the past is not the key to them because it does not necessarily serve to explain them; nor are they necessarily the key to the past since they are the result of today's conditions. The term "historical factor" is thus another abstraction which too often is used without any clear notion of what it does imply.

Isolation is often referred to as a cause or contributing factor in endemism. Isolation may explain abstractly the conditions which operate to preserve or encourage genetic purity by preventing gene infiltration. It may also aid in maintaining reduced competition. But since neither isolation nor the condition that it implies plays a part in bringing the plant into existence or in preadapting it to the habitat, it cannot of itself initiate any endemic. In all of these supposed functions isolation is important for what it implies and not for what it of itself does. The plant comes into any given habitat as a seed already endowed by genetic processes with a tolerance range for environmental factors that determines its capacity to function. Isolation in any given habitat is merely a way of stating that the plant or the species has a sort of priority to function unmolested by forces that do not exist in this particular habitat. A factor that does not exist in a habitat never exercises any influence on the plants of that habitat. Isolation is an abstraction definable only in terms of negative forces. Neither it nor the absent factors that it implies can be a stimulus of utility to the functioning of any physiological or genetic mechanism. At this point the "Sewell Wright effect" (16) may be adduced to refute my contentions. However, in explaining the "Sewell Wright effect," isolation is a convenient mode of expression for what it implies. The significant point in the "Sewell Wright effect" is the existence of a small population operating wholly within its own genetic influence.

Because the above difficulties are involved in the concept of isolation, it becomes very important that facts be kept in their proper place. This may appear to be trivial quibbling over definition and concept, but by being precise here we are in a better position to understand why there is no striking endemism in many hundreds of isolated islands. In spite of their isolation, coral islands are notoriously lacking in specific plant endemism. Being essentially alike environmentally, these islands offer little opportunity for environmental selection to operate. Were isolation a causal factor in highly restricted patterns of distribution, there would be no reason why every island should not develop populations of highly restricted species.

Attempts have often been made to correlate the number of endemics in an area with both the size and the age of the area. As for size of area, it is to be expected that there will be correlation in numbers only when there is also relative habitat diversity. Age of area is an abstract expression which implies a complex series of problems involving such features as maturity of terrain, leaching of soils, and time required in genetic processes, all of which may conceivably have some bearing on the problem. But their effect could be completely nullified by lack of environmental diversity. Old land masses are not consistently inhabited by many endemics, and some newly available areas have several. On the other hand, it is conceivable that the factors implied by age of land mass, together with great environmental diversity, might produce numbers of endemics wholly out of proportion to either of these influences alone.

A great deal has been written about area and its significance in the interpretation of the development of vegetation and as a basis for the explanation of various historical trends. Since the plant is adapted through genetic processes to a given set of environmental conditions, the area the plant occupies is purely incidental to the condition to which it is adapted. It occupies this area only because these conditions prevail there. The size and the shape of the area occupied are the product of today's facts, both genetic and environmental. Area as such has no historical significance in vegetation. Thus the concept of "age and area" (15) loses its significance unless it can be established that the condition was expanding its area at a consistent rate or that the mutation rate, or the rate of other genetic phenomena that might enlarge tolerances, was uniform and persistent and was regularly producing types that could persist and expand the area of the species. Likewise, Hultén's idea of equiformal progressive areas (5) does not take these facts into consideration. Since size and shape of the area occupied reflect the occurrence of conditions, any correlation of area with history or historical sequences is strictly coincidental. The important point is that one would of necessity have to establish his historical facts independently of the pattern of distribution of species. The pattern of distribution is determined by causes inherent in the locality and most probably has had no correlative relationship with the history of the flora over any wide area. The type of plant occupying the area (the ecotype) in most instances must have been produced reasonably close to the condition under which it grows. Any species capable of extensive migration must, by the very nature of things, be exceedingly plastic, that is, it must be very diverse genetically and capable of meeting differing habitats with new ecotypes.

Documentation of some of the ideas herein expressed will follow as Part 2 of this paper in a subsequent number of this journal, wherein the nature and occurrence of concentrations of highly restricted species will be discussed.

Summary of Part 1

1. The dynamics of the geographic distribution of any species involves the interaction between the environment, the physiological processes of the individuals of a population, and the genetic processes that fix tolerances and maintain or elaborate the population and preadapt individuals to environmental fluctuations.

2. Endemic species differ in no significant way from (so-called) "ordinary" species in their dynamics; restriction in geographic range as it applies to endemic species is, therefore, of the same order—so far as cause and effect are concerned—as is the restriction of any and all other species.

3. The area occupied by any species is determined by factors whose various conditions occupy area independently of the fact that species might be restricted by them. Since only environmental conditions independently occupy area, it is the environment that determines the pattern of distribution of all plant species by permitting the functioning of only those individuals whose tolerances have been preadapted to the special conditions of the environment.

4. Of the various categories of environmental factors, the condition of any factor or combination of factors may serve to restrict the range of some species of plants. Of these factors, however, the edaphic factor is most apt to occur in sharply defined patterns and often in small areas. In this connection, the regular occurrence, the world over, of highly restricted species in association with the occurrence of certain minerals and metals in the soil solution, suggests that these substances play an important role in problems of geographic distribution of highly restricted species.

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Literature Cited

1. Engler, A. Versuch einer Entwicklungsgeschichte der Pflanzenwelt. 2: 48. 1882.
2. Foster, A. S., and M. R. San Pedro. Field studies on Microcycas calocoma. Memorias de la Sociedad Cubana de Historia Natural Felipe Poey 16: 105–121. 1942.
3. Goode, R. D'O. A theory of plant geography. New Phyt. 30: 149–171. 1931.
4. Gordon, A., and C. B. Lipman. Why are serpentine and other magnesian soils infertile? Soil Sci. 22: 291–302. 1930.
5. Hultén, E. Outline of the history of arctic and boreal biota during the

Quaternary period. Their evolution during and after the glacial period as indicated by the equiformal progressive areas of present plant species. Stockholm. 1937.
6. JOHNSTON, I. M. Gypsophily among Mexican desert plants. Jour. Arnold Arb. 22: 145–170. 1941.
7. LIVINGSTON, B. E., and F. SHREVE. The distribution of vegetation in the United States as related to climatic conditions. Carnegie Inst. Wash. Publ. no. 284: 1–585. 1921.
8. MASON, H. L. The principles of geographic distribution as applied to floral analysis. Madroño 3: 181–190. 1936.
9. ————. Distributional history and fossil record of Ceanothus. Van Rensselaer, M. and H. E. McMinn. Ceanothus. Santa Barbara. 1942.
10. ————. Review of Cain, Foundations of plant geography. Torreya 45: 17–21. 1945.
11. MILTON, C. K., K. J. MURATA and M. M. KNECHTEL. Weinschenkite, Yttrium phosphate dihydrate, from Virginia. Am. Mineralogist 29: 92–107. 1944.
12. ROBINSON, W. O., G. EDGINGTON and H. G. BYERS. Chemical studies of infertile soils derived from rocks high in magnesium and generally high in chromium and nickel. U. S. D. A. Tech. Bull. No. 471. 1935.
13. STEBBINS, G. L. The genetic approach to problems of rare and endemic species. Madroño 6: 241–258. 1942.
14. TURESSON, G. The genotypical response of the plant species to its habitat. Hereditas 3: 211–350. 1922.
15. WILLIS, J. C. Age and area. Cambridge. 1922.
16. WRIGHT, S. Evolution in Mendelian populations. Genetics 16: 97–159. 1931.

A "NEW" CULTIVATED SUNFLOWER FROM MEXICO

CHARLES B. HEISER, JR.

The study of the origin of the cultivated sunflower (*Helianthus annuus* L.) is still a relatively unexplored field. *Helianthus annuus* (including *H. lenticularis* Dougl.) is a complex assemblage of weeds of roadsides and city dumps, and of plants cultivated for their seeds or for ornamental purposes. From what is known at present it is assumed that the cultivated sunflower arose from a wild or weed type *H. annuus*.

The sunflower was introduced into Europe in the sixteenth century. In the 1758 edition of Dodonaeus (2) the sunflower is mentioned. The seeds of this plant are stated to be flat and long, and somewhat "browne" or "swarte," and formerly were grown in Spain. Gerard (3) in 1597 describes a sunflower with seeds "black and large," and goes on to describe a second kind of sunflower with the seeds "long and black with certain lines or strakes of white running amongst the same." It is quite probable that the sunflower was first introduced into Europe by the Spanish and that this was a black-seeded variety which in all probability came from Mexico or the southwestern United States. The introduction of the striped variety probably occurred at a later date and this plant may have been introduced from the northern United

States or Canada, where the Indians are known to have cultivated sunflowers. The Mammoth Russian variety, which has reentered this country, probably represents an amalgamation of several races.

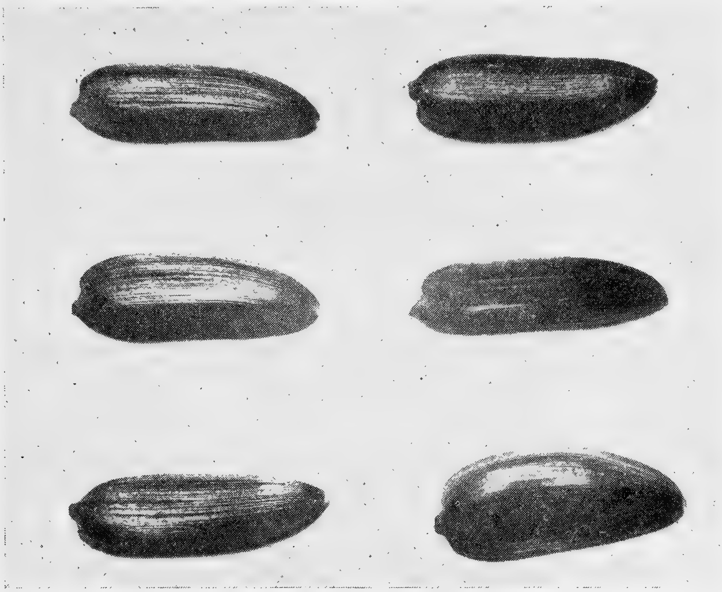

Fig. 1. Achenes of *maiz de teja,* ×2.5.

The earliest description of a cultivated sunflower in Mexico is by Hernández (5), who made his observations during the years 1570–75. Unfortunately neither Hernandez nor any of the other early observers have any reference to the color of the achenes. In 1896 Edward Palmer is reported (7) to have obtained sunflower achenes in Durango, Mexico, and mentioned them as having "a good, plump kernel" and black shells which yield a purplish dye "which is esteemed by some." In the account of the Russian expedition to Mexico in 1925–26, *H. annuus* is recorded as now being cultivated in northern Mexico in limited quantities in maize fields (1). The few samples which were obtained represented late and very late forms, most of which were very tall. Unfortunately a more detailed description is not given.

The finding of a previously unknown cultivated form of sunflower in Teocaltiche, Jalisco, Mexico, by Dr. Carl O. Sauer of the University of California, is of particular interest in this connection. The achenes of this sunflower (text figure 1), called *maíz de teja*[1] by the native from whom they were obtained, were turned over to me for study.

[1] The name *maíz de Texas* is given by Martínez (6) and *maiz de tejas* by Bukasov (1) for Mexican sunflowers.

These achenes, the large size of which undoubtedly indicates a cultivated strain, are long, narrow, and a shining black. In these respects they resemble to some extent the Hopi cultivated sunflower (4), but they are distinguished readily from the modern

Table 1. Comparison of Three Cultivated Sunflowers

Character	Maiz de Teja	Hopi	Mammoth Russian
achenes			
shape	narrow (with beak)	narrow	broad
color	black	purple	gray striped
hypocotyl			
color	red	red	green
length	long	long	short
stem			
pubescence	scattered hairs	scattered hairs	more densely hairy
leaves			
color	deep green, dull	deep green, shiny	light green, dull
size	small	medium	large
margin	nearly entire	slightly serrate	serrate
decurrence on petiole	present	present	usually absent
involucral bracts			
pubescence	medium	light	dense
attenuation	long	short	long to very long
chaff (pales of the receptacle)			
color	purple	purple	green
corolla			
color of lobes	deep red	deep red	yellow (rarely red)
shape	narrow	intermediate	broad
bulb of tube	poorly developed with long hairs	well developed, short hairy to glabrate	well developed, densely long hairy
stigma			
color	purple	purple	yellow (rarely red)
hardiness	weak	fairly robust	very robust
maturation	very late	late	early to late

Russian cultivated strains which usually have a plumper seed and never develop such a deep pigmentation. The small beak present on the upper portion of this Mexican achene, however, is an outstanding character and it appears to be unique among the annual sunflowers.

In order to make further comparisons, these and several other lots of sunflowers were grown in an experimental plot at the Missouri Botanical Garden during the summer of 1945. The plants grown from the seed obtained in Teocaltiche were extremely late in maturing and were destroyed by a severe October storm while still in the "bud" stage. All of the other sunflowers growing in the same experimental plot, including a number of modern Russian varieties as well as the Hopi sunflower and weed sunflowers, had already matured their seed by this time. It may be significant that *maíz de teja* failed to flower in this particular environment. Perhaps through long selection *maíz de teja* has become adapted to a particular set of growing conditions.

During the winter of 1945–46 samples of the Mexican, Hopi, and Mammoth Russian sunflowers were grown in the greenhouse of the Division of Genetics, University of California, Berkeley, in order to study the behavior of the three strains when grown under presumably identical conditions. There are still insufficient data to draw any final conclusions regarding the relation of these three strains to each other. The Mexican plants appear to be rather closely allied to the Hopi plants in a number of characteristics, the most notable exceptions being the nature of the pubescence and the attenuation of the involucral bracts. In the latter character the Mexican plants approach the condition found in the Mammoth Russian variety. The Mexican plants again were the last to mature under greenhouse conditions. Some of the outstanding differences and similarities that have been observed thus far in these three varieties of sunflower are tabulated in Table 1.

The exact relationship of these Mexican sunflowers to the cultivated sunflower of the Hopi and to the various types cultivated in Europe and North America scarcely can be discussed in the light of the published evidence now available. Fortunately, sunflower seeds of various types have been found at different prehistoric sites in the United States. When these have been carefully surveyed and analyzed the problem will take more definite shape. It is also highly desirable that additional information be obtained on the primitive sunflowers of Mexico.

The author wishes to thank Dr. Edgar Anderson and Dr. Carl O. Sauer for helpful suggestions and for reading the manuscript.

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Literature Cited

1. Bukasov, S. M. The cultivated plants of Mexico, Guatemala and Colombia. Bull. Appl. Bot. Genetics & Plant Breeding. Supplement no. 47. (English summary.) 1930.
2. Dodonaeus, R. A nievve herball; or historie of plants. . . . London, G. Dewes. 1578.
3. Gerard, J. The herball or general historie of plants. . . . London, J. Norton. 1597.
4. Heiser, C. B. The Hopi sunflower. Bull. Mo. Bot. Gard. 33: 163–166. 1945.
5. Hernandez, F. Quatro libros de la naturaleza, y virtudes de las plantas, . . . Traduzido. . . . Francisco Ximénez. . . . En Mexico. . . . 1615. Morelia, J. R. Bravo. 1888.
6. Martinez, M. Catálogo de nombres vulgares y científicos de plantas mexicanas. Mexico, D. F., Imprenta mexicana. 1937.
7. True, R. H. In U. S. D. A. Bur. Pl. Ind. Bull. 233, Seeds and Plants Imported. Inventory no. 26. Entry no. 29984. 1912.

TRIFOLIUM MONANTHUM GRAY

James S. Martin

Some eight entities have been described in the *monanthum* group of *Trifolium* and at least fourteen different combinations have been made. The difficulty of application of these various names is caused by the large degree of intergradation which exists between all possible entities. Although the recognition of the four varieties proposed in the following treatment entails the addition of a new name, the geographical correlation of these four varieties seems to justify such action.

I wish to express my appreciation to the curators of the following herbaria for the loan of material: University of California, Berkeley, California (UC); Dudley Herbarium, Stanford University, California (DH); Pomona College, Claremont, California (P); Gray Herbarium, Harvard University, Cambridge, Massachusetts (G); Missouri Botanical Garden, St. Louis, Missouri (MBG); New York Botanical Garden, New York, New York (NY); Philadelphia Academy of Sciences, Philadelphia, Pennsylvania (PA); Intermountain Herbarium, Utah State Agricultural College, Logan, Utah (IH); and University of Washington, Seattle, Washington (W).

Key to Varieties of Trifolium monanthum

Leaflets of the upper leaves mostly acute, oblanceolate or elliptical.
- Plants moderately to strongly villose; peduncles usually bent near the top, the inflorescence thus at right angles to the peduncles . . . . d. *T. monanthum* var. *Eastwoodianum*
- Plants glabrous to sparingly villose; inflorescences usually erect on straight peduncles . . . . b. *T. monanthum* var. *Grantianum*

Leaflets of the upper leaves mostly rounded or retuse, obcordate to oblanceolate.
- Involucral lobes mostly 0.5–2 mm. long; stems 5–30 cm. long; plants usually noticeably villose . . . . c. *T. monanthum* var. *parvum*
- Involucral lobes mostly more than 2 mm. long, if shorter, the stems less than 5 cm. long; plants glabrous or sparingly villose . . . . a. *T. monanthum* var. *typicum*

a. T. monanthum Gray var. **typicum** nom. nov. *T. monanthum* Gray, Proc. Am. Acad. 6: 523. 1865. *T. monanthum* Gray f. *spatiosum* McDerm., No. Am. Sp. Trifolium 98. 1910 (based on *Hall* and *Chandler 613*, Black Mountain, Fresno County, California, July, 1900, UC; isotypes, MBG, NY, DH).

Glabrous to sparingly villose; stems 1–10 (20) cm. long; leaflets obcordate, obovate, or oblanceolate, rounded, truncate, or retuse at the apex, 2–5 mm. wide, 4–12 mm. long; inflorescences

1–2 (4)-flowered; peduncles usually straight, the flowers erect; involucral lobes 1–5 mm. long; calyx teeth shorter than or about equal to the tube in length. Flowering from June to August.

Type. Soda Springs in the Upper Tuolumne Valley, California, June 26, 1863, elevation 8600 feet, *W. H. Brewer 1704* (G; isotypes, UC, DH).

Distribution. Sierra Nevada from Plumas County to Tulare County, California, east throughout the mountain ranges of Nevada, South Coast Ranges in Ventura and Los Angeles counties, California; along streams and in meadows, 5000 to 11,500 feet elevation.

Representative material. *W. A. Archer 5468; I. W. Clokey 7562, 7984; V. Duran 3078; R. Ferris 3745, 8960, 8993; A. A. Heller 9306, 10200; C. L. Hitchcock 5462; A. H. Holmgren 1609; B. Maguire 22500, 22547; W. H. Shockley 499.*

The typical variety is best exemplified by material from the region from Mount Rose, Nevada, to Yosemite National Park, California. Specimens collected from Lake Tahoe to Butte and Plumas counties and in Fresno County, California, and the Charleston Mountains of Nevada are often somewhat intermediate between the typical variety and the varieties *Grantianum* and *Eastwoodianum.* The leaflets tend to be larger and more nearly acute than those of the typical group and in some cases the calyx teeth are longer, although all are glabrous or very sparingly pubescent. Some, at least, of these have been referred to *T. monanthum* f. *spatiosum* by McDermott but are not sufficiently different to be so recognized.

b. T. MONANTHUM Gray var. GRANTIANUM (Heller) Parish, Plant World 20: 220. 1917. *T. Grantianum* Heller, Muhlenbergia 1: 136. 1906. *T. monanthum tenerum* Parish, Bot. Gaz. 38: 461. 1904, name mistakenly applied. *T. monanthum* Eastw. *apud* Parish, loc. cit., listed in synonymy. *T. simulans* House, Bot. Gaz. 41: 341. 1906 (based on *H. M. Hall 710,* Strawberry Creek, San Jacinto Mountains, California, July 22, 1897; isotypes, G, UC). *T. monanthum* Gray var. *Grantianum* Zeile *apud* Munz, Man. So. Calif. Bot. 255. 1935.

Glabrous or but sparingly villose; stems 3–30 cm. long; leaflets oblanceolate to obovate or more commonly elliptical, acute (rarely somewhat rounded but then mucronate), spinose-serrate, 2–5 mm. wide, 7–20 mm. long; inflorescences (1) 3–6-flowered, peduncles usually straight, the flowers erect; involucral lobes (1.5) 3–5 (6) mm. long; calyx teeth longer or shorter than the tube. Flowering from late May to July.

Type. Mount San Gorgonio, San Bernardino Mountains, California, July 23, 1904, *Geo. B. Grant 6343* (W, no. 79713; isotypes, UC, P, DH).

Distribution. San Bernardino, San Jacinto, and San Gabriel mountains of southern California, moist stream banks and meadows, 5000 to 9500 feet elevation.

Representative material. *V. Duran 3525; H. M. Hall 710, 1812, 2200, 2463, 2552, 7510, 7564, 7571; A. A. Heller 8937; P. A. Munz 6010, 8458, 8610, 8781, 10485, 10486, 10697, 15385; J. Roos 2362.*

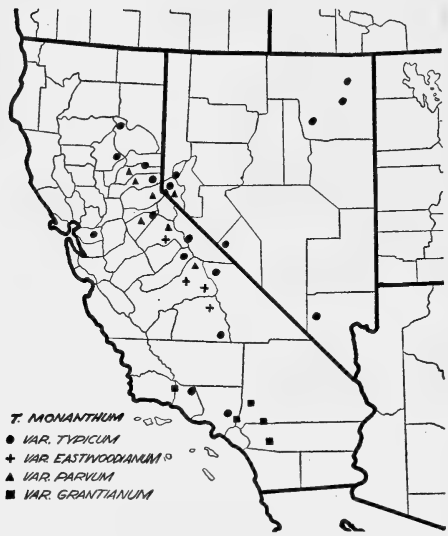

FIG. 1. Distribution of *Trifolium monanthum.*

The variety *Grantianum* occurs only in the mountains of southern California where it is not likely to be mistaken for any other plant. The very acute leaflets are unlike those of any other variety except var. *Eastwoodianum,* a plant which is always much more pubescent and which does not occur south of Tulare County. *T. simulans* House is considered a synonym; isotypes of this species differ from the type of var. *Grantianum* only in being a little larger and in having longer calyx teeth.

c. T. MONANTHUM Gray var. PARVUM (Kell.) McDerm., No. Am. Sp. Trifolium 105. 1910. *T. pauciflorum* Nutt. var. *parvum* Kellogg, Proc. Calif. Acad. Sci. 5: 54. 1873. *T. multicaule* Jones, Bull. Torrey Bot. Club 9: 31. 1882 [based on *M. E. Jones (2592?)*, Soda Springs, Nevada County, California, July 30, 1881 (?), P; isotypes, PA, IH]. *T. parvum* (Kell.) Heller, Muhlenbergia 1: 114. 1905. *T. monanthum* Gray var. *parvum* (Kell.) McDerm. f. *glabrifolium* McDerm., op. cit. 108 (based on *Hall* and *Babcock,* Porcupine Flat, Yosemite National Park, California, July, 1902, UC, no. 33605).

Moderately villose or rarely nearly glabrous; stems 4–30 cm. long; leaflets obovate to oblanceolate, rounded at the apex, serrulate, 2–7 mm. wide, 4–20 mm. long; inflorescences (1) 4–8 (10)-flowered, peduncle usually bent below the inflorescence, the flowers thus more or less at right angles to the peduncle; involucral lobes 0.5–2 (5) mm. long; calyx teeth usually equal to or longer than the tube. Flowering from June to August.

Type. Cisco, Sierra Nevada, California, July 6, 1870, *A. Kellogg* (isotypes, NY, UC).

Distribution. Sierra Nevada from Nevada County to Fresno

County, California, common in meadows, open areas in forest, and along streams, 5000 to 9000 feet elevation.

Representative material. *H. M. Hall 256, 3385, 3654, 4776, 8737, 8740, 8759, 8775; A. A. Heller 6942, 8986, 9831, 12151, 13296; M. E. Jones 2592.*

This variety is most easily distinguished by the reduced involucres and the usually 4–8-flowered inflorescences which appear to be more or less at right angles to the peduncles. I have not seen the type but the isotypes represent a depauperate, few-flowered phase. The more abundant and larger phase with 5–8-flowered inflorescences is represented by the type collection of Jones' *T. multicaule.*

d. T. MONANTHUM Gray var. **Eastwoodianum** nom. nov. *T. tenerum* Eastwood, Bull. Torrey Bot. Club 29: 81. 1902, not *T. monanthum tenerum* Parish, Bot. Gaz. 38: 461. 1904.

Moderately to rather densely villose; stems 10–35 cm. long; leaflets oblanceolate to elliptical, often very narrowly so, acute, conspicuously spinose-serrate, 2–5 mm. wide, 7–18 mm. long; inflorescences (1) 3–4 (7)-flowered, peduncles usually bent below the inflorescences and the flowers thus seemingly at right angles to the peduncles; involucral lobes (2) 3–4 (5) mm. long; calyx teeth usually a little longer than the tube. Flowering in July and August.

Type. Summit, trail to South Fork of King's River, California, July 1–13, 1899, *A. Eastwood* (isotype, UC).

Distribution. Sierra Nevada from Tuolumne County to Tulare County, California, moist stream banks and meadows, 5000 to 10,000 feet elevation.

Representative material. *M. S. Baker 4450b; W. R. Dudley 1576, 2094; H. M. Hall 437, 5565; R. Hopping 360; P. A. Munz 7566, 15936.*

This variety is somewhat similar to var. *Grantianum* in respect to leaflet characters but is always conspicuously villose and the inflorescences are usually at right angles to the peduncles. By these two characters the two varieties can be easily distinguished, especially when considered in connection with their geographical separation. This variety has been known as *T. monanthum* var. *tenerum* based on a publication by Parish (Bot. Gaz. 38: 461. 1904) in which he gave *T. monanthum* Eastwood (probably intended as *T. tenerum* Eastw.) as the basis for the name and cited two specimens, both of which belong to the variety *Grantianum.* One of the specimens cited is the type collection of *T. monanthum* var. *Grantianum* (Hell.) Parish so that Parish's var. *tenerum* becomes a synonym of var. *Grantianum,* necessitating a new varietal epithet for the entity in question.

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THE STATUS OF THE SECTION TROPANTHUS GRANT IN MIMULUS OF SCROPHULARIACEAE

H. E. McMinn

Since the earliest attempts by man to classify plants there have been—and there will continue to be—differences of opinion regarding the grouping of plant specimens into named categories such as species, subspecies, genera and sections. These differences of opinion are due to many causes, one of which is the lack of sufficient material for study. This lack of material sometimes leads to misidentification and subsequent wrong classification which often results in the describing of new species. This in itself is a matter of some importance, but when the new species is taken as the type of a new section in a genus, then it becomes a matter of great importance. Such procedure becomes critical when the characters of the new section are used as evidence for breaking down the boundaries of two genera. It is the belief of the writer that one such instance is exemplified by the describing of the species *Mimulus Treleasei* Grant (1, pp. 325–326) and the subsequent establishing of the section *Tropanthus* (1, pp. 324–325) in *Mimulus* of Scrophulariaceae by the same author. Although the section was made in 1924, this writer was not aware of the basis for founding the section until recently when he began a comprehensive study of the genus *Diplacus*.

The section *Tropanthus* was based upon a single specimen of Scrophulariaceae collected at Tehuacan, Mexico, June 2, 1905 (*Wm. Trelease, no. 68,* Missouri Botanical Garden Herbarium no. 112585). The author honored the collector of the specimen by naming it *Mimulus Treleasei* Grant, and stated that, "The type sheet contains only two short branches of this unusual plant, and as this is the only material known it has been impossible to tell anything about the size of the plant nor can the color of the flowers be determined." The author's photograph of the type (1, pl. 3, opposite p. 374), however, only shows a single short branch, not "two short branches." An examination of the type sheet itself (pl. 20, fig. A) shows a single short branch which is undoubtedly the same as that photographed by the author of *Mimulus Treleasei.* Due to this apparent contradiction, one might believe that one branch of the type had been removed when studying the material, but there is no evidence or mention of such removal.

The first impression, as well as later ones gained from more careful study of the type of *Mimulus Treleasei,* led the writer to conclude that the plant was not a *Mimulus,* but that it belonged to the genus *Berendtia* A. Gray (2, p. 379) [*Berendtiella* Wettst. et Harms (4)]. The species appeared to be *Berendtia laevigata* Robins. & Greenm. (3, p. 39) the type of which was collected

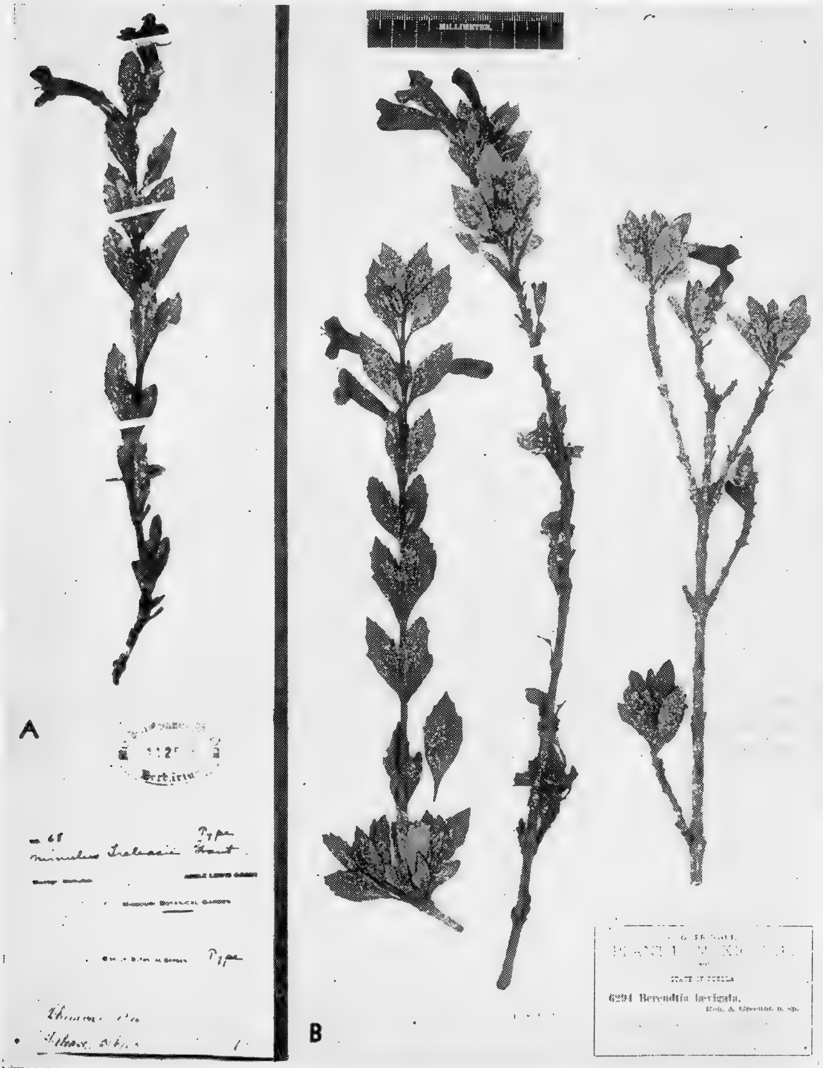

PLATE 20. TYPE SPECIMEN OF MIMULUS TRELEASEI (A) AND BERENDTIA LAEVIGATA (B).

also near Tehuacan, Mexico ("C. G. Pringle, on calcareous ledges near Tehuacan, Puebla, altitude 5,500 feet, 24 December, 1895, no. 6294"). This plant was described in 1896, thirty years before the published date of the new species, *Mimulus Treleasei.* Since the type of *Berendtia laevigata* (pl. 20, fig. B), deposited at the Gray Herbarium and a duplicate of the type deposited at the Missouri Botanical Garden appear to be the same entity as the type of *M. Treleasei,* deposited at the Missouri Botanical Garden, it would seem that Mrs. Grant was not aware of the earlier collection or that she considered the two collections as belonging to different genera. That the two collections are almost identical in their characters is evidence that they belong to the same genus and species. The presence of bractlets on the pedicels of the flowers in both collections is evidence that neither belongs to the genus *Mimulus.*

In the monograph of the genus *Mimulus,* the author of the section *Tropanthus* very definitely attempts to show that *Diplacus* Nutt. should be a section of *Mimulus* L. rather than a distinct genus (1, pp. 114–115). She presents arguments based upon her studies of *Mimulus* to show that all but two of the characters usually used to separate *Diplacus* from *Mimulus* are not valid. These two are "its shrubbiness and peculiar glutinous exudation." As evidence that these characters are not valid, the author presents characters of her newly described species. She states that, "*M. Treleasei,* a newly described species collected by Trelease in the State of Puebla, Mexico, though shrubby and having a glutinous exudation, is not in most of its other characters related to *Diplacus.*" She concludes that, "there are then no sufficient characters for maintaining *Diplacus* as a genus" (1, p. 115). The writer is not here particularly concerned as to whether *Diplacus* Nutt. is a genus, but he is concerned by the use of the characters of the section *Tropanthus* to disregard it as such.

In conclusion, it is the opinion of the writer that because the material upon which the section *Tropanthus* is based was wrongly identified, the section is not valid; hence the use of any of its characters as evidence for reducing *Diplacus* Nutt. from a genus to a section of *Mimulus* is not justifiable!

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Literature Cited

1. Grant, A. L. A monograph of the genus Mimulus. Ann. Mo. Bot. Gard. 11: 99–388. 1924.
2. Gray, A. Characters of new plants of California and elsewhere, principally of those collected by H. N. Bolander in the State Geological Survey. Proc. Am. Acad. Arts and Sci. 7: 327–401. 1868.
3. Robinson, B. L. and J. M. Greenman. Descriptions of new and little known phanerograms, chiefly from Oaxaca. Contr. Gray Herb., New Series No. X, in Proc. Am. Acad. Arts and Sci. 32(1): 34–51. 1896.
4. Wettstein, R. v. and H. Harms. Scrophulariaceae. Engler and Prantl, Nat. Pflanzenf. Gesamtregister zum II bis IV Teil [Nachtrag]: 459. 1899.

REVIEW

American Species of Amelanchier. By GEORGE NEVILLE JONES. Illinois Biological Monographs, Vol. XX, no. 2. Pp. 1–126. [Feb.] 1946. The University of Illinois Press, Urbana. $1.50 paper, $2.00 cloth.

This is a detailed account and analysis of some thousands of herbarium specimens and of the "nearly two hundred binomials and trinomials representing the species of *Amelanchier* in America." It is well illustrated with fourteen maps and twenty-three half-tone plates, the latter intended to show the usual leaf-shapes in the several species and also to illustrate the actual types or type material of critical entities. The paper is conveniently arranged, the style and typography are pleasing, the keys and descriptions are ample, and the citations of literature not only account for all synonymous names published in the genus but also include a multitude of references to *Amelanchier* names as used in floras and manuals and other technical and popular works. As Dr. Jones mildly says in his introduction, the species of *Amelanchier* are "sometimes somewhat difficult to distinguish," and his reduction of all the American members of the genus to eighteen species with distinctive geographical ranges will be welcomed alike by the amateur and professional botanist. Included in the paper are separate keys to flowering and fruiting material, a highly desirable feature in any treatment of a group of plants in which the individuals in flowering condition bear so little resemblance to the same plants in fruit and with mature foliage. The treatment of species is in general conservative, as may be imagined from the large number recognized by earlier authors but here reduced to synonymy. The author has gone over the literature on *Amelanchier* very thoroughly, and has put his species on a firm nomenclatural basis through study of the types wherever these are known to be extant.

A few minor errors and imperfections may be noted. What is evidently intended for a new species, *Amelanchier neglecta,* is proposed without either Latin description or reference to previous publication and so is not validly published. Specimens of *Amelanchier spicata* are cited from Alabama, but none from Georgia; the range of the species, as shown in map 7, includes two localities in Georgia but none in Alabama. In this connection it is worth noticing that the policy stated on page 12, that of citing only a part of the collections studied, may lead to confusion on the part of those using the monograph unless the mapping of ranges and the selective citation of specimens are carefully coordinated. Specimens of *Amelanchier laevis,* for example, are cited from Georgia from the extreme northern counties only. Map 4, however, indicates that the southernmost limit of this essentially Appalachian species is much further south, evidently well within the limits of the Coastal Plain. On page 47 are cited specimens of *Amelanchier canadensis* collected at Franklin, Georgia, but map 6 does not indicate this extension of range; it shows instead a locality which is apparently near Rome, Georgia, a northwesterly range-extension which is not referred to in the citation of specimens.

An improvement might have been brought about in the paper by the inclusion of data obtained from several of the smaller, regional herbaria which have rich local collections, particularly in the southeastern United States and in the Rocky Mountain–Great Basin region. Where critical entities are involved, and especially when herbarium material from some areas is not generally available in large amounts in most collections, it seems unwise to lean so heavily on so few herbaria, even if they be as inclusive as those of Harvard University.

A change for the better might have been made in the lists of specimens examined, by citing county names in addition to the bare collectors' localities or, if space was at a premium, by citing the county names instead of the specific localities, at least for the eastern states. On page 56, for example, are cited specimens collected by [F. J.] Hermann at Portage Lake, Michigan. It so happens that this is not the large and well known Portage Lake in Houghton County, nor the smaller lake of the same name in Crawford County, but a still smaller body of water, omitted from ordinary maps, in Washtenaw County.

Most of us who have studied *Amelanchier* in the field and in the herbarium will agree that the number of species is relatively small. Unfortunately no one up to the present time has been able to explain clearly how to separate some of the critical species from their close relatives. It seems to me that this is the major fault of this monograph, that the author still does not offer convincing criteria by which the critical species may be delimited. *Amelanchier alnifolia* Nutt., for example, as defined by Dr. Jones, is common and widely distributed from Colorado and North Dakota westward and northwestward. *Amelanchier pumila* Nutt., which is dotted sparingly through a part of the same range, is distinguished in the keys on the sole basis of its complete lack of pubescence. Quite possibly it may be a valid species, and not merely a glabrous form of *A. alnifolia,* but from the descriptions and the photograph of Nuttall's specimen of *A. pumila* (Pl. IX, f. 2) it is evident that it is not very different from *A. alnifolia,* which is *almost* instead of *completely* glabrous; this hardly seems a convincing character on which to maintain a species.

An equivalent situation obtains in the northern Great Basin, particularly in northern and western Nevada, where a common *Amelanchier* has the permanently puberulent foliage of *A. utahensis* but the glabrous twigs and five styles of *A. alnifolia,* which is said not to occur in Nevada. Perhaps the two species are less sharply separated in nature than the monograph would have us believe, or perhaps certain characters of pubescence and reduction in number of flower parts have been overemphasized. The obvious similarities which link all the amelanchiers of western North America seem far more worthy of recognition than do the rather trivial morphological differences among them. The author of this paper has chosen to take a positive stand by defining as species certain populations which are, truly enough, rather easily recognized and more or less geographically regionalized. These populations, however, are by no means always (or even often) to be sharply delimited; they may equally well be regarded as varieties or subspecies or ecospecies or some other units of a single highly variable species or, on the other hand, be divided into a score of species. If one is to establish what are essentially arbitrary limits for the species he has decided upon in this group, he must offer considerable justification for such a course.

In the introduction to this monograph the possibility of extensive hybridization in *Amelanchier* is dismissed rather impatiently. Presumably this is a subject for judgment by a geneticist, but even to a lay observer there are suggestions of hybridity in some groups of the genus. In the Maryland woods here at the edge of the Coastal Plain there are apparently two species of shrubby amelanchiers with small flowers. One is a low shrub flowering perhaps a week before its somewhat larger associate. According to Jones' key it is evident that these plants must be either *A. canadensis* or *A. spicata.* Unfortunately not all plants fall clearly into one species or the other. In a random selection from a series of shrubs may be found all possible combinations of the characters of style-fusion and ovary-pubescence used in the key. Very probably the plants really represent two species, but if so their distinctive characters seem to have become rather tangled. Unlike the "species" of western North America, many of these plants of the eastern states are distinctive in habit and appearance as well as in flowering season, and apparently this is not a case of intergrading populations but of different plants which have been insufficiently studied.

In the same patch of woods mentioned above are numerous plants of the large-flowered amelanchiers which are truly arborescent. Some are woolly-leaved while in flower (a character of *A. arborea*) while others have reddish and almost glabrous leaves (as in *A. laevis*). The broad sepals of *A. arborea,* however, may be found associated with either type of pubescence, as may the glabrous racemes of *A. laevis.* It is not at all clear from examination of these individuals whether *A. arborea* and *A. laevis* represent two species, or simply races of one and the same species, or whether the puzzling intermediates have resulted from hybridization or in some other manner.

The two preceding examples are enough to suggest, at least, that we know too little about the genetical behavior of *Amelanchier*. Perhaps the problems involved are insoluble, but at least they deserve consideration. The members of the Rosaceae, including the Pomoideae, are noted for their sexual irregularities and other reproductive anomalies. Whether due to hybridism, peculiar chromosome distribution, polyploidy, or parthenogenesis, to combinations of these, or to other factors, the multiplicity of forms in *Amelanchier* (as also in *Crataegus, Malus, Rubus* and other genera), is so great as to defy taxonomy based on herbarium material alone. I think we shall not arrive at any very satisfactory scheme of classification of these genera until we know more about their genetical peculiarities. Studies of these will not be easy, for, in growing these long-lived woody species, mature fertile seedlings of known parentage are not quickly obtained, but experimental studies of seedling populations should without fail form the basis of any future attempts to reduce the species of the Pomoideae to a tangible system. The present monograph will serve as a morphological and geographical basis for future work on *Amelanchier*.—ROGERS MCVAUGH, Plant Industry Station, U. S. Department of Agriculture, Beltsville, Maryland.

NOTES AND NEWS

Dr. G. L. Stebbins, Jr., Associate Professor of Genetics, University of California, Berkeley, is absent on sabbatical leave until January, 1947. During the autumn he will deliver the Jessup Lectures on Evolution at Columbia University. These lectures will be published subsequently in book form.

As a member of an expedition sent out under the auspices of the United States Commercial Corporation, Dr. F. Ray Fosberg is exploring for plants in Micronesia.

At the invitation of the Ministerio de Educacion Nacional de Colombia, T. Harper Goodspeed, Professor of Botany, University of California, Berkeley, left on July 4 to give a series of lectures at Bogotá and Medellín. He will return to Berkeley in time for the fall semester.

The following recent appointments have come to our attention: Daniel I. Axelrod as Assistant Professor of Geology, University of California, Los Angeles; Charles B. Heiser, Jr., as Instructor in Botany, University of California, Davis; John L. Morrison as Instructor in Botany, New York State College of Forestry, Syracuse University, New York; Robert M. Muir as Instructor in Botany at Pomona College, Claremont, California.

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A WEST AMERICAN JOURNAL OF BOTANY

Contents

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THE EDAPHIC FACTOR IN NARROW ENDEMISM. II. THE GEOGRAPHIC OCCURRENCE OF PLANTS OF HIGHLY RESTRICTED PATTERNS OF DISTRIBUTION

Herbert L. Mason

It was my objective in the first part of this paper (4) to point out that of the three aspects of the dynamics of plant geography, namely, the environment, the physiology of the individual, and the genetics of the population, only the environmental conditions independently occupy area and hence constitute the precise determinants of particular patterns of potential area of species; and, that of environmental factors, the edaphic factor is most apt to occur in small, sharply defined areas and hence might be looked upon as a determinant of narrow patterns of endemism. We may now very briefly consider some of the aspects of the geographic pattern of restriction of plant species in nature that seem to support these conclusions. To this end we will consider especially certain cases of plants having highly restricted patterns of distribution and occurring aggregated into definite areas. We shall note further that these areas are in regions of great environmental diversity and often of local edaphic peculiarity as well.

A survey of the occurrence of highly restricted plant species throughout the world reveals that such species occur in almost all parts of the land area of the earth. However, certain regions are remarkable for the concentrations of localized species in their floras. These are frequently referred to in the literature as "endemic areas." Some of these areas rich in highly restricted endemics are on islands while others are on the continents. It is a matter of great interest that of islands rich in endemics, most, if not all, are either of volcanic origin or contain large outcrops of metamorphic rock such as gneiss, schist, chert, or serpentine in which the basic metals and other minerals occur, often over a highly localized geographic pattern. Of the islands or island groups richest in percentage of endemism in their floras, the Hawaiian Islands, St. Helena and the Canary Islands, all are of volcanic origin. New Zealand is largely volcanic or igneous and also contains considerable serpentine and other metamorphics. Madagascar has a small volcanic area and a large area of gneiss and serpentine. Corsica possesses a large expanse of folded gneiss and much serpentine containing considerable nickel. A large part of New Caledonia is serpentine containing important nickel and chromium deposits. Juan Fernandez and the Galápagos Islands are volcanic. Tasmania and Ceylon both have extensive surfaces composed of serpentines. Cuba has much ser-

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pentine and chromite. The presence of serpentine on many of these islands suggests the occurrence also of other rock containing the ferro-magnesian metals. There are probably other minerals as well that may exercise similar influences on the vegetation of these areas. The volcanic and metamorphic nature of these islands together with their montane topography suggest great environmental diversity and especially edaphic diversity. Since non-volcanic islands and islands with little or no altered rock in their surface features do not demonstrate nearly such high degrees of endemic restriction in their floras, it would seem that there must be some relationship of a cause-and-effect nature between these special geological features of vulcanism and metamorphism and the occurrence of such concentrations of endemic restriction.

In general, on the continents as on the islands, endemics are concentrated in regions noted for their great environmental diversity. On the continents the greatest environmental diversity occurs in mountainous areas, particularly in arid and semi-arid regions. Here the altitudinal effects of climate and such special features as rain shadows, wind gaps, cold-air drainage, and slope exposure serve to multiply habitats caused by diversity of an edaphic nature resulting from such forces as orogenic diastrophism, vulcanism, igneous intrusion, and alteration through metamorphism. Weathering of the type characteristic of arid regions usually results in highly mineralized soils. Under these climatic conditions the leaching of soils proceeds very slowly. In mountainous areas the localization of habitats is often more pronounced on the upper slopes; as one ascends a mountain, habitats are apt to become smaller and more localized in character and area. This is especially true where the mountain has resulted from folding and faulting of strata and the subsequent erosion and dissection of the fault blocks and folds. The restriction of plants to some of these localized montane habitats on the continents frequently has led to rather unrealistic conclusions as to relict endemism on these mountains. It is often implied that the mountain was once an island, a postulate that seems unnecessary in view of the localization of the habitats on the mountain. Some continental mountains and mountain peaks have been islands and some of their plant species may date back historically to these insular times. The restriction of the species in these areas today, however, is a problem of the conditions of today's environment and the present genetic constitution of the species population. Such conditions of the environment would probably express themselves floristically in some restrictive or specialized way regardless of the history of the flora or whether or not the mountain peak had been an island.

Because islands are isolated from one another as well as from the continents, and because such isolation is often thought of as affording the most suitable conditions for speciation to proceed toward the production of endemics, it has been common practice to interpret endemism, wherever it may be found, in terms of insular history or at least to inject into it an insular connotation. I have discussed (4) some of the difficulties inherent in the concept of isolation when applied as a causal factor in endemism and have pointed out that the causes of restriction in pattern of area occupied must be sought in some environmental condition that independently occupies area.

It is significant that both on continents and on islands there occur local concentrations of endemics that seem to relate themselves to the occurrence of ions of any of several minerals which are often present in the soil solution in a concentration sufficient to exercise a restrictive effect on the vegetation through their toxicity. As a result, many of the common species of such regions are excluded from these local areas and in their places are plants that tolerate these special conditions or may even demand them. The vegetation of such areas is usually sparse and the populations of individual species are often discontinuous or localized. This condition of the environment must be closely related to some of the important causes of highly restricted patterns of distribution of plants both on islands and on continents. Of the countless thousands of seeds that chance to find their way into these toxic areas, only a very few are so constituted physiologically and genetically as to become established as functioning plants and give rise to a persistent population.

There is no evidence that the concentration and distributional pattern of endemics in continental areas has resulted from any different dynamics than such features of insular floras. In general, continental floras are larger and the mass of their species may occupy wider area, but the problems of restriction in range are identical in both. The important difference between continental and insular floras relates to problems of dispersal and establishment and the history of migration rather than to the problems of endemic restriction. Therefore, for purposes of example, it makes little difference whether we use a continental area or an insular area.

The California Flora

Certain features of the California flora, where a considerable percentage of endemism prevails and floristic diversity is closely integrated with environmental diversity, may serve to illustrate some of the problems I have discussed previously (4). Here, I think, we can clearly demonstrate the significance of certain edaphic situations in areas of endemic concentration and in addition see conclusive evidence that area in general, as occupied by species populations, is incidental to environmental conditions.

California is a region of varied relief where many complex mountain ranges and their intervening valleys lie across the path of the moisture-laden winds from the ocean. Climatically, the result is a very diverse pattern of seasonal rainfall ranging from over 100 inches annually in the northwest to less than 5 inches annually in the southeastern part of the state. Between these extremes there is no simple gradient, but a diverse pattern resulting from complications of topography that may steepen the gradient locally and produce rather sharply defined rain shadows and other similar features. Correlated with topography and rainfall is a considerable variation in seasonal and diurnal progression of temperature. Above 4,000 feet winter snows persist and seasonal dormancy prevails. Elsewhere seasonal dormancy is apt to be rather unstable as to duration and extent and to vary considerably from one species to another. In these areas, spring flowering may begin anywhere from November to March. Because of cold ocean currents along the coast and warm currents farther offshore, frequent fog, conforming to a seasonal, diurnal, and geographic pattern, envelops the maritime area. Boundaries between climatic situations often are reasonably sharp under such topographic and geographic conditions. Such a boundary would be of the nature of a steepened climatic gradient and is usually associated with some local topographic feature. The summer fog may regularly overhang a certain coast range ridge each afternoon and go no farther inland. Here the gradient of relative humidity across the coast ranges is locally steepened. The eastern boundary of the coast redwood coincides with the usual line of occurrence of such a steepened gradient. The dramatic change from upland coniferous forest to Great Basin sagebrush on the east slope of the Sierra Nevada is the expression of a steepened climatic gradient involving various aspects of the moisture relations of humidity and rainfall and ground water as these are modified by topography and drainage. The deserts, the upland coniferous forest, the foothill coniferous forest, and many other of the major floristic assemblages are all geographic expressions of the interrelationship of climate and topography and in many places are definable by rather sharp boundaries which give expression to steepened climatic gradients. Probably the best example of such a feature is the perpendicular 5,000-foot south wall of Yosemite Valley and the effect it produces on surface climate and on vegetation. Glacier Point at the top of the cliff is clothed with a red fir forest while the valley floor at the bottom of the cliff is clothed with the arid phase of the yellow pine forest. The lateral distance is but a very few feet, the vertical distance less than a mile. On a map such a boundary could only be indicated by a sharp line. I go into this detail because there are those who maintain that climatic boundaries do not exist, and that climatic features are expressible only in terms of gradients. So far as vegetation is concerned, the steepening of the climatic gradient is apt to produce an effective climatic boundary.

The edaphic variation in the area occupied by the California flora is enormously complex. There is very little in the way of cause of edaphic variation that has not left its mark in this region. A glance at the geological map of California (1) will disclose some of the outlines of this diversity as wrought by the events of geological history, but the details significant to environmental diversity are of such a nature as to defy adequate mapping. There is outlined on this map the surface occurrence of about eighty different rock systems, of which thirty-four are igneous and forty-six are sedimentary in origin. They range in age from Archean to Recent. Most of the older rock is metamorphosed. The northern California coast ranges are dominated by the Jurassic Franciscan series which taper into island-like patches in southern California. We shall return later to a discussion of this series of rock; it is sufficient here to say that they have been invaded locally by ultra-basic intrusives which are heavily serpentinized and that many other rocks of the series have also been serpentinized. The southern coast ranges are dominated by Cretaceous and Tertiary marine sediments. Most of southern California, however, is dominated by grano-diorites, undivided granites, and acid intrusives of uncertain Mesozoic and pre-Mesozoic origin. The Sierra Nevada owes its existence to the upwelling of an enormous batholith composed of various types of granite. These granites reach the Great Valley flora on their southwestern margin but are overlain by complicated Jurassic rock along their northwestern margin. To the east they are flanked by an extensive series of metamorphics. In the north they give way to volcanics. The Great Valley is recent alluvium. In the extreme northwestern part of the state, the Klamath Mountains are dominated by ancient gneissoid and schistose rocks together with very diverse types of metamorphics, volcanics, and ultra-basic intrusives. Throughout the entire California region there are local occurrences of volcanics of various types and ages and of metamorphics that are exceedingly diverse in type as well as in chemical composition. The geological map presents these rock systems each in terms of its age and general origin but in no way depicts the tremendous variation in lithology or in chemical composition which, in the case of the metamorphics and volcanics as well as in some of the older sediments, is very great.

The general correspondence of many elements of the flora of California to the distribution of lithological features is no less striking than is the above-mentioned floristic differentiation that is to be related to climatic features. Much of the diversity of the California flora results from the superposition of lithological features across the areas of special climatic conditions, thus creating local habitats that are occupied by special populations of plants. Certain of these lithological features support unusual concentrations of species of highly restricted range, thus suggesting that these plants may be particularly adapted to the special conditions present. This is especially striking in serpentinized areas where the localization of some of the ferro-magnesian metals reaches toxic concentrations lethal to many of the plants one might expect to find. Endemic restriction in California is by no means confined to serpentine areas nor is it always associated with the ferro-magnesian metals. Since these problems have not as yet been investigated from a physiological and biochemical point of view we can only postulate cause-and-effect relationships. These are problems that new techniques in biochemistry, plant physiology, and genetics have placed within our scope of investigation and beginnings are now being made toward their solution. Endemic restriction has been studied from the point of view of sterility of soils, but not from the point of view of the vegetation that flourishes in an area, an approach which may do much to solve the problem of narrow endemic restriction.

Endemism in the California Flora

It is impossible to give a precise figure as to the percentage of endemism in the California flora chiefly because of the difficulties of taxonomic evaluation of the complex groups of entities that develop under such diverse geographic conditions. Many aspects of endemism are concealed under aggregate specific categories in current usage. These often are composed of genetic races and minor variations with special habitat adaptations, which, if carefully depicted, might aid considerably in solving the complex problems of endemism. There are few if any of the major divisions of the California flora that do not have some element of highly restricted endemism in their population. This may also be said of the major topographic features. Jepson (2) records about forty per cent endemism for the California flora. Most of the valid species described for this area since the appearance of Jepson's "Manual" are endemic, so that this figure must be raised considerably. There are also extensive sections of the state that have not been adequately explored and, since these regions are chiefly areas of great edaphic diversity, it is to be expected that several more species will be added to the known flora.

Jepson (2) noted that local endemic species in California seemed to be aggregated into definite areas. He interpreted these concentrations as comprising ten such areas, three of them in insular and southern California and seven in northern California. Since we intend to demonstrate that area is incidental to environmental condition, we need not go into the matter of the adequacy or inadequacy of their number and distribution. Although his discussion is meager, in his interpretation Jepson points to the classical concept of relict and recent species and emphasizes age and history of land mass, particularly with respect to its elevation and subsidence. He leans strongly on the concept of "mountain top" endemics and refers broad endemics to climatic features of the region. Although his "Franciscan area" conforms to the areal pattern of much of the Franciscan lithological series of northern California, he makes no mention of any lithological relationships. Detailed discussion of a part of one of Jepson's endemic areas will serve to illustrate the main points of the present paper.

The Napa-Lake Area

In northern California, Napa and Lake counties are designated by Jepson as his Napa-Lake endemic area. We will consider a portion of this area involving southern Lake County and northern Napa County and the adjoining margins of Sonoma, Colusa, and Yolo counties (fig. 1). This area is approximately thirty miles square and manifests marked floristic diversity and richness as well as considerable endemic concentration. In addition there are many species of special habitats that recur elsewhere only where such special habitats reappear in the coast ranges or in the Sierra Nevada foothills. In this small area there outcrop no less than sixteen distinct geological series, ranging from sedimentary rock of Jurassic and Cretaceous origin to Recent alluvium; metamorphic rocks of both igneous and sedimentary origin, some of which are highly serpentinized; volcanics involving basalt, rhyolites, tuffa, and obsidian, ranging from unclassified Tertiary in age through Pliocene, Pleistocene, and Recent time; and finally a considerable expanse of ultra-basic igneous intrusives which have been highly serpentinized. Commercially exploited minerals of the region are mercury, gold, silver, and sulphur. Hot springs and mineral springs are common. The geological outcrops form the surface pattern of the high relief and one finds the usual habitat features to be expected in mountains. Several streams traverse the region and Clear Lake penetrates about one-fourth of the way through the area from the northwest. Several small lakes and ponds, ranging from very alkaline to highly acid in character, occur within the area. Some of them, such as Borax Lake, are almost entirely devoid of marginal vegetation, while others, like Boggs Lake, possess a rich marsh flora in floating bogs. In the playas and the alluvial meadows that are common throughout the region there is evidence of many more lakes of past time.

The outstanding geological feature of this area, aside from its local diversity, is the fact that it is dominated by a basement of metamorphosed Franciscan rocks of Jurassic age which have been invaded in many places by ultra-basic intrusives. The Franciscan rocks themselves have become serpentinized in many places; in others, their dominant ferro-magnesian character makes them the habitat of a peculiar flora. These Franciscan rocks are so important to the problem of endemism in northern California that it is necessary to emphasize their nature. They are the dominating feature of the geology of the northern California coast ranges. Reed, in the "Geology of California" (6, p. 29) says, "The Franciscan series may with almost equal propriety be considered 'blanket' or 'basement.' It consists of a complex series of sediments and interbedded or intruded igneous rocks of peculiar types. Equally peculiar metamorphic rocks are associated with them in many places. In some regions the latter are limited to the contacts of the igneous and sedimentary rocks; in others they constitute the whole series over large areas.

"An important constituent of most Franciscan areas is serpentine, derived from peridotite and similar basic rocks. Partly because of the prevalence of this rock, the series as a whole yields to deforming forces much more readily than the Granitic Basement. Extreme complexity of structure is almost a distinguishing feature of the Franciscan. Where it is overlain even by a thin cover of sediments, the latter also yield easily to deforming stresses. Folds of many types and sizes are therefore characteristic of areas underlain by the Franciscan."

The Franciscan is characterized by a considerable diversity of lithology. Of sediments there are conglomerates, sandstone, shale, variegated chert, limestone, and a small amount of coal. The igneous series includes schist, basalt, diabase, peridotite, pyroxinite, and gabbro; these latter are usually serpentinized. The metamorphics may be quartz schist, quartz albite schist, prasinite, blue schist, talc rock, or serpentine rock. Unfortunately, the geological map of California does not differentiate the lithological types within the Franciscan, and hence does not give an adequate idea of the lithological diversity of any area dominated by the Franciscan series. Not all of these lithological types will be found within the area under discussion, but a sufficient variety exists to add materially to the edaphic diversity of the region. Of special interest is the series of basic metals usually associated with the Franciscan, particularly where it has been serpentinized. Many of these metals become ionized in the soil solution in quantities sufficient to be lethal to many plants and are an important factor in the sterility of soils derived from such rocks (7). These metals comprise the ferro-magnesian complex and include, in addition to iron and magnesium, considerable quantities of chromium, manganese, nickel, and titanium. Whether or not titanium plays any role in the restriction of plants is not known; it is a matter of interest, however, to note its presence in considerable quantities in nearly all Franciscan rocks. The important feature of the occurrence of these metals and minerals to our thesis is the fact that they are not distributed uniformly throughout the serpentines but occur singly or in groups of various composition in local surface areas in contrast to other surface areas of differing composition and concentration.

It should be evident from this very brief discussion of the out-

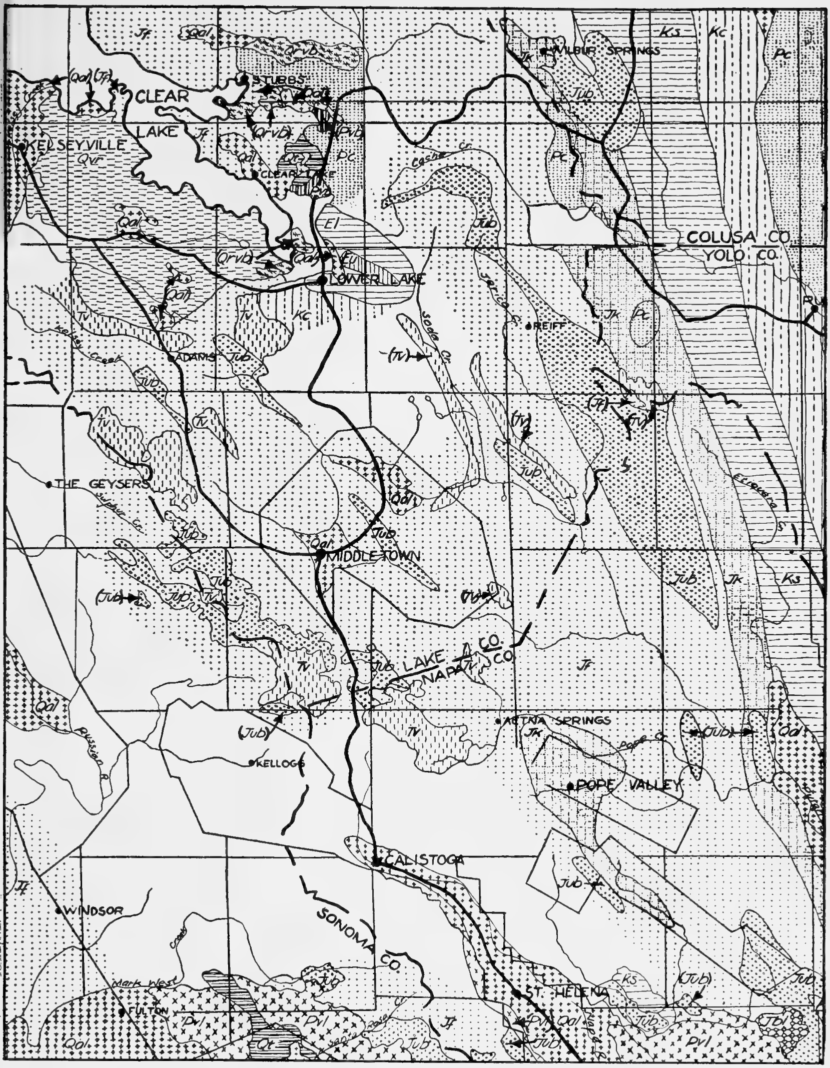

FIG. 1. Geology of the Napa-Lake Area. *El,* Lower Eocene marine sediments; *Eu,* Upper Eocene marine sediments; *Jbi,* Jurassic basic meta-igneous rocks; *Jf,* Franciscan group; *Jk,* Knoxville formation; *Jub,* Jurassic ultra-basic intrusives; *Kc,* Upper Cretaceous marine sediments; *Ks,* Lower Cretaceous marine sediments; *Pc,* undivided Pliocene non-marine sediments; *Pvb,* Pliocene basalt; *Pvl,* Lower Pliocene volcanics and interbedded sediments; *Qal,* alluvium; *Qrvb,* Recent basalt; *Qt,* terrace deposits; *Qvr,* Pleistocene rhyolite; *Tv,* undivided Tertiary volcanics; *clear areas,* unmapped geology and lakes. Adapted from O. P. Jenkins, Geologic Map of California, 1938.

standing geological features that this is a region not only of high edaphic diversity, but that this diversity embraces rocks of peculiar types, rich in minerals that are restrictive to many plants and to which other plants may have been adjusted through genetic processes involving tolerance. When one adds to this the complicated climatic mosaic, characteristic of mountainous sections in arid regions, some idea may be obtained of the tremendous environmental diversity that prevails in this very small area.

Floristic Diversity

In response to such environmental diversity, the flora of this area, in spite of its local paucity on certain very extensive "barrens," is so diverse as to total an inordinately high number of species for so small an area. More than one thousand species of spermatophytes and ferns are known here, or about one out of every four of the species listed in Jepson's "Manual." In other words, one-fourth of the species of the flora of all of California is found in this area of only thirty square miles. This is not so surprising when it is realized that the eastern extension of the redwood forest reaches this area; both the upland and the foothill coniferous forests are represented; the "black oak–madrone" forest, the valley oak meadows, and several distinct types of chaparral occur here. Except for certain types of chaparral and the oak-covered hills, none of these floral assemblages really typify the area. However, some of them may have been more extensive in the not-too-distant past, for on every hand there is evidence of repeated fire. In prehistoric times this was the home of a large Indian population which used burning in its program of game management.

Looking at the floristic diversity from another point of view, we find that of the thirty species of conifers reported from north of San Francisco Bay, twelve occur here, yet the area is only locally clothed with coniferous forest and one normally thinks of this region as being outside the coast range coniferous belt. Of the fifteen species of oaks recorded in California by Jepson, ten occur here. The genus *Navarretia,* comprising twenty-nine species in western North America, has eighteen species in this area, seven of which are restricted to this locality or occur elsewhere only in one or two isolated spots. Of the forty-four species of *Ceanothus* in California, ten occur here. Of the ten species of *Linum* in California, seven occur here. A large number of serpentine endemics find their way into this area, but endemism within the region is by no means confined to the conditions prevailing in serpentine.

Endemism in the Napa-Lake Area

Although an impressive number of species and smaller taxonomic categories occur in this area and are not known outside of it, none of them conforms to the pattern of the whole area but rather to the pattern of certain localized conditions that prevail within the area. Furthermore, a large number of the peculiar plants of the region occur discontinuously throughout the area on special habitats and recur beyond in one or more places on similar habitats only. Most of these habitats involve peculiar rock types. The uniformity of this coincidence of restricted endemism and peculiar environments suggests that these plants owe their distributional pattern to the configuration of the pattern of edaphic conditions. To these conditions they are physiologically adapted through the processes of genetics and evolution. Of the particular environments within this area wherein restricted endemics are found, three are outstanding. Most striking are those associated with the various local conditions that prevail within the chemical structure of serpentine and its various mineral associates. Next, are those associated with conditions prevailing in association with the volcanics. Finally, there are the conditions prevailing in the vernal pools and other similar habitats wherein the ground is covered with water during the establishment phase of the seedlings, while flowering and fruiting of many of the species population takes place only under conditions of extreme drought. There are endemics in other situations as well, but the spectacular concentrations are manifested in these three situations.

Endemism in the serpentine areas presents the most complex problems. Here the distribution patterns of the various serpentine endemics range from (a) species that are general to serpentine practically wherever it occurs in the California area through (b) species that are discontinuous on the serpentine, to (c) species that are known only from one small locality or niche in a given serpentine area. *Quercus durata* is fairly common over most of the serpentine areas of the northern California coast ranges; *Cupressus Sargentii* is highly discontinuous on serpentine, although it is known from southern California (Santa Barbara County) to southern Oregon; *Collomia diversifolia* is known from only four localities, three in the Napa-Lake area and one in the Mount Hamilton Range. A few species, like *Linum bicarpellatum,* are known from but a single locality; but their number is very small, and is no more spectacular in the Napa-Lake area than in any of several other serpentine districts. Most significant to our problem is the fact that many of these supposedly highly localized Napa-Lake species are being found on similar serpentine outcrops elsewhere as a result of more thorough exploration. We now know several of these endemics to occur in the Red Mountains of the Mount Hamilton Range (8) and another series of them to occur in the serpentines of the foothills of the Sierra Nevada in Eldorado County. This seems to be pretty clear evidence that we are dealing with environmental conditions rather than with any of the spatial or historical attributes of area. Aside from the fact that the rocks in the different sites on which these plants are growing are all of Jurassic age, their precise histories subsequent to that time have varied. They have in common similar chemical composition and occur in similar climates. Although the species of the area must be in tune with climate, climate may be ruled out as a cause of their narrow restriction because in all of these areas, adjacent rock masses in apparently identical climates have not proven suitable habitats for these species. We are left with the condition of edaphic factors, either water relations of the substratum or the chemical and physical character of the soils and soil materials. Localization on serpentine is often very narrow. *Linum bicarpellatum* occupies only a few hundred square feet. The area occupied by *Collomia diversifolia* in each of its occurrences is even smaller. Both of these species occur where vegetation is sparse and competition does not appear to be a factor. Often a group of individuals will occur in a situation completely devoid of any associated vegetation; outside of this one colony the soil is naked. Clearly it is not competition with other plants that restricts such species. Their behavior suggests the presence of toxic substances in the soil or perhaps the absence of some critical substance. It is significant that certain genera, such as *Linum, Navarretia, Streptanthus,* and *Astragalus,* show a marked tendency toward taxonomic elaboration in the presence of local aspects of serpentine.

The volcanics of this area likewise possess a considerable population of endemic species and of species occurring discontinuously elsewhere under similar conditions. Aside from the broad lithological classification, nothing is known as to the nature of metals that may be local in any rock or soil type. The close proximity of some of these outcrops to the Jurassic ultra-basic intrusives would make some infiltration of ferro-magnesian metals inevitable. In addition, the basalts are by nature highly charged with ferro-magnesian metals. Most conspicuous among the habitats of peculiar plant species of this area, however, is a matrix made up of volcanic ash and obsidian rubble. Unlike the serpentines, it is fairly rich in species of plants. The surface layers of the soil become excessively dry during the summer so that herbs are less common than shrubs, but these few herbs comprise most of the endemics in these conditions. That the problem is related to the ferro-magnesian metals is suggested by the occurrence of several highly discontinuous species, such as *Eriastrum Abramsii,* which in some other localities is on serpentines but is not as yet known on any of the local serpentines of the Napa-Lake area. This may be a dangerous conclusion because of the possibility that in this case we may be dealing with distinct ecotypes of the species adapted to a special condition in all of its various localities.

The third condition of concentration of endemics is the vernal pools and other habitats where water stands in spring and extreme drought frequently prevails in summer. Here the problem varies with the particular lithology, since similar water conditions occur in conjunction with serpentine, volcanics, adobe clay, and the margins of peat bogs. It is in these habitats that the genus *Navarretia* of the Polemoniaceae is undergoing elaborate speciation. Three closely related species occur respectively in adobe clay, the volcanics, and on the margins of a peat bog. Distinct color forms of one of the species occur in two ponds less than a mile apart; in one pond the plants are white-flowered, in the other, light blue. Locally, on the margin of the blue colony, a dark, blue-flowered strain appears to be developing. These vernal pool plants begin their life history submerged. The leaves are linear-terete; the hypocotyl develops a thick cortical layer made up of very large air cells. As the water recedes and the soil dries the new growth becomes rigid and the leaves and bracts become spinose dissected. At flowering time the soil is usually deeply cracked and dry. Species of several genera undergo a similar growth history in these pools. Most spectacular is the genus *Eryngium* of the Umbelliferae, whose aquatic phase possesses floating leaves and whose arid phase is exceedingly spinose. There are, on the other hand, other plants that complete their life cycle before the land becomes excessively dry. Among these are the species of *Downingia* (Lobeliaceae), many of which are endemic to vernal pool conditions in California; one is endemic within the Napa-Lake area. These vernal pools present complex problems with respect to rate of water recession and hydrogen-ion concentration as well as to the mineral constituents of the water and the soil solution. Obviously the boundary of the pool presents one limiting factor to the spread of these plants. However, within the water conditions common to all of the pools, there is evidence from the differences in the floras that other edaphic factors are operating and have operated long enough to have selected several local endemic types. Some of these endemics at present are known only from single pools; in these pools they are often very abundant.

Within the Napa-Lake endemic area of Jepson, there is apparently ample evidence that the endemism is to be related in most instances to edaphic conditions and that the area as outlined by Jepson is of significance only because it contains several different edaphic situations on which endemics have developed. Strictly speaking, however, these conditions in most instances overstep the boundaries set by Jepson, and often widely so. However, whether these conditions occur within or without the area they are almost always very localized.

Taxonomic Aspects of Certain Endemics

Considering these problems from the point of view of taxonomic relationships and comparative distributional patterns of closely related forms, we can arrive at more corroborative evidence to support the general thesis that distributional pattern is the direct result of environmental condition, and that the edaphic factor is most apt to be responsible for highly restricted patterns of distribution. It is important to emphasize at the outset that very little is known about cause-and-effect relationships between taxonomic entities and any environmental conditions to which they may seem to be adapted. It is, however, equally important to call attention to cases where consistent occurrence in a given situation suggests that a relationship exists between the conditions prevailing in the habitat and the physiological and genetic makeup of the plant, even though we cannot state precisely what the nature of that relationship may be. For illustrative material of these relationships I have selected a varied group of plants, some of which belong to genera containing several species with apparent restrictive adaptations to environmental conditions; others are single localized species isolated from a widespread closely related species by adaptation to a peculiar habitat; still others may be only genetic races within a species, which show restrictive habitat preferences not shared by the species or its normal associates in other situations.

Libocedrus decurrens is a common member of the upland coniferous forest of the Sierra Nevada. It occurs normally with *Pinus ponderosa* and *P. Lambertiana* chiefly on soils associated with granitic rocks. In the northern Sierra Nevada, however, where much serpentine prevails, it is predominantly a serpentine inhabitant; in the Napa-Lake area of the North Coast Ranges it is confined to serpentine. Both of the species of pines associated with *Libocedrus decurrens* in the Sierra Nevada occur also in the Napa-Lake area. Although in one outstanding situation in the Napa-Lake area, where the geological contact between the serpentine and adjacent rock passes between a colony of *Pinus Lambertiana* and one of *Libocedrus decurrens,* the pine does not occur over the contact on the serpentine and the *Libocedrus* does not occur off the serpentine. *Pinus ponderosa,* on the other hand, occurs on both sides of the contact. We are dealing here with what appear to be cases of selective tolerance. The main Sierra Nevada race of *Libocedrus* is adapted to granitics; the race of the North Coast Ranges is a serpentine endemic. Apparently mixed populations occur in the northern Sierra Nevada, but the non-serpentine race is less common than the serpentine race. *Pinus Lambertiana,* although known from several rock types, does not tolerate serpentine. Such differences in tolerance, where they characterize whole populations, must be interpreted as resulting from genetic processes whether they involve whole species or only races within species.

Collomia diversifolia, a serpentine endemic of very localized occurrence, is known from two localities in Lake County and one in adjacent Colusa County. It was believed to be a Napa-Lake endemic until Mrs. Sharsmith (8) found it in the Mount Hamilton Range in Santa Clara County. It is closely related taxonomically to the widely ranging *C. heterophylla,* which is known from many diverse types of soils including some serpentine. It is not known, however, from the heavy ultra-basic intrusives such as those on which *C. diversifolia* occurs. Here, again, it seems obvious that the genetic forces that operated to set these two species apart, acted upon physiological as well as morphological characters with the result that so long as each retains its present physiological and genetic constitution, the geographic area of the one will be separate from that of the other.

Among genera most conspicuous for their endemic species in the California flora is *Navarretia.* Within the Napa-Lake area speciation has proceeded along very interesting lines in different groups of the genus. In vernal pools not more than four or five miles distant from one another occur *N. Bakeri, N. pleiantha,* and *N. pauciflora* (3), all close relatives of *N. leucocephala* of the Great Valley and of *N. prostrata* of southern California. Their morphological features, particularly with respect to stamen insertion, suggest that a relationship with *N. prostrata* is closer. Their floral structures, with minor exceptions of size and color of corolla, are identical; the chief differences are in the inflorescence, the bracts, and the habit of the plants. They, however, show striking ecological preferences: *N. Bakeri* occurs in vernal pools in adobe soil in oak-grassland; *N. pleiantha* occurs on the margin of an acid bog in soil very rich in organic materials; *N. pauciflora* occurs in a playa in volcanic ash heavily strewn with obsidian rubble. All of these species begin their life cycles as aquatics and mature as extreme xerophytes. Speciation apparently has proceeded here along lines dictated by edaphic conditions. The genetic diversity evident in the plants of any particular pool does not appear very great. This may, however, be more apparent than real. Genetic diversity here is probably masked by rigid habitat selection, but such diversity will soon disappear as a result of random fixation unless some agency for gene infiltration from other habitats is operative.

Another set of closely related species involves *Navarretia Jepsonii, N. mitracarpa,* and *N. Jaredi.* *Navarretia mitracarpa* must be ruled out of our discussion because it has been collected only once from "somewhere in Lake Co.," and we do not know under what conditions it grows. *Navarretia Jaredi* exhibits considerable local variation on serpentine and other ferro-magnesian rocks of the South Coast Ranges. It is not, however, an inhabitant of vernal pools. *Navarretia Jepsonii,* a plant of vernally wet habitats and for the most part aquatic in its seedling stages, is confined to highly serpentinized ultra-basic intrusives. Its chief claim to distinction is a doubled number of capsule valves and the membranous character of the matured capsule. Morphologically *N. mitracarpa* forms a connecting link between *N. Jepsonii* and *N. Jaredi*. Here, again, is a case of speciation involving both morphological and physiological characters and exhibiting differences in geographic restriction.

A third case in the genus *Navarretia* is that of *N. eriocephala* occurring on ultra-basic intrusives in Lake, Solano, and Colusa counties in the North Coast Ranges and across the Great Valley in Eldorado County on similar rock. This discontinuity is clearly related to the nature of the edaphic conditions.

The distributional patterns of the members of the genus *Cupressus* are likewise of such a nature as to suggest a close relationship with edaphic conditions. In the Napa-Lake area both *C. Macnabiana* and *C. Sargentii* occur. Both are confined to serpentine and grow together at many places in the inner North Coast Ranges. *Cupressus Sargentii* occurs in highly localized spots as far south as Santa Barbara County, and extends into the outer coast ranges. *Cupressus Macnabiana* occurs both farther north and eastward than does *C. Sargentii*. The fact that these two plants grow together in parts of their ranges suggests that they can tolerate certain conditions in common. Their restriction must be related to different causes. We must not rule out the possibility that we may be dealing with distinct ecotypes in the various habitats. Closely related to *C. Macnabiana* are *C. Bakeri* of the Modoc lava beds and *C. nevadensis* from igneous rocks near Bodfish, Kern County. Since lavas are often rich in ferro-magnesian minerals we find here a thread of consistent edaphic pattern for the speciation in this group of closely related species. Likewise, *Cupressus macrocarpa, C. Goveniana,* and *C. pygmaea* occur on grano-diorites which are similarly rich in ferro-magnesian minerals. Possibly speciation throughout the genus *Cupressus* has followed a closely related edaphic pattern of environmental restriction.

The genus *Streptanthus* (5) is replete with serpentine endemics. Of nineteen species in California, eleven are confined to serpentine or other closely related ferro-magnesian rocks: *S. Breweri* occurs through the middle and inner coast ranges from Tehama County to San Benito County; *S. glandulosus* ranges from Colusa County to San Luis Obispo County; *S. polygaloides* occurs along the northern Sierra Nevada foothills; the remaining eight species are exceedingly local in their occurrences, some being known only from single localities, ranging from serpentine outcrops in the mountains of San Benito County to the ultra-basic intrusives of Lake and Colusa counties. *Streptanthus* is another genus in which speciation has been concerned with selective elaboration over the edaphic environment.

Summary

Consideration of these endemics in terms of any specific local area soon makes one aware that many of them exceed the limits

of the area and recur elsewhere in similar edaphic situations. These facts serve to emphasize the importance of environmental condition over area particularly where area is delineated on some historical or supposedly historical basis. It is obvious that the Napa-Lake area owes its high concentration of endemics to its great edaphic diversity and especially to the fact that this diversity involves peculiar rocks and their associated minerals. Next in order of importance is the presence in the area of a number of genera capable of elaboration over these peculiar habitats. Those genera which give rise to an occasional endemic species are not responsible for the large number of endemics. It is, on the other hand, such genera as *Navarretia, Linum,* and *Streptanthus* which develop many local species and habitat races, that build up the population of restricted endemics in a small area and that give the impression of some sort of genetic instability. It becomes clear that diversity in the environment must work with genetic diversity and must involve diverse tolerances, to produce situations such as that in the Napa-Lake area or in any rich floras. The paucity of a flora will reflect a failure of some aspect of this diversity. The localization of the area of any of the members of such floras is purely an expression or indicator of habitat conditions. The significant configuration of area is that which coincides with environmental conditions as these involve presence or absence or degree or amount, or as area may be delineated by the extremes of some critical conditions.

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Literature Cited

1. Jenkins, O. P. Geologic map of California. Div. Mines, Dept. Natural Resources, State of California. 1938.
2. Jepson, W. L. Manual of the flowering plants of California. Berkeley. 1925.
3. Mason, H. L. Five new species of Navarretia. Madroño 8: 196–200. 1946.
4. ———————. The edaphic factor in narrow endemism. I. The nature of environmental influences. Madroño 8: 209–226. 1946.
5. Morrison, J. L. A monograph of the section Euclisia Nutt. of Streptanthus Nutt. Unpublished thesis. University of California Library, Berkeley. 1941.
6. Reed, R. D. Geology of California. Tulsa, Oklahoma. 1933.
7. Robinson, W. O., G. Edgington, and H. G. Byers. Chemical studies of infertile soils derived from rocks high in magnesium and generally high in chromium and nickel. U. S. D. A. Tech. Bull. no. 471. 1935.
8. Sharsmith, H. K. Flora of the Mount Hamilton Range of California. Am. Midland Nat. 34: 289–367. 1945.

STUDIES IN THE CARYOPHYLLACEAE—II. ARENARIA NUTTALLII AND ARENARIA FILIORUM, SECTION ALSINE

Bassett Maguire

A densely cespitose, low, gray-green plant growing in the rocky embankment of the road-cut caught our eye from the moving car, while Professor Holmgren and I were crossing the low pass of the Shoshone Range during the past field season in southern Nevada. The plant, just coming into flower, had the habit of the Montana and Wyoming plains *Arenaria Hookeri,* but the delicacy and flower character of *A. Nuttallii.* On two other occasions we found this plant in fine condition in loose talus on sterile, partly denuded, low-altitude slopes, again further on in the Shoshone Range, and in the Toiyabe Range.

Critical study in the herbarium confirmed our field designation of the plant as *A. Nuttallii,* but necessitated a review and redefinition of the entire species, the results of which are presented herein.

1. Arenaria Nuttallii Pax, Bot. Jahrb. 18: 30. 1893. Perennial from a deep-set taproot; multicipital, the crown branches numerous, frequently matted, becoming ligneous, short, or if buried in loose talus extensive and much branched; stems leafy, less than 10 cm. high, weak and diffuse or more or less cespitose, erect and brittle, stipitate-glandular, more or less densely so upwards toward the inflorescence, scantily or not at all pubescent toward the base, rarely completely glabrous; leaves 5–10 mm. long, plane or acerose, subulate, pungent or abruptly apiculate, 3-nerved, strict or recurved and squarrosely spreading, the primary leaves broadly subulate, distinctly 3-nerved, abruptly pointed, the secondary usually acerose, indistinctly 3-nerved, the apex abrupt or pungent, the bases connate, particularly the lower long-sheathing, imbricate, or the upper internodes equaling the leaves; flowers few or many, sometimes reflexed, in spreading cymes, inflorescence more or less densely stipitate-glandular; sepals 3.5–6.5 mm. long, broadly to narrowly lanceolate, acuminate or pungently attenuate, 1–3-nerved, scantily or moderately glandular; petals shorter or conspicuously exceeding the sepals, narrowly or broadly elliptic, obtuse, or acutish; filaments slightly included, those opposite the sepals with a conspicuous basal gland; ovules several; capsules short, ovate-pyramidal, thin-walled, 3-(4)-valved, valves entire; styles 3 (4), slightly capitate; seed brown to brown-black, 1.0–1.3 mm. broad, 1.25–1.75 mm. long, papillae transversely elongate, low, the marginal more prominent.

Plants characteristically forming low dense mats, or sometimes cespitose, on talus or loose gravelly soil, foothills to alpine sites, in the mountains from Alberta and British Columbia south to southern California, Nevada, Utah, and Wyoming.

In the Great Basin, in the Sierra Nevada, and in the Siskiyou Mountains and nearby coast ranges three fairly distinct and restricted populations have been set off. These have developed differences primarily in sepal, petal, leaf-form characters, and to some extent in habit and pubescence. The remainder of the species from Oregon northward, and throughout its Rocky Mountain range, is polymorphous in these characters, and in many individuals is with difficulty distinguished from one or the other of the segregated subspecies. Within this major population, however, no recognizable variant has been cut off.

Key to the Subspecies of A. Nuttallii

1. Leaves ascending or strict, neither arcuate nor squarrose.
    2. Leaves abruptly acute or apiculate, infrequently pungent; sepals acuminate, midrib not prominent.
        3. Petals shorter than the sepals; Cascade Range, Rocky Mountains .... 1a. subsp. *Nuttallii.*
        3. Petals longer than the sepals; north California coast ranges, Siskiyou Mountains .... 1d. subsp. *gregaria.*
    2. Leaves strongly pungent; sepals narrow, pungently attenuate, midrib prominent; Sierra Nevada Range .... 1c. subsp. *gracilis.*
1. Leaves arcuate or squarrose.
    2. Sepals 3.5–5.5 (6.0) mm. long, lanceolate, sometimes broadly so, acuminate, 1-nerved (occasionally 3-nerved); petals shorter than the calyx; Cascade Range, Rocky Mountains .... 1a. subsp. *Nuttallii.*
    2. Sepals 5.5–6.6 mm. long, narrowly lanceolate, pungently attenuate, 3-nerved; petals more or less equaling the calyx; central Great Basin .... 1b. subsp. *fragilis.*

1a. A. Nuttallii subsp. **Nuttallii** Maguire, nom. nov. *A. pungens* Nutt. ex Torr. & Gray, Fl. N. Am. 1: 179. 1838, as to type, not *A. pungens* Clem. 1816. *A. Nuttallii* Pax, in Bot. Jahrb. 18: 30. 1893. *A. Nuttallii* var. *gracilipes* M. E. Jones, Proc. Calif. Acad. Sci. 5: 626. 1895. *Alsinopsis occidentalis* Heller, Muhlenbergia 8: 96. 1912.

Leaves mostly strict and abruptly pointed, but becoming recurved and pungent; sepals more or less broadly lanceolate, acuminate, 1-nerved, rarely 3-nerved; petals shorter than the sepals.

Type. "Summits of hills in the Rocky Mountain range (lat. 41°). Stems about 4 inches high, forming considerable caespitose tufts. Leaves rigid, 3-nerved. Sepals unusually long and acute." Nuttall. Isotype at the New York Botanical Garden.

More than 80 per cent of the specimens reviewed have ascending, abruptly pointed leaves, and fairly broad, merely acuminate and 1-nerved sepals. There is a strong tendency toward departure from these characters in the development of recurved pungent leaves and 3-nerved narrow sepals in the remaining 20 per cent. There is, however, no correlation between this tendency and geographic segregation, nor indeed in the coincidence of the characters themselves. Each may appear independently of the other. It does seem, though, that plants of lower altitudes tend to develop arcuate pungent leaves and attenuate tri-nerved sepals. The Nuttall type is a plant of this character.

Representative specimens. Sheep Mountains, Waterton Lake, Alberta, Canada, 1895, *J. Macoun 10100;* Bridger Mountains, Montana, June 15, 1897, *Rydberg* & *Bessey 4046;* Glacier National Park, Montana, July 20, 1932, *Maguire 738;* Boulder Lake, Custer County, Idaho, July 24, 1941, *Cronquist 3386;* Wyoming Range, Sublette County, Wyoming, July 18, 1922, *Payson* & *Payson 1922;* Buffalo, northern Wyoming, July, 1900, *Tweedy 3602;* Mt. Naomi, Cache County, Utah, August 18, 1938, *Maguire 16194;* Wasatch Plateau, Sanpete County, Utah, August 8, 1940, *Maguire 20002;* Mt. Adams, Washington, August 10, 1882, *Howell 3858* (cited as var. *gracilipes* Jones, Proc. Calif. Acad. Sci. 5: 627. 1895, but is entirely typical of subsp. *Nuttallii*) ; Fourth Creek, Chelan County, Washington, August 17, 1932, *Thompson 8905.*

Specimens approaching subsp. *fragilis* in leaf and/or sepal characters. Yakima Region, Washington, July, 1883, *Tweedy sine* No.; Crane Mountain, Lake County, Oregon, July 11, 1936, *Thompson 13212;* Pete's Point, Wallowa County, Oregon, July 28, 1933, *Peck 17866;* Mt. Jackson, Glacier National Park, Montana, August 24, 1926, *Somes 66;* Bush Ranch, Sweetwater County, Wyoming, June 10, 1900, *Nelson 7089;* Alta, Utah County, Utah, August 7, 1879, *Jones 1203;* Rocky Mountains, *Nuttall* (type).

1b. A. Nuttallii Pax subsp. **fragilis** Maguire & Holmgren, subsp. nov. Caulibus 10 cm. altis, internodis foliis aequalibus; foliis 8–10 mm. longis, fere arcuatis pungentibusque; sepalis pungentibus, acuminatis, attenuatisque, 3-nerviis; petalis sepalos excedentibus aut brevioribus.

Stems about 10 cm. high, brittle, internodes equaling the leaves; leaves 8–10 mm. long, strongly arcuate and pungent, sepals pungently acuminate and attenuate, 3-nerved; petals exceeding or somewhat shorter than the sepals.

Type. Frequent, semi-denuded, loose calcareous soil with heavy clay subsoil, south-facing slopes, associated with *Artemisia tridentata* subsp. *nova,* O'Donnell Canyon, west slopes Paradise Range, 5500 feet, southwest corner Lander County, Nevada, June 12, 1945, *Maguire* & *Holmgren 25390.* New York Botanical Garden.

A vigorous population more upright and cespitose in habit than the other subspecies. Loose gravelly slopes at low altitudes; known in the Intermountain Region from Esmeralda and Nye counties, Nevada, Mono County, California, north to Elko and Humboldt counties, Nevada, and Malheur County, Oregon.

Representative specimens. Summit, Owens Valley, Mono County, California, May 22, 1897, *Jones sine* no.; Mt. Magruder, Esmeralda County, Nevada, June 26, 1941, *Alexander* & *Kellogg 2417;* Wassuk Range, Mineral County, Nevada, June 25, 1940, *Train 4151;* Ione Pass, Shoshone Range, Nye County, Nevada, June 12, 1945, *Maguire* & *Holmgren 25376;* hills five miles north of Reno, Washoe County, Nevada, July 1, 1907, *Heller 8657;* Star Peak, West Humboldt Mountains, Humboldt County, Nevada, July 31, 1912, *Heller 10634* (intermediate to subsp. *Nuttallii*); stony hills near Dry Creek, Malheur County, Oregon, June 10, 1901, *Cusick 2556.*

1c. A. Nuttallii Pax subsp. **gracilis** (Gray) Maguire, comb. nov. *A. pungens* var. *gracilis* Gray, Proc. Am. Acad. 29: 304. 1894. *A. Nuttallii* var. *gracilis* (Gray) Robinson, Proc. Am. Acad. 29: 304. 1894.

Leaves 5–8 mm. long, pungent, strict, or the primary somewhat recurved; fascicled secondary leaves numerous; sepals 3.8–5.0 (6.0) mm. long, narrowly and pungently attenuate, 1-nerved, the nerve prominent; petals shorter than the sepals.

Type. Mountains above Big Tree Grove, California, *Bolander 4976.* Gray Herbarium.

A compact leafy and fairly uniform population of the higher mountains, the central Sierra Nevada Range south to the San Bernardino Mountains, California.

Representative specimens. Siberian Pass, Sierra Nevada, Tulare County, *Hall* & *Babcock 5479;* Big Pine Creek, Inyo County, July 15, 1941, *Alexander* & *Kellogg 2573.*

1d. A. Nuttallii Pax subsp. **gregaria** (Heller) Maguire, comb. nov. *A. gregaria* Heller, Bull. S. Calif. Acad. 2: 67. 1903. *A. Nuttallii* var. *gregaria* (Heller) Jepson, Fl. Calif. 492. 1914.

Sometimes prominently stipitate-glandular throughout, particularly in the inflorescence; leaves strict or occasionally somewhat recurved, 3–8 (12) mm. long, abruptly apiculate; sepals 3.6–4.5 (4.8) mm. long, lanceolate, acuminate, 1-nerved; petals exceeding the sepals.

Type. Open stony slopes near Summit Lake, Mt. Sanhedrin, Lake County, California, July 15, 1902, *Heller 5892.* Isotype New York Botanical Garden.

Plants of gravelly ridges, slopes, and talus, from Lake County, California, northward in the coast ranges to the Siskiyou Mountains and the Mt. Shasta region.

The subsp. *gregaria* is less uniform than either subsp. *gracilis* or subsp. *fragilis,* but is not so closely intergradient with subsp. *Nuttallii* as the latter. Some forms of subsp. *gregaria* are more conspicuously long glandular-pubescent than any of the other subspecies. Its petals consistently exceed the sepals, a development occurring otherwise only in subsp. *fragilis.*

Representative specimens. Scott Mountain between Trinity and Siskiyou counties, California, July 29, 1937, *Howell 13640;* north side Mt. Shasta, Siskiyou County, California, June 11–16, 1897, *Brown 434;* Sanger Peak Lookout, Siskiyou County, California, July 7, 1939, *Hitchcock & Martin 5279.*

2. Arenaria filiorum Maguire, Bull. Torrey Bot. Club 73: 326. 1946.

Small glabrous cespitose annuals from a slender taproot; stems slender, numerous, 2–5 cm. high, closely branching from the base upwards, at maturity becoming reddish-purple; leaves usually 5–10 mm. long, triquetrous, subcrassulus, 1-nerved or with faint lateral veins, obtuse, the pairs loosely connate at the base; inflorescence of 1 or mostly several flowers, the cymes not symmetrical, the bracts herbaceous; the sepals 3.5–4.8 mm. long, ovate-lanceolate, pink becoming purplish in age, strongly 3-nerved, the margins narrowly scarious; petals more or less equaling, or shorter than, the sepals, narrow oblong-obovate, entire; stamens included, staminal disc broad; ovules numerous; styles 3 (4); capsule shorter than the sepals, firmly chartaceous, ovate, dehiscing to the base by 3 retuse valves; seed numerous, 0.7–1.0 mm. broad, reniform, the papillae elongate, regular, low, inconspicuous, the testa dark red-brown.

This distinct species was collected in company with my son on the beach of Navajo Lake, where it was common and growing intimately with *A. rubella.*

Type locality. Common, gravelly beach, Navajo Lake, Iron County, Utah, July 13, 1940, *Maguire 19472.* New York Botanical Garden. Cotypes. Frequent, open park in aspen-spruce, 2 mi. north of Posey Lake, Aquarius Plateau, 10,000 ft., June 29, 1940, Garfield County, Utah, *Maguire 20105;* frequent, stony ridge and slopes, loose calcareous talus, head Mayfield Canyon, ½ mi. above Ranger Station, *Maguire 19988.*

Distribution. Gravelly soils and talus, most frequently above 10,000 ft.; the southern Colorado Rockies, the high plateaus of south central Utah, and the Charleston Mountains, Clark County, Nevada.

Representative specimens. East Brian Head Peak, 11,000 ft., Iron County, Utah, June 23, 1940, *Maguire 20097;* near Ironton, San Juan County, Colorado, July 21–31, 1899, *C. C. Curtis sine* no.; Charleston Mountains, Clark County, Nevada, August 8, 1935, *Clokey 5460.*

Arenaria filiorum is habitally similar to *A. rubella,* and like this species, has strongly 3-nerved sepals. Where the two grow intimately in the same area, as frequently they do, *A. filiorum* even from a distance is instantly recognizable by its more vigorous growth and coarser appearance, altogether apart from distinction by critical characters.

Because of its total glabrosity and 1-nerved leaves, our plant may be associated with the boreal *A. Rossii.* However, in character of general habit (in the Caryophyllaceae generally of consideration) and in the important seed differences, the two stand as entirely distinct. A table of contrastive and comparative characters for these three species of *Arenaria* follows.

A. rubella	*A. filiorum*	*A. Rossii*
Plants wholly glandular-puberulent.	Plants wholly glabrous.	Plants wholly glabrous.
Leaves 3-nerved, not fleshy.	Leaves 1-nerved, fleshy, triquetrous.	Leaves 1-nerved, plane, not fleshy.
Flowers usually 3–5 in an open cyme.	Flowers usually 3–5 in an open cyme.	Flowers solitary.
Pedicels slender, seldom exceeding 1 cm. in length.	Pedicels slender, seldom exceeding 1 cm. in length.	Pedicels capillary, 2–4 cm. long.
Sepals strongly 3-nerved.	Sepals strongly 3-nerved.	Sepals 1-nerved, with weak lateral veins.
Seed 0.4–0.7 mm. wide, inconspicuously low-papillate, testa light red-brown.	Seed 0.7–1.0 mm. wide, papillae low, elongate, regular, testa very dark red-brown.	Seed oblong (?), 0.5–0.7 mm. long, light red-brown, almost smooth.
Circumpolar; in America extending south to Quebec and in the Rocky Mountains to New Mexico and Arizona.	Apparently concentrated in the high plateau region of south central Utah, and in addition known from the Charleston Mountains, southern Nevada, and southeastern Colorado.	Arctic America, and in the Rocky Mountains as far south as Wyoming (one doubtful record from Colorado); apparently also in easternmost Siberia.

New York Botanical Garden
New York, N. Y.

A WHITE GAILLARDIA IN TEXAS

V. L. Cory

In a "Revision of the Genus Gaillardia" by Susan Fry Biddulph (Research Studies, State College of Washington 12: 251, 1944), a paragraph is devoted to the treatment of the white *Gaillardia* growing in southern Hardin County, Texas, material of which had been sent to her by myself and later by my friend, Mr. P. A. Winkler, a landscape gardener and botanist of Beaumont. The author grew this plant in her garden, and the rays and disks were pure white, nevertheless she states: "Because *G. lutea* has also been collected in Hardin County, the 'white *Gaillardia*' may be only an albino form of that species." Two collections of *G. lutea,* the yellow *Gaillardia,* are cited from Hardin County by Mrs. Biddulph: the earlier having been collected at Fletcher in 1916 (*Palmer 10569*), and the other being my own collection from the vicinity of Fletcher Lake (*Cory 20067*). The fact is that neither of these collections is the yellow *Gaillardia*. Mr. Palmer assures me that in his notebook the flowers are recorded as being white, and the locality of collection is the same as mine; but his collection preceded mine by twenty years. During the four different years that I have botanized in Hardin County I have never seen specimens of the yellow *Gaillardia*. Mr. Winkler has botanized Hardin County for many years, and he assures me that he has never seen the yellow *Gaillardia* therein. Furthermore, the nearest recorded locality for the species is in Newton County, and all of the other recorded localities are at least one hundred miles away. Therefore it is my opinion that the white is not an albino form of the yellow as interpreted by Mrs. Biddulph. In my experience, such forms occur only along with the species.

In October, 1945, another locality where the white *Gaillardia* occurs was visited and the plants were studied. In this locality which is also on a tributary of Village Creek two and one-half miles west of Silsbee and five miles north of the other localities, the plants showed a different aspect. Instead of being erect and about three decimeters tall, the stems were sprawling and as much as nine decimeters long. Most of the plants bore white flowers (*Cory 49879*) but in one limited locality were several plants with pink rays (*Cory 49885*). Without opportunity to observe the behavior of the pink-flowered form under cultivation, I shall content myself by merely calling its existence to attention.

Even though it is an endemic plant restricted to a limited area, the white *Gaillardia* is so closely related to the yellow *Gaillardia* that it seems proper to designate it as a variety of that species. In gratitude for his responsibility in making us acquainted with the white *Gaillardia* and with the localities where it grows, I wish to dedicate this new variety to my friend, Mr. P. A. Winkler.

Gaillardia lutea Greene var. **Winkleri** var. nov. A specie differt corollis ligulatis discoideisque albis.

Type. Vicinity of Fletcher Lake, about five miles south of Silsbee, Hardin County, Texas, September 15, 1936, *Cory 20067* (Gray Herbarium, Harvard University).

The Winkler *Gaillardia* is showy and merits use as an ornamental in areas where gaillardias thrive; the species, on the other hand, does not command attention.

An albino form of *Gaillardia pulchella* was described in 1914 by Cockerell (Gard. Chron., ser. 3, 55: 67. 1914). It was apparently no more than just that, for it is not mentioned in the latest edition of "The Standard Cyclopedia of Horticulture" by L. H. Bailey, nor is there any mention therein of any white *Gaillardia*.

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For classified items see: Biographical articles, Chromosome numbers, Reviews. New scientific names are printed in bold-face type.