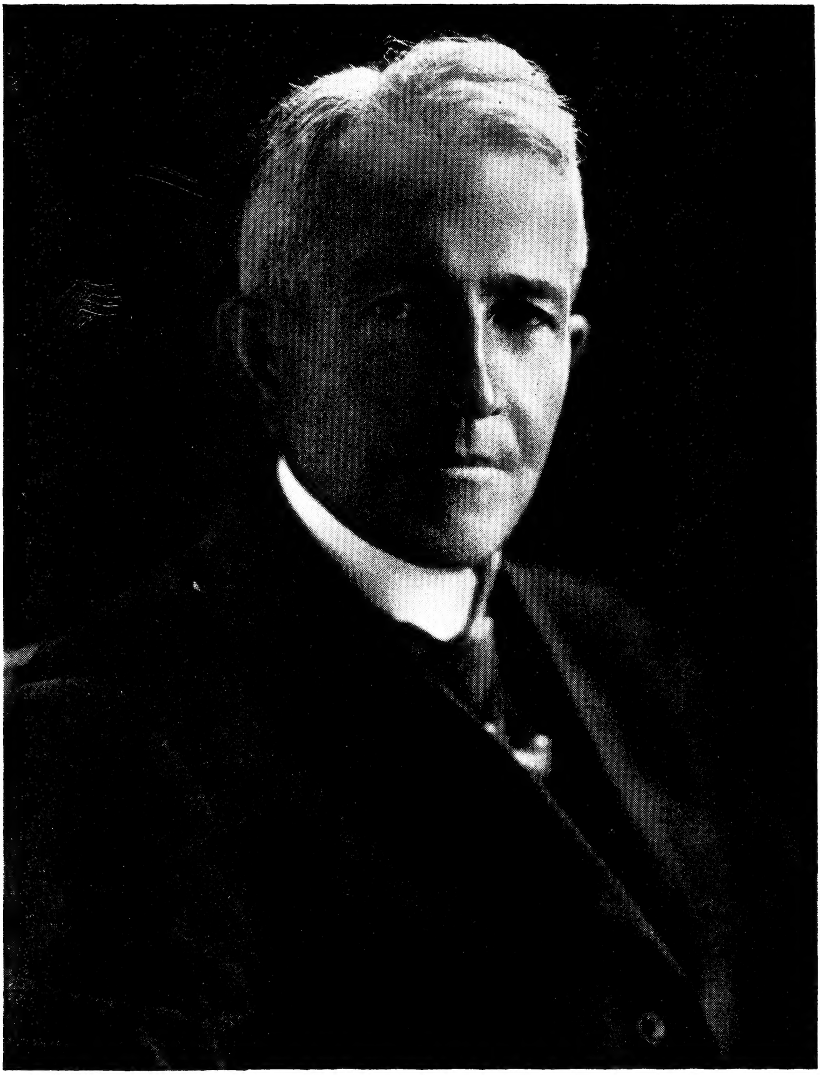

George James Peirce

Frontispiece to Volume 10, Madroño

MADROÑO

A WEST AMERICAN JOURNAL OF BOTANY

VOLUME X
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To Dr. George James Peirce, botanist, teacher, administrator, humanitarian, steadfast friend of the California Botanical Society, we dedicate this tenth volume of Madroño. Now in his eighty-third year and Professor of Botany Emeritus at Stanford University, Professor Peirce has been an enthusiastic and inspiring teacher with a career characterized by close, sympathetic and friendly relations with his students. In recent years, more and more of his time has been dedicated to public service in his home community. His is a life that commands the respect and has won the love of all who know him. We welcome this opportunity to express to him our appreciation, to wish him the joy of continued good health, and to congratulate him on the satisfactions that come from an eminently useful life.

CONTENTS

ERRATA

Page 51, line 23: for *P. linearipetiolum* read *P. linearipetiolatum.*
Page 63: *for* Plate 1 *read* Plate 3.
Page 88, line 21: for *G. chamissionis* read *G. chamissonis.*
Page 94, line 26: for *dasystachum* read *dasystachyum.*
Page 94, line 28: for *dasytachum* read *dasystachyum.*
Page 161, line 41: *for* dicussed *read* discussed.
Page 195, line 3: *for* though *read* through.
Page 196, line 16: *for* 3a *read* 4.
Page 196, in diagram: *for* Synonomy *read* Synonymy.
Page 210, line 9: for *T. cucumeriodes* read *T. cucumeroides.*
Page 217, line 1: *for* diagramatic *read* diagrammatic.

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Contents

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TAXONOMIC OBSERVATIONS ON THE NORTH AMERICAN SPECIES OF HORDEUM

Guillermo Covas

In his "Manual of the Grasses of the United States," A. S. Hitchcock (1935) recognized in the genus *Hordeum* eight species and four varieties. Since no species occur in Canada, Mexico, or Central America which are not also found in the United States, this treatment included all of the North American species of the genus which Hitchcock recognized. Closer examination of the morphology and the cytology of these species has shown his treatment to be inadequate.

In this paper, some modifications of Hitchcock's taxonomic treatment of the genus are given, including the description of three new species.

The conventional morphological characters used in the classification of the Gramineae are sometimes insufficient for the identification of the species of *Hordeum.* Characters of the spike, glumes, lemmas, anthers, leaves, etc. are often very similar in distantly related species, and, in addition, the variation between species often is confounded by qualitative and quantitative intraspecific fluctuation. The presumably allopolyploid character of many of the species is largely responsible for this pattern.

The proper taxonomic treatment of this genus was realized by Hauman (1916) when he pointed out: ". . . une monographie, même partielle, du genre *Hordeum* ressort sans doute encore de la botanique de l'avenir, dont la systematique devenue expérimentale, se sera transformée en une réelle investigation phylogénique basée sur l'observation, en culture, de la constance et de l'hérédité des caractères."

The structure of the epidermal cells of the leaves has been a valuable character for the differentiation of some species. These observations were based on the work of Prat (1932), who emphasized the importance of such a complex tissue in the taxonomic arrangement of the grasses.

For the identification of species of *Hordeum,* the following characters of the epidermis of the blade must be taken into consideration: (a) form of walls of elongate cells; (b) presence or absence of paired siliceous and suberized cells; (c) disposition of siliceous cells in the nerves; (d) size of stomata. These characters can be easily observed by diaphanizing a little piece of the blade, heating it with a crystal of phenol, removing the excess of liquefied phenol, and mounting in Canada balsam or similar media. With this treatment the siliceous cells become reddish (Johansen, 1940: 198).

Although the characters mentioned are rather constant in

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all the leaves of the adult plant, the observations were made in the middle part of the second leaf below the spike.

In relation to the cytological evidence, all the species of *Hordeum* studied have the basic chromosome number x = 7, and the chromosomes are not conspicuously differentiated from each other, except that two pairs possess satellites, as was observed in both diploid and tetraploid species. However, the number of chromosomes has been valuable for clarifying the interrelationship of several species, and the recognition of diploid and tetraploid forms in a complex has allowed further segregation of species on the basis of morphological characters neglected thus far.

Table 1. Chromosome Numbers in North American Species of Hordeum

Species	Chromosome number (2n)	Count made by
H. californicum	14	Stebbins & Love (sub *H. nodosum,* pro parte) Chin (sub *H. nodosum,* pro parte)
H. Hystrix	14	Covas
	28	Chin (sub *H. Gussoneanum*)
H. marinum	14	Ghimpu, Griffee, Wulff
H. murinum	14	Ghimpu, Perak, Stolze
	28	Andres, Chin, Griffee, Stählin, Aase and Powers
H. pusillum	14	Andres, Chin, Kihara, Perak
H. Stebbinsii	14	Covas
H. vulgare	14	Griffee, etc.
H. brachyantherum	28	Stebbins & Love (sub *H. nodosum,* pro parte) Chin (sub *H. nodosum,* pro parte)
H. depressum	28	Covas
H. jubatum	28	Andres, Chin, Griffee, Perak, Stählin, Stebbins and Love
	14	Tanzi
	ca. 14	Brown
H. leporinum	28	Perak

The number of chromosomes of species of *Hordeum* recently has been compiled by Darlington and Janaki Ammal (1945) and by Myers (1947). Table 1 gives all of the chromosome numbers found in North American species of *Hordeum.* Those counts made by myself are given in boldface; counts made by other authors are given as cited by Myers.

All the North American species, except *H. arizonicum* and *H. murinum,* were observed in culture. Many interspecific crosses were attempted and some of them have been successful; this material will be the object of further cytogenetic studies.

I wish to acknowledge appreciation to Dr. G. L. Stebbins, Jr., Division of Genetics, University of California, Berkeley, at whose suggestion this study was elaborated, for helpful advice and criticism. Also, I am indebted to the curators of the following herbaria for the loan of material: Gray Herbarium, Harvard University (GH); New York Botanical Garden (NY); United States National Herbarium (US); California Academy of Sciences (CAS); Dudley Herbarium, Stanford University (DS); University of California, Berkeley (UC); Grass Herbarium of the Agronomy Division, University of California, Davis (UC-D); Herbarium of Mr. A. Ruiz Leal, Mendoza, Argentina (Leal). The abbreviations used, insofar as possible, are those proposed by Lanjouw (1939).

TAXONOMIC TREATMENT

The species of *Hordeum,* native or naturalized in North America, can be recognized by means of the following key, in which is included *Hordeum nodosum,* an exclusively Old World species, which repeatedly has been reported as growing in both North and South America.

KEY TO THE NORTH AMERICAN SPECIES OF HORDEUM

A. Perennials.
  B. Auricles small (0.2–1.5 mm. long) but usually present; elongate epidermal cells of the leaf blade with undulate walls (fig. 1); paired siliceous and suberized cells in the epidermis of the blade frequent; lodicules 1.3–1.9 mm. long; anthers 2.8–4.3 mm. long; Old World . . *H. nodosum*
  BB. Auricles obsolete or absent; elongate epidermal cells of the leaf blade with straight walls; epidermis of the blade without paired siliceous and suberized cells; lodicules less than 1.3 mm. long; anthers 1–3 mm. long; native in North America.
    C. Glumes and awns 1.8–8 cm. long . . . . 3. *H. jubatum* including var. *caespitosum*
    CC. Glumes and awns less than 1.8 cm. long.
      D. Leaves pubescent, 1.5–5 mm. wide; siliceous cells in the nerves of upper epidermis of blades usually isolated or forming short stripes; pedicels of lateral spikelets erect, almost straight (fig. 5, left); glumes of central spikelet 1½ to 2½ times as long as the palea; prolongation of rachilla usually very short or wanting; anthers usually 1.5–3 mm. long; diploid species; California . . 1. *H. californicum*
      DD. Leaves usually glabrous, sometimes scabrous or shortly pubescent, 3–9 mm. wide; siliceous cells in the nerves of upper epidermis of blades forming rather continuous stripes, only inter-

rupted by hair- or apiculated-cells; pedicels of lateral spikelets usually curved (fig. 5, right); glumes of central spikelet often scarcely longer than the palea; prolongation of rachilla usually well developed; anthers usually 1–1.5 mm. long; tetraploid species; widespread in boreal and western North America .... 2. *H. brachyantherum*

AA. Annuals.

E. Glumes of central spikelet and the inner ones of lateral spikelets with ciliate margins.

F. Floret of central spikelet sessile or subsessile, its lemma, awn and palea all longer than those of the lateral spikelets; inner glumes of lateral spikelets narrower than those of the central spikelet; palea of lateral florets almost glabrous; diploid species .... 10. *H. murinum*

FF. Floret of central spikelet borne on a pedicel usually as long as the pedicels of the lateral spikelets, its lemma, awn and palea all shorter than those of the lateral spikelets; inner glumes of lateral spikelets as broad as those of the central spikelet; paleas of lateral florets pubescent.

G. Spike very dense (6–8 spikelets per cm. of rachis); rachis with ciliate margins; the cilia 0.25–0.75 mm. long; prolongation of rachilla of lateral spikelets 1.0–2.2 mm. long, rather stout; stamens of central florets included at anthesis, their anthers 0.2–0.5 mm. long, entire or shortly lobed at the base, their filaments without starch grains; diploid species .... 9. *H. Stebbinsii*

GG. Spike not very dense (3–5 spikelets per cm. of rachis); rachis with margins scabrous or very shortly ciliate, the cilia 0.1–0.3 mm. long; prolongation of rachilla of lateral spikelets 2.8–3.7 mm. long, rather slender; stamens of central florets exserted at anthesis, their anthers 0.8–1.5 mm. long, with strongly bilobed base, their filaments containing conspicuous starch grains which become strongly colored in iodine solution; tetraploid species .... 11. *H. leporinum*

EE. Glumes not ciliate.

H. Auricles very long; rachis continuous; all three spikelets sessile, fertile .... 12. *H. vulgare* f. *hexastichon*

HH. Auricles obsolete or wanting; rachis articulate; lateral spikelets pedicelate, usually neuter.

- I. Inner glumes of lateral spikelets strongly broadened, 0.6–1.8 mm. wide.
  - J. Spike ovate, usually less than 4 cm. long; awns strongly spreading; introduced from the Old World...... 4. *H. marinum*
  - JJ. Spike linear-oblong, usually over 4 cm. long; awns and glumes suberect; native to North America.......... 6. *H. pusillum*
- II. All glumes linear-subulate, less than 0.6 mm. wide.
  - K. Spike ovate to ovate-oblong, usually less than 5 cm. long; awns and glumes strongly spreading at maturity; bases of glumes of lateral spikelets prominent above the pedicel, both inserted at almost the same level; lodicules glabrous; diploid species introduced from the Old World.. 5. *H. Hystrix*
  - KK. Spike linear-oblong, usually over 5 cm. long; awns and glumes suberect; bases of glumes of lateral spikelets not prominent above the pedicel, the inner one inserted at a lower level than the outer; lodicules ciliate at margins; polyploid species native to North America.
    - L. Central spikelet 13–22 mm. long including awn; pedicels of lateral spikelets almost straight; lateral florets with acute but awnless lemmas; tetraploid species; California, Oregon, Idaho, Washington, British Columbia.. 7. *H. depressum*
    - LL. Central spikelet 26–32 mm. long including awn; pedicels of lateral spikelets curved; lateral florets with acuminate, very shortly awned apex; hexaploid (?) species; Arizona, southeastern California................ 8. *H. arizonicum*

1. **Hordeum californicum** Covas et Stebbins, sp. nov. *H. nodosum* auct. americ. non L., pro parte.

Perenne caespitosum; culmi erecti 20–65 cm. alti. Folia viridula vel glauca; vaginae inferiores pilosulae, superiores glabrae; ligula truncata, 0.15–0.4 mm. longa; lamina 1.5–5 mm. lata, pilosulae, basi exauriculata. Spica 2.5–8 cm. longa, 0.4–0.7 cm. lata aristis non computatis; articulis rachiae elongatis, margine ciliatis. Terniorum spicula intermedia sessilis, 12–22 mm. longa aristis computatis; glumae setaceae, scabrae, 8–17 mm. longae, 0.08–0.2 mm. latae; glumella glabra, in parte superiore scabra; palea 5.5–9.5 mm. longa, acuminata, in parte superiore scabra; antherae 1.5–3 mm. longae. Spicula laterales pedicellatae, neutrae vel ♂ vel ☿; pedicellis erectis, gracilis; glumis setaceis, scabris, 0.1–0.18 mm. latis; glumella subulata vel lanceolata, scabra. Chromosomae 2n = 14.

Perennial with tufted, erect culms 20–65 cm. tall. Leaves bright green or glaucous, the basal ones with retrorsely pubescent sheaths, the upper ones with glabrous sheaths; ligule truncate 0.15–0.4 mm. long; blades 1.5–5 mm. wide usually pubescent on both surfaces (the hairs usually ascending, short and stout to long and slender); elongate epidermal cells of the blade with straight walls; siliceous cells in the nerves of upper epidermis usually isolated or forming short stripes; auricles wanting or vestigial. Spike linear-oblong, green or purplish, 2.5–8 cm. long, 0.4–0.7 cm. wide without awns; rachis articulate, with usually elongate segments ciliate at the margins. Central spikelet sessile, 12–22 mm. long including awn; glumes setaceous, scabrous, 8–17 mm. long, 0.08–0.2 mm. wide; lemma usually glabrous, scabrous toward apex, sometimes hispid-pubescent, tapering into an awn 7–15 mm. long; palea 5.5–9.5 mm. long, usually acuminate, scabrous toward apex; anthers 1.5–3 mm. long; prolongation of rachilla wanting or commonly weak and not reaching the middle of palea. Lateral spikelets pedicellate, the pedicels slender, almost straight, 1–1.8 mm. long; glumes setaceous, scabrous, 0.1–0.18 mm. wide, usually parallel in the basal portion; floret commonly neuter, sometimes staminate or perfect, 3.5–9 mm. long; lemma commonly subulate, scabrous; palea frequently wanting. Modal diameter of pollen grains 32–36 μ. Modal length of stomata 30–34 μ. Chromosome number 2n = 14.

Type. Grassy pasture, in alluvial soil from shale and granitic formations, altitude 1700 feet (520 m.); foot of Haystack Hill, Hastings Reservation, Jamesburg, Monterey County, California, May 15, 1948, *G. L. Stebbins 3944* (UC 754600; isotypes, NY, GH, US, DS, UC-D).

Specimens examined. California. San Diego County: Palomar Mountain, *Orcutt* (DS 190554). San Miguel Island: head of Willows Canyon, *Hoffmann* (UC 675632). Santa Barbara County: Santa Barbara, *Elmer 3939* (GH, DS); Point Sal west of Guadalupe, *Beetle 1927* (UC-D). San Luis Obispo County: Rancho Asuncion, Templeton, *Burtt Davy 7600* (UC); San Luis Obispo, *Stebbins 3357* (UC); 1 mile north of Moro Beach, *Wiggins 3605* (DS); roadside near San Luis Obispo, *Condit* (UC 454-061); Cholame, without collector (UC 337742). Monterey County: summit of Jolon Grade, *Ferris 8422* (GH, UC, DS); 1½ miles east of Jamesburg, *Stebbins 3415* (UC); Pacific Grove, *Heller 6703* (GH, DS); 2½ miles north of Lynch Ranch, *Graham 393*

(UC); mouth of Garrapata Creek, *Ferris 3709* (DS); Tassajara Hot Springs, *Elmer 3315* (DS); 2 miles south of Monterey, *Stebbins 3437* (UC, GH, US); 6 miles east of Carmel, *Stebbins 3435* (UC, US). San Benito County: trail to Hepsedam Peak, *Dudley* (DS 18633); New Idria, *Dudley* (DS 18640). Santa Clara

TABLE 2. DIFFERENTIATING CHARACTERISTICS OF HORDEUM NODOSUM, HORDEUM CALIFORNICUM, and HORDEUM BRACHYANTHERUM.

	H. nodosum	*H. californicum*	*H. brachyantherum*
Chromosome number (2n)	28	14	28
Leaf blade	Rather stiff, glabrous to pilose, 1–5 mm. wide	Rather soft, pubescent, 1.5–4 mm. wide	Rather soft, usually glabrous, 3–9 mm. wide
Auricles	Usually present	Wanting or vestigial	Wanting or vestigial
Walls of elongate epidermal cells of leaf blade	Undulate	Straight	Straight
Paired siliceous and suberized cells in the epidermis of leaf blade	Present	Absent	Absent
Siliceous cells in the nerves of upper epidermis of leaf blade	Usually isolated or forming short stripes	Usually isolated or forming short stripes	Usually forming long stripes
Ratio (length/maximum width) of the segments of rachis	2–3	2–3	1.2–2.2
Ratio (length of glumes of central spikelet/ length of palea)	1.0–1.2	1.5–2.5	1.2–1.8
Prolongation of rachilla of central spikelet	About as long as the middle of the palea	Usually wanting or not reaching the middle of the palea	Usually surpassing the middle of the palea
Length of anthers (mm.)	2.8–4.5	1.5–3	1–1.8
Length of lodicules (mm.)	1.3–1.9	0.7–1.1	0.7–1.1
Pedicels of lateral spikelets	Usually straight	Usually straight	Usually curved
Lemma of lateral floret	Usually hispid toward apex	Usually scabrous	Usually scabrous
Modal length of stomata (μ)	44–50	30–34	42–48
Modal diameter of pollen grains (μ)	39–44	32–36	39–44

County: Saratoga, *Pendleton 1456* (UC-D). Mount Hamilton Range, Stanislaus County: junction of Adobe Creek with Arroyo del Puerto Creek, *Sharsmith 3760* (UC); Adobe Creek, *Sharsmith 3606* (UC); Colorado Creek, *Sharsmith 3176* (UC). San Mateo County: Spring Valley, *Demaree 9144* (GH). Alameda County: Codornices Park, Berkeley, *Stebbins 3411* (UC, NY, US); Berkeley hills, *Long 166a* (UC). Tuolumne County: Long Gulch near Rawhide, *Williamson 226* (DS). Marin County: San Anselmo Canyon, *Howell* (CAS). Napa County: road from Rutherford to Monticello, *Stebbins* and *Covas 3933* (UC, GH). Sacramento County: ½ mile west of Scott Ranch, *Nordstrom 5703* (UC). Lake County: 2 miles north of Middletown, *Wolf 1899* (DS); 2½ miles northeast of Middletown, *Stebbins* and *Covas 3922* (UC, GH, NY, US); north side of Cobb Valley near Glenbrook, *Tracy 14017* (GH). Mendocino County: Sherwood Valley, *Burtt-Davy* and *Blasdale 5179* (UC); Ukiah, *Burtt-Davy* and *Blasdale 5021* (UC).

This new species was referred previously to *H. nodosum* L. (see key and table 2 for differential characters). Stebbins and Love (1941) and Chin (1941), independently, found diploid forms in the complex called *H. nodosum;* those forms correspond now to *H. californicum,* while the tetraploid forms must be referred to *H. brachyantherum* Nevski (= *H. boreale* Scribn. & Smith). *Hordeum californicum* was subsequently recognized as a different species by Dr. Stebbins (verbal communication) on the basis of the differences between the spontaneous tetraploid forms and the artificially produced tetraploid.

Hordeum californicum and *H. brachyantherum* are two closely related species, which often are difficult to separate. However they must be regarded as different species, on the basis of the following facts:

a) Although there is no single morphological character which absolutely differentiates the two species, a combination of several characters defines them fairly accurately. The main differential characters are shown in table 2. Perhaps the best distinctive character is the disposition of the siliceous cells in the upper epidermis of the leaf blade.

b) The different chromosome number is an effective barrier

Explanation of the Figures. Plate 1.

Plate 1. North American Species of Hordeum. Fig. 1, *H. nodosum,* lower epidermis of leaf blade, ×290 (*Kneucker 535*). Fig. 2, *H. brachyantherum,* upper epidermis of blade, the siliceous cells in black, ×235 (*Stebbins 2747*). Fig. 3, *H. californicum,* upper epidermis of blade, the siliceous cells in black, ×235 (*Stebbins 3437*). Fig. 4, lateral spikelets, ×7: left, *H. depressum* (*Beetle 4373*); right, *H. Hystrix* (*Beetle 2954*). Fig. 5, bases of spikelets, ventral side, ×10: left, *H. californicum* (*Stebbins 2734*); right, *H. brachyantherum* (*Stebbins 3103*). Fig. 6, *H. Stebbinsii,* chromosome complement, late diakinesis, n = 7, ×1075 (from near Davis, Yolo County, California). Fig. 7, *H. depressum,* chromosome complement, somatic cell, 2n = 28, ×1210 (from near Concord, Contra Costa County, California).

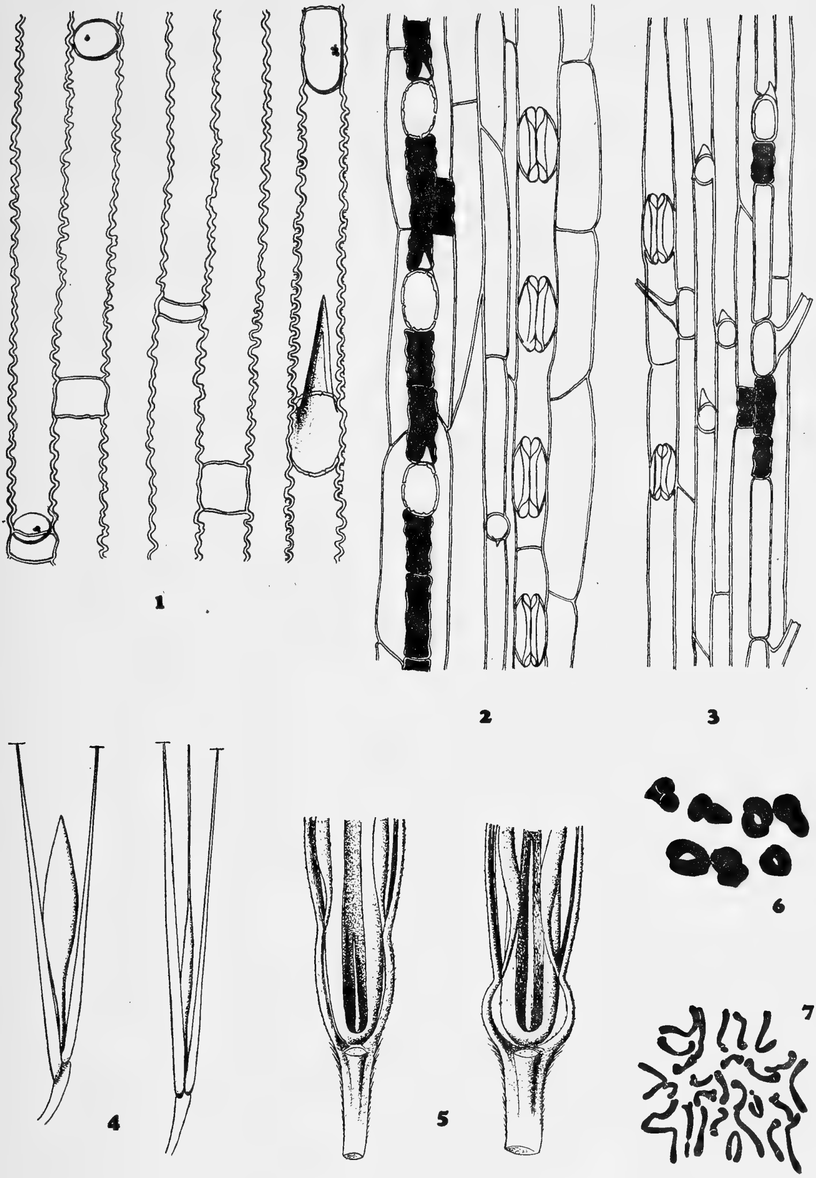

Plate 1. North American Species of Hordeum.

against the interchange of genes between the two species. In attempts to make artificial hydrids between *H. californicum* and *H. brachyantherum* only five seeds were obtained in more than two hundred cross-pollinated florets.

c) The tetraploid produced artificially by Dr. Stebbins from *H. californicum* (by use of colchicine) is similar to this species in qualitative characters, differing only in the larger size of cells and vegetative and reproductive organs.

d) The geographic distributions of *H. californicum* and *H. brachyantherum* follow a quite different pattern. *Hordeum californicum* occurs in the interior coast ranges of northern California, reaching the coast in central and southern California; occupies hills, slopes, stream sides, usually in not very heavy soil and not in alkali or saline areas. *Hordeum brachyantherum,* in California, grows in the mountains and along the coast and is a plant of bottom lands, often in sub-alkaline soils. Sometimes (in Lake County, Alameda County, etc.), the two species grow in neighboring areas, but there they occupy different habitats and show no sign of intergradation.

A fact which provides a good basis for explaining the nature of the interrelationship between *H. californicum* and *H. brachyantherum* is that this last species often approaches *H. californicum* in its morphological characters, while *H. californicum* is a less variable species which never looks like the typical *H. brachyantherum.* Thus it is not risky to assume that *H. brachyantherum* is an allopolyploid derived from *H. californicum* and some undetermined diploid species. A similar pattern of mutual variation was pointed out by Anderson (1936) in the case of *Iris virginica* and its derivative *Iris versicolor.*

2. HORDEUM BRACHYANTHERUM Nevski in Acta Inst. Bot. Acad. Sci. U.R.S.S. 1(2): 61. 1936. Based on *H. boreale* Scribn. & Smith in U. S. Dept. Agric. Bull. Agrost. 4: 24. 1897. Non Gandoger in Bot. Not. 1881:157. Hultén, Flora of Alaska and Yukon, in Lund, Univ. Årssk. N. F. Avd. 2 Bd. 38, 1: 265. 1942. *H. nodosum* var. *boreale* (Scribn. & Smith) Hitchcock in Am. Jour. Bot. 21: 134. 1934, type locality: Atka Island, Aleutian Islands. *H. nodosum* auct. americ. non L., pro max. parte.

This species, like the preceding one, was referred by many authors to *H. nodosum* L. Both species are tetraploid, but there

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EXPLANATION OF THE FIGURES. PLATE 2.

PLATE 2. NORTH AMERICAN SPECIES OF HORDEUM. FIG. 8, *H. Stebbinsii,* spikelets, ventral side, ×3 (from the type). FIG. 9, *H. leporinum,* spikelets, ventral side, ×3 (*Burtt-Davy 1685*). FIG. 10, *H. murinum,* spikelets, ventral side, ×3 (*Muenscher 5658*). FIG. 11, *H. arizonicum,* spikelets, ×4 (from the type). FIG. 12, prolongation of rachillas of lateral spikelets, ×6: left, *H. Stebbinsii;* center, *H. leporinum;* right, *H. murinum.* FIG. 13, *H. Stebbinsii,* anther of central floret, ×60. FIG. 14, *H. leporinum,* anther of central floret ×60.

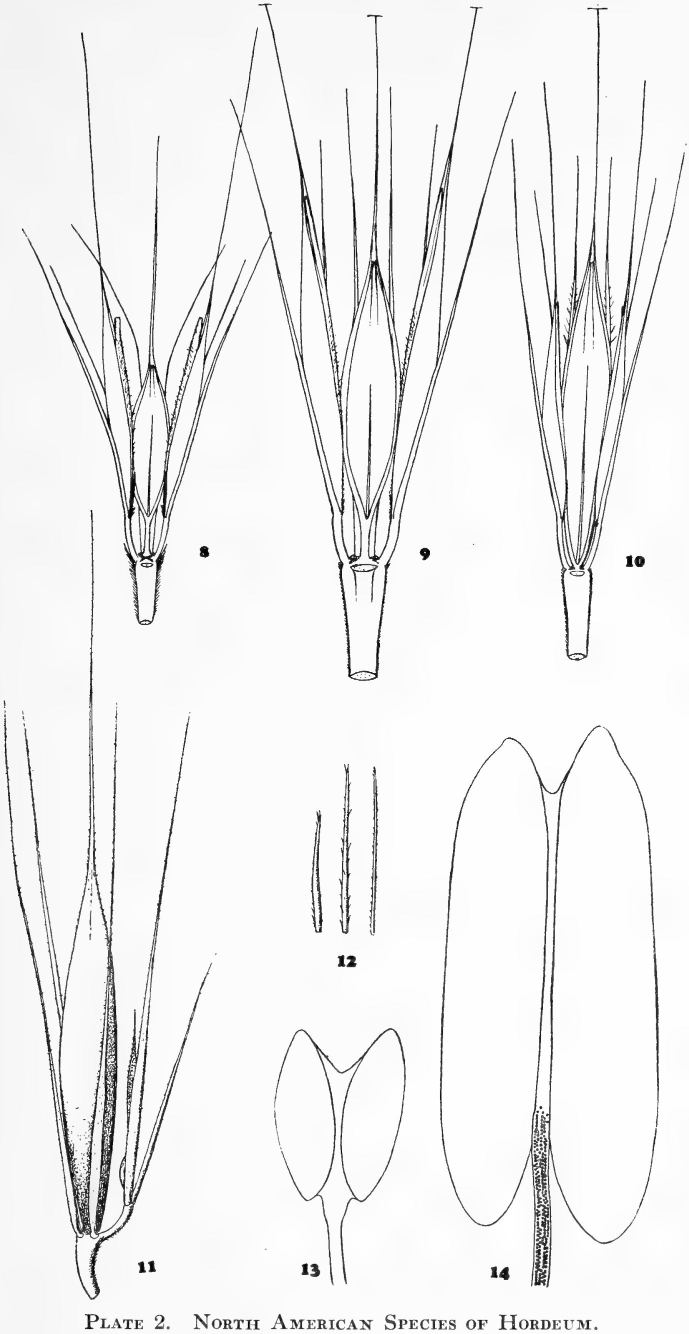

Plate 2. North American Species of Hordeum.

are conspicuous morphological differences and, conjecturally, there are no direct phylogenetic relationships between the two entities. *Hordeum brachyantherum* is closely related to *H. californicum* and sometimes it is difficult to separate the two species, while *H. nodosum* seems to be related to Asiatic species like *H. turkestanicum* Nevski and *H. Bogdani* Wilensky. The main morphological difference between *H. brachyantherum* and *H. nodosum* is found in the elongate epidermal cells of the leaf blade, which have straight walls in the first species and undulate walls in *H. nodosum.* This last character also was observed in *H. turkestanicum* Nevski, from central Asia, *H. stenostachys* Godron, of South America, and two apparently undescribed species from Argentina. For other differential characters see key and table 2. Specimens were seen from New Mexico, Arizona, California, Nevada, Utah, Colorado, Oregon, Idaho, Wyoming, Washington, Montana, British Columbia, Labrador, Newfoundland, Alaska, Aleutian Islands. To this species belong also the specimens from Mississippi: Starkville, *Tracy 279* (US) and from Maine: North Berwick, *Parlin 1556* (US). In these localities *H. brachyantherum* must be regarded as an introduced species.

3. Hordeum jubatum L. Sp. Pl. 85, 1753. "Habitat in Canada." *Critesion geniculatum* Raf. in Jour. Phys. 89: 103. 1819. *Critesion jubatum* (L.) Nevski in Komarov, Flora U.R.S.S. 2:721. 1934.

Nevski (l.c.) separates this species in the monotypic genus *Critesion* Raf. characterized by the very long, capillary, glumes and awns. It is not possible to support this segregation, for there are species and forms with glumes and awns of intermediate length between those of *H. jubatum* and the short awned species; such is the case of *H. comosum* Presl and *H. jubatum* L. var. *caespitosum* (Scribn.) Hitchcock. There are no other characters for separating the two genera.

On the basis of morphological characters, *H. jubatum* shows a close relationship with *H. comosum* Presl, a diploid species from the Andes of South America which is possibly one of the ancestors of *H. jubatum* (a tetraploid species); the other parent would be a species related to *H. californicum.*

3a. H. jubatum L. var. caespitosum (Scribn.) Hitchcock in Proc. Biol. Soc. Washington 41: 160. 1928. *H. caespitosum* Scribn. in Davenport Acad. Sci. Proc. 7: 245. 1899. Type locality: Geranium Park, Wyoming, ex Hitchcock 1935: 871. *H. adscendens* H.B.K., Nov. Gen. & Sp. 1: 180. 1816. Type locality: ". . . convalli Mexicana inter montem Chapultepec et Carpio."

This variety differs from the type only in having shorter awns and glumes (1.8–3.5 cm. long), but intermediate forms are found. According to the size of pollen grains and stomata, this form is also tetraploid.

The type of *H. adscendens* H.B.K. was not seen, but the specimens from central Mexico agree with the description of this species and are very similar to the forms growing in the central and western United States, which have been identified as *H. jubatum* var. *caespitosum*. *Hordeum adscendens* H.B.K. was described as an annual species; perhaps this statement is inaccurate, although it is possible that in arid regions the plants, potentially perennials, behave as annuals.

Hordeum jubatum var. *caespitosum* seems to be an entity intermediate between *H. jubatum* and *H. brachyantherum* and it is not improbable that this variety has evolved from the hybridization of these species, whose areas overlap in west and midwest United States and in Canada.

Representative specimens. MEXICO. Xochimilco, *Hitchcock* (US 1019072, pro parte); Rancho Posadas, prés de Puebla, *Nicholas* (US 566882), *Arsène 2285* (US), and *Nicholas* and *Arsène 76* (US); Prov. San Luis, *Virlet 1422* (US). UNITED STATES. NEW MEXICO. 2 miles east of Aragon, *Goddard 832* (UC). NEVADA. Washoe County: Sparks, *Kennedy 3055* (DS). COLORADO. Montrose County: Paradox, *Walker 195* (GH); Golden, *Jones* (DS 172272 and 163832). WYOMING. Bitter Creek, *Nelson 3692* (GH); Point of Rocks, *Merrill* and *Wilcox 19* (UC). WASHINGTON. Douglas County: Orondo to Waterville, *Benson 1605* (DS); without loc., *Sandberg* and *Leiberg 245* (DS, UC). MONTANA. Bozeman, *Blankinship 608a* (DS, UC).

4. **HORDEUM MARINUM** Huds. Fl. Angl. ed. 2, 1: 127, 1778. *H. maritimum* With. Bot. Arr. Veg. Brit. ed. 2, 1: 27, 1787.

This species and the following one, *H. Hystrix* Roth, are two closely related entities native to the Old World and naturalized in North America, although *H. Hystrix* is widespread while *H. marinum* was found only in eastern United States.

Specimen examined. NEW JERSEY. Camden, in ballast, *Scribner 776* (UC). This specimen was cited tacitly by Hitchcock (1935: 266).

5. **HORDEUM HYSTRIX** Roth, Catalecta bot. 1 :23. 1797. *H. Gussonianum* Parl. Fl. Paler. 1: 256. 1845. *H. maritimum* With. subsp. *Gussonianum* (Parl.) Asch. et Graeb. Synop. Mitteleurop. Fl. 2: 737. 1902.

This entity differs from *H. marinum* Huds. only in having the inner glumes of the lateral spikelets not broadened, but specimens with intermediate forms are sometimes found. Only cytogenetic evidence can decide whether the two entities are or are not conspecific.

6. **HORDEUM PUSILLUM** Nutt. Gen. Plant. 1: 87. 1818. "On the arid and saline plains of the Missouri."

Extremely variable species which grows from northern United States to central Argentina. A form growing in southwestern

California and northern Baja California is characterized by having a very broad rachis, the outer lateral glumes also broadened, glumes of the central spikelet narrower and culms with pubescent nodes. This probably is a different ecospecies. The size of the stomata and pollen grains indicates that, like the typical form, it has the diploid chromosome number. A representative specimen is: Baja California, 20 miles south of Tia Juana, *Wiggins 5130* (DS, UC).

One specimen (Arizona, near Granite Reef Dam, *Gillespie 55935* DS, UC), seems to correspond to a tetraploid form, on the basis of size of stomata and pollen grains.

A form with pubescent lemmas was described by Hitchcock as var. *pubens* (Jour. Wash. Acad. Sci. 23: 453. 1933).

7. **Hordeum depressum** Rydb. in Bull. Torrey Bot. Club, 36: 539. 1909. Based on *H. nodosum* L. var. *depressum* Scribn. & Smith in U. S. Div. Agrost. Bull. 4: 24. 1897. *H. Gussonianum* Hitchcock (1935: 266) non Parl., pro parte. Type locality: near Lexington, Oregon.

Hitchcock, in Jepson's "Manual of Flowering Plants of California" (1923: 106) considered this species to be a valid entity, but subsequently (1935: 266) included it in *H. Gussonianum* Parl. (*H. Hystrix* Roth). The two species are clearly different (see key) and, in addition, *H. depressum* is a tetraploid while *H. Hystrix* is diploid.

The chromosome complement of this species (pl. 1, fig. 7) shows one pair of chromosomes with small, spherical satellites and one pair with elongate satellites. The same pattern was observed in *H. brachyantherum.*

The morphological characters of *H. depressum* provide a good basis for the assumption that this species is an allopolyploid involving *H. californicum* and *H. pusillum,* or other species closely related to these (see table 3).

Several specimens from California, Mount Pinos region (*Dudley* and *Lamb, 4456, 4628, 4710,* DS) show characters intermediate between *H. californicum* and *H. depressum.* They are diploids, according to the size of stomata and pollen grains, have partially sterile pollen and apparently are annuals. Perhaps they have evolved from the cross of *H. californicum* and *H. pusillum* without further polyploidy.

Representative specimens. California. Orange County: Laguna Beach, *Munz 2192* (DS). Santa Barbara County: vicinity of Prisoner's Harbor, Santa Cruz Island, *Abrams* and *Wiggins 125* (DS, UC). Ventura County: 10 miles south of Oxnard, *Beetle 3076* (UC-D). Kern County: 6 miles east of Lost Hills, *Beetle 3265* (UC-D) San Luis Obispo County: 8 miles northwest of San Luis Obispo, *Wiggins 3597* (DS). Tulare County: near Earlimart, *Howell 24278* (CAS); near Terrabella, *Beetle 4236* (UC-D). Kings

Table 3. Differentiating Characteristics of Hordeum depressum, Hordeum arizonicum, and their Related Species

	H. californicum	*H. depressum*	*H. pusillum*	*H. arizonicum*	*H. jubatum*
Chromosome number (2n)	14	28	14	42 (?)	28
Habit	Perennial	Annual	Annual	Annual	Perennial
Ratio (length of glumes of central spikelet/length of palea)	1.5–2.5	1.2–2.0	1.2–1.7	2.5–3.5	5–12
Length of lemma of central spikelet, including awn (mm.)	12–22	10–18	10–15	26–32	40–80
Width of glumes (mm.) central	0.08–0.20	0.20–0.35	0.40–1.20	0.20–0.30	0.08–0.18
inner lateral	0.08–0.18	0.20–0.45	0.60–1.70	0.40–0.50	0.08–0.20
outer lateral	0.08–0.18	0.15–0.30	0.20–0.40	0.25	0.07–0.18
Pedicels of lateral spikelets	Usually straight	Usually straight	Curved	Curved	Curved
Lemma of lateral floret	Usually subulate	Acute, awnless	Acute, awnless	Acuminate, shortly pointed	Acuminate, shortly awned (2-6mm.)
Modal length of stomata (μ)	30–44	42–48	29–35	56–64	40–46
Modal diameter of pollen grains (μ)	32–36	43–50	33–36	60–68	42–48

County: 4 miles south of Armona, *Beetle 2972* (UC-D). Monterey County: Castroville, *Beetle 4375* (UC-D). Contra Costa County: near Concord, *Kennedy 4831* (UC-D). San Joaquin County: Durham Ferry Road, *Stanford 1260* (CAS). Yolo County: Woodland, *Beetle 4375* (UC-D). Lake County: 2½ miles northeast of Middletown, *Stebbins* and *Covas 3925* (UC). Colusa County: 4 miles east of Williams, *Ferris 518* (DS). OREGON. Morrow County: near Lexington, *Leiberg 39* (GH, UC), isotype of *H. nodosum* var. *depressum*. IDAHO. Nez Perce County: Lewiston, *Henderson 2845* (US); about Lewiston, *A. A.* and *E. G. Heller 3025* (UC). WASHINGTON, Kitsap County: Keyport, *Otis 1612* (DS). Whatcom County: Point Francis, *Muenscher 8980* (GH). BRITISH COLUMBIA. Vancouver Island: vicinity of Victoria, *Macoun 222* (GH).

8. **Hordeum arizonicum** Covas sp. nov. *H. adscendens* Hitchcock non H. B. K.

Annum; culmi erecti vel basi geniculati, 30–70 cm. alti. Folia glauca; vaginae inferiores pilosae vel ciliatae, superiores glabrae; ligula truncata 1–2.5 mm. longa; lamina 5–15 cm. longa, 3–6 mm. lata, subtus ciliato-scabra, supra pilosulo-scabra, basi exauriculata. Spica 6–12 cm. longa, 6.5–8 mm. lata aristis non computatis, articulis rachiae margine ciliatis. Terniorum spicula intermedia sessilis, 26–32 mm. longa aristis computatis; glumae lineari-subulatae, 22–26 mm. longae, 0.2–0.3 mm. latae, hispidulo-scabrae; glumella glabra, papulosa, in aristam 17–20 mm. longa attenuata. Spicula laterales pedicellatae, neutrae, pedicellis curvatus, 1–1.5 mm. longis; gluma interiore lineari-subulata, hispidulo-scabra, 19–25 mm. longa, 0.4–0.5 mm. lata, exteriore lineari-setacea, 0.25 mm. lata; glumella subulata, 6–7.5 mm. longa, in acumen capillare 1–2 mm. longum attenuata. Chromosomae 2n = 42 (?).

Annual with erect culms sometimes geniculate at base, 25–70 cm. tall. Leaves glaucous, the basal ones with hairy, sometimes ciliate sheaths; upper leaves with glabrous sheaths; auricles wanting or vestigial; ligule truncate, 1–2.5 mm. long; blade 5–15 cm. long, 3–6 mm. wide, shortly ciliate-scabrous on the nerves of under side and shortly pubescent-scabrous on the upper side; elongate epidermal cells of the leaf blade with straight walls. Spike 6–12 cm. long, 6.5–8 mm. wide excluding awns; rachis articulate, with almost rectangular segments 1.5–2 mm. long, 0.6–0.9 mm. wide, the margins shortly ciliate. Central spikelet sessile, 26–32 mm. long including awn; glumes linear-subulate, 22–26 mm. long, 0.2–0.3 mm. wide, conspicuously hispid-scabrous; lemma glabrous on the dorsal side, papillose, somewhat scabrous toward apex, tapering into an awn 17–20 mm. long; palea about 8 mm. long, papillose, scabrous toward apex and pubescent on the upper middle of ventral side; rachilla shortly hispid-scabrous, longer than the middle of palea. Lateral spikelets on curved pedicels 1–1.5 mm. long; inner glumes linear-subulate, very scabrous, 19–25 mm. long, 0.4–0.5 mm. wide; outer glumes linear-setaceous, about 0.25 mm. wide; lemmas subulate, 6–7.5 mm. long, with acuminate apex scarcely awned. Modal diameter of pollen grains 60–68μ. Modal length of stomata 58–64μ. Hexaploid (?)

Type. Fort Lowell, Arizona *J. J. Thornber 536* (US; isotypes, DS, UC).

Specimens examined. ARIZONA: Santa Cruz bottoms, *Griffiths 2709* (US) and *4063* (US). Phoenix, *Williams 3029* (US) and *Gould 3516* (UC). Sacaton, *Peebles* and *Harrison 1636* (US). West of Apache Junction, *Silveus 2672* (US). Mission Pool, Tucson, *Benson 9392* (DS, UC). Fort Lowell, *Thornber 404* and *538* (US). CALIFORNIA: United States Yuma Field Station, Bard, *Reeder 21* (US).

This new species was referred by Hitchcock (1935: 268) to *H. adscendens* H.B.K. which is a synonym of *H. jubatum* var. *caespitosum*; this variety differs from *H. arizonicum* in the perennial habit, the leaves scabrous, the glumes setaceous less than 0.2 mm. wide and in being a tetraploid, while *H. arizonicum,* according to the size of pollen grains and stomata, is a high polyploid, perhaps a hexaploid which probably has evolved from the cross of *H. jubatum* (tetraploid) and *H. pusillum* (diploid), as is suggested by the morphological characters (see table 3).

9. **Hordeum Stebbinsii** Covas, sp. nov. *H. murinum* auct. non L., pro parte. *H. murinum* L. var. *pedicellatum* Pau et Font Quer in Font Quer, Iter maroc. no. 96. 1927.

Annum; culmi erecti vel adscendentes, 10–50 cm. alti. Folia glauca; vaginae glabrae; ligula truncata 0.8–1.5 mm. longa; lamina sparse pilosa, 2.5–7 mm. lata, basi auriculata; auriculae 1–3 mm. longae. Spica ovato-oblonga, densissima, 4–9 cm. longa, 6–10 mm. lata aristis non computatis; articulis rachiae margine ciliatis. Terniorum spicula intermedia sessilis; glumae lineari-lanceolatae, scabrae, utrinque ciliatae, 12–22 mm. longae, 0.3–0.5 mm. latae; flosculo stipitato; glumella glabrae, in parte superiore scabra, in aristam 8–25 mm. longam acuminata; palea 5–9 mm. longa, lateralium ¾ partes aequans; antherae 0.2–0.5 mm. longae. Spicula laterales pedicellatae, neutrae vel masculae, gluma interiore lineari-lanceolata, scabrae, utrinque ciliatae, 0.3–0.5 mm. lata, exteriore lineari-subulata, 0.2–0.3 mm. lata; glumella in parte superiore scabra, in aristam acuminata, arista reliquas aristas superante; palea utrinque pilosa, 7–10 mm. longa. Chromosomae $n = 7$.

Annual, with erect or ascending culms, often pruinose, 10–50 cm. tall. Leaves glaucous with smooth sheaths; blades usually sparsely pubescent, 2.5–7 mm. wide, auriculate at base; auricles 1–3 mm. long; ligule truncate 0.8–1.5 mm. long. Spike ovate-oblong, 4–9 cm., 6–10 mm. wide excluding awns, very dense (6–8 spikelets per cm. of rachis), the apical spikelets with shorter awns than the central or basal ones; segments of rachis ciliate at margins; cilia 0.25–0.75 mm. long, gradually shorter toward the base of segments. Central spikelet 16–36 mm. long including awn, sessile; glumes linear-lanceolate, 3-nerved, 12–22 mm. long, 0.3–0.5 mm. wide, with long cilia on both margins; floret pedicelled, the pedicel 1.2–1.7 mm. long, as long as the pedicels of lateral spikelets; lemma glabrous, scabrous only on the nerves near apex, tapering into an awn 8–25 mm. long; palea 5–9 mm. long, glabrous inside, sparsely pubescent between the nerves outside, about ¾ times as long as the paleas of lateral florets; anthers very small, included at anthesis, 0.2–0.5 mm. long, with entire or shortly bilobed base; filament 0.7–0.9 mm. long, broadened at apex, without conspicuous starch grains; prolongation of rachilla setaceous, scabrous, 3–4 mm. long. Lateral spikelets on a slender pedicel 1.2–1.7 mm. long, ciliate inside; inner glumes linear-lanceolate, similar to the central ones; outer glumes linear-subulate, 0.2–0.3 mm. wide; florets usually neuter, sometimes staminate, more developed than the central fertile floret; lemmas scabrous toward apex, tapering into an awn longer than that of central lemma; palea ciliate-pubescent on both sides, scabrous on the nerves near the notched apex, 7–10 mm. long; stamens, when fertile, exserted at anthesis, with anthers somewhat larger than those of central floret; prolongation of rachilla subulate, stout, scabrous, 1.0–2.2 mm. long, usually orange colored at maturity. Modal diameter of pollen grains 33–38μ. Modal length of stomata 32–38μ. Chromosome number n = 7 (fig. 6).

Type. Roadside weed, 5 miles southeast of Middletown, Lake County, California, May 9, 1948, *G. L. Stebbins* and *G. Covas 3927* (UC 754601; isotypes, NY, GH, DS, UC-D).

Specimens examined Morocco. Marsa Saguira, *Font Quer 96* (UC), isotype of *H. murinum* var. *pedicellatum*. Egypt. Damietta, *Ehrhenberg* (UC 330933). Mexico. Baja California: San Antonio, *Brandegee 82* (UC). United States. Arizona. Tucson, *Thornber* (UC 33927); Wickenburg, *Jones* (UC 407728). Tempe, Maricopa County, *Gillespie 5589* (UC). California. San Diego County: Warner's Ranch, *Hall 6465* (UC); 3 miles west of Dulzura, *Wiggins 2191* (UC). Los Angeles County: Santa Catalina Island, *Brandegee* (UC 120595); San Clemente Island, *Munz 6620* (UC). Santa Barbara County: Santa Cruz Island, *Brandegee* (UC 185567). Riverside County: Thomas Ranch, *Hall 2176* (UC). Tulare County: Tulare, *Loughridge* (UC 38658). Monterey County: Capitola, *Stebbins 3941* (UC, GH, US); 11 miles west of Soledad, *Stebbins 3948* (UC, GH, UC-D, US). Fresno County: Pine Ridge, *Hall* and *Chandler 306* (UC). Stanislaus County: Adobe Valley, Mount Hamilton Range, *Sharsmith 3539* (UC). Lake County: 2½ miles northeast of Middletown, *Stebbins* and *Covas 3951* (UC, GH, NY, UC-D, US). Glenn

County: near Norman, *Burtt-Davy 4292* (UC). Nevada: between Glendale and Burkerville, *Maguire* and *Blood 1302* (UC). Argentina. Mendoza: Lujan, Potrerillos, *Semper 8242* (Leal); Las Heras, La Crucesita, *Semper 4160* (Leal); Godoy Cruz, *Ruiz Leal 3344* (Leal); Tunuyan, Real de las Cuevas, *Ruiz Leal 3186* (Leal). For this species only the material in the Herbarium of the University of California and in that of Mr. A. Ruiz Leal (Mendoza, Argentina) has been studied.

I am glad to give to this species the name of Dr. G. L. Stebbins Jr., who recognized diploid and tetraploid forms in the complex which comprised this new species and *H. leporinum* Link (see discussion on the following species).

TABLE 4. DIFFERENTIATING CHARACTERISTICS OF HORDEUM STEBBINSII, HORDEUM LEPORINUM, AND HORDEUM MURINUM

	H. Stebbinsii	*H. leporinum*	*H. murinum*
Chromosome number (2n)	14	28	14
Density of spike (spikelets per cm. of rachis)	6–8	3–5	3–6
Length of the cilia on the margins of the segments of the rachis (mm.)	0.25–0.75	0.10–0.30	0.10–0.30
Floret of the central spikelet	Pedicellate	Pedicellate, sometimes subsessile	Sessile or subsessile
Ratio (width of glume of central spikelet/width of inner glume of lateral spikelet)	1	1–1.3	1.4–2
Ratio (length of central palea/length of lateral paleas)	0.7–0.8	0.7–0.9	1.0–1.4
Anthers of central floret	Base entire or shortly bilobed; 0.2–0.5 mm. long	Base strongly bilobed; 0.8–1.5 mm. long	Base strongly bilobed; 0.7–1.0 mm. long
Filaments of stamens	Without starch grains	With starch grains	With starch grains[1]
Prolongation of rachilla of lateral spikelets	Stout, often orange-colored, 1.0–2.2 mm. long	Intermediate, 2.8–3.7 mm. long	Setaceous, not colored, 2.2–3.1 mm. long
Palea of lateral floret	Pubescent	Pubescent, sometimes glabrous toward apex	Almost glabrous

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[1] This character was observed also in *H. vulgare, H. bulbosum, H. marinum,* and *H. Hystrix.*

10. HORDEUM MURINUM L. Sp. Pl. 85. 1753. "Habitat in Europae locis ruderatis." *H. ciliatum* Gilib.?, Excert. Phyt. 2: 520. 1792.

This species, together with *H. leporinum* Link and *H. Stebbinsii* Covas, forms a complex which often has been classified as *H. murinum* L. Some authors recognized *H. leporinum* as a subspecies of *H. murinum,* while Nevski (1934: 726) and Parodi (1941: 9) give specific status to Link's entity.

Hordeum murinum seems to be a mesophytic species of cool-temperate regions while *H. Stebbinsii* is rather xerophytic, growing in warm-temperate regions. Both species are diploid and although they are closely related do not overlap in many of the differential characters. On the other hand, *H. leporinum* is a more vigorous species growing in intermediate habitats and with morphological characters which often overlap either those of *H. murinum* or *H. Stebbinsii* (see table 4). *H. leporinum,* being a tetraploid species, can then be regarded as an allopolyploid derived from *H. murinum* and *H. Stebbinsii,* which originated probably in the Mediterranean region, where the areas of the parental species come together.

Specimen examined. WASHINGTON. Clallam County: Dungeness, *W. C.* and *M. W. Muenscher 5658* (UC). Other specimens were seen from Europe. (For this species only the material in the Herbarium of the University of California has been studied.)

11. HORDEUM LEPORINUM Link in Linnaea 9: 133. 1835. "Frequens in Graecia." *H. murinum* L. subsp. *leporinum* (Link) Aschers. et Graebn. Synop. Mitteleurop. Fl. 2(1): 739. 1902. *H. ambiguum* Doell in Martius, Fl. Bras. 2(3): 231, t. 57. 1880.

The North American material classified as *H. murinum* L. is mostly *H. leporinum* Link. This species shows great variability, mainly in quantitative characters, but ordinarily it is not difficult to recognize *H. leporinum* and its two probable parents, *H. murinum* and *H. Stebbinsii.*

12. HORDEUM VULGARE L. Sp. Pl. 84. 1753.

The common barley (f. *hexastichon*) can be considered a naturalized species at least in certain districts of California, where it grows in almost pure stands on the roadside, mainly in slightly alkaline soils.

SPECIES EXCLUDED

HORDEUM NODOSUM L. Sp. Pl. ed. 2: 126. 1762, "Habitat in Italia, Anglia." *H. secalinum* Schreb., Spicil. Fl. Lips. 148. 1771. The North American specimens referred to this species are either *H. brachyantherum* Nevski or *H. californicum* Covas and Stebbins (see discussion on these species).

HORDEUM MONTANENSE Scribn. in Beal, Grasses N. Am. 2: 644, 1896. *Hordeum Pammeli* Scribn. & Ball, Iowa Geol. Surv. Suppl. Rep. 1903: 335, 1904. This entity is quite probably a sterile intergeneric hybrid involving *Hordeum jubatum* L. and *Elymus viriginicus* L. The material examined shows 100 per cent pollen sterility and no seeds or developing ovaries were found. Specimens examined. WYOMING. *Griffiths 930* (US). ILLINOIS. Stark County: 2½ miles north of Wady Petra, *Chase 1919* (US); *Chase 45* (US).

Also the following specimens are presumably intergeneric hybrids which have been given no taxonomic designation: OREGON. Hot lake, *Piper* (US 1107887), probably *H. jubatum* L. x *Elymus triticoides* Buckl. SOUTH DAKOTA. Brookings, *Jarvis* (US 730679), probably *H. jubatum* L. x *Elymus canadensis* L. NOVA SCOTIA. Colchester County: Lower Onslow, *Roland 41076* (GH), probably *H. jubatum* L. x *Elymus sp.*

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HEMIZONELLA BECOMES A MADIA

David D. Keck

Madia minima (A. Gray) Keck, comb. nov. *Hemizonia minima* A. Gray, Proc. Am. Acad. 6: 548. 1865. *H. parvula* A. Gray and *H. Durandi* A. Gray, *ibid.* 549. *Hemizonella minima* A. Gray, *H. parvula* A. Gray, and *H. Durandi* A. Gray, *op. cit.* 9: 189. 1874. *Harpaecarpus parvulus* Greene, Fl. Fran. 416. 1897. *H. minimus* Greene, *ibid.* 417. *Hemizonella minima* var. *parvula* Hall, Univ. Calif. Publ. Bot. 3:148. 1907. *Melampodium minimum* Jones and *M. Durandi* Jones, Contr. West. Bot. 15: 156. 1929.

This plant, commonly known as *Hemizonella minima,* is a *Madia* in habit, entire leaves, enveloping involucral bracts with villous-ciliate margin, corollas, and fertile striate epappose akenes. Although a few authors have put it in the genus Harpaecarpus with *H. exiguus* (Sm.) A. Gray [= *Madia exigua* (Sm.) A. Gray], to which it is most closely related, it has been usually excluded from association with that species because its akenes are obcompressed instead of laterally compressed as in other species of *Madia. Madia nutans* (Greene) Keck and other examples have already weakened the generic importance of this character. The chromosome number also points to the inclusion of the genus *Hemizonella* in *Madia,* for its single species has a somatic count of 32 chromosomes, the same number as is found in *Madia exigua* and closely related species in the section *Eumadia* but otherwise known from but one other species in the entire subtribe. As there are 7 different chromosome numbers among the 17 species of *Madia,* this fact assumes added significance.

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DOES PINUS PONDEROSA OCCUR IN BAJA CALIFORNIA?

John W. Duffield and W. C. Cumming

We recently had occasion to make a brief visit to the Sierra de San Pedro Martir, a range which rises above 10,000 feet in the Northern District of Baja California. Our principal object was to collect seed and botanical specimens of the conifers—particularly the pines—of this region. Having reviewed the literature on the pines of Baja California, we were prepared to encounter *Pinus ponderosa* in this region, and were particularly eager to add this material to the living collection of local races of *P. ponderosa* maintained by the Institute of Forest Genetics. Three days' travel through the Sierra de San Pedro Martir, and careful inspection of several localities which Martinez (1945) credits with *P. ponderosa* failed to reveal the occurrence of this species. All yellow pines found were quite clearly *P. Jeffreyi.*

In view of the disputed relationship of *P. Jeffreyi* to *P. ponderosa,* we believe that the evidence supporting our conclusion should be reviewed.

Goldman (1916) studied the yellow pines of the Sierra del Pinal and the Sierra de San Pedro Martir. In his words:

> "Having the somewhat uncertain status of *Jeffreyi* in mind, we were anxious to discover whether more than one pine of the *ponderosa* type occurs in these mountains. Cursory examination in the field seemed to show a wide range of variation irrespective of altitude and we came to no satisfactory conclusion, possibly because we were unaware of some of the distinguishing characters of the two forms. We found trees with large and with small cones standing in close proximity and by this character alone easily separable. But other trees were seen with cones so nearly intermediate in size that we abandoned this character as unreliable. A study of these pines may demonstrate the occurrence of two forms, as in southern California. Our specimens were referred to *Jeffreyi* by George R. Shaw."

Wiggins (1940) made a more intensive study of this problem, taking into account other characters which distinguish these two forms. His conclusions:

> "On the basis of field observations, comparison of herbarium specimens, and kodachrome slides it seems clear to me that the yellow pine of Baja California is *Pinus Jeffreyi.*"

Dr. Wiggins collected seed from the vicinity of Laguna Hanson, from the Sierra Juarez, and from La Grulla in the Sierra de San Pedro Martir and sent samples of these three lots to the Institute of Forest Genetics in order that seedlings might be raised for more intensive comparative study. These seedlings now have reached the age of nine years, and were recently examined by Dr. W. P. Stockwell and the writers. They show clearly four of the characters which distinguish *P. Jeffreyi* from *P. ponderosa,* namely glaucous shoots, non-resinous buds, lines of stomata which appear continuous because of waxy deposits between the stomatal openings, giving the foliage a bluish cast, and oleoresin which contains an aldehyde as shown by tests with Schiff's reagent (Mirov, 1942).

A study of yellow pine materials deposited in the University of California Herbarium at Berkeley reveals that all Baja California collections are of *P. Jeffreyi.* We feel that much of the current uncertainty as to the status of *P. Jeffreyi* may be attributed to the fact that this form is distinguished from *P. ponderosa* by many characters, most of which may not be observed to advantage in dried herbarium specimens. Without elaborating this point, we refer to the papers of Mirov (1929, 1942) and Bradshaw (1941), which list a number of these characters, and emphasize the variability exhibited by both forms in such commonly used characters as cone size and direction of cone-scale prickles.

With regard to Goldman's (1916) findings, two interpretations may be made. We may, in agreement with Goldman, dismiss cone size as a distinguishing character in view of the cones of intermediate size which one commonly finds. Some workers may, on the other hand, regard these intermediates as evidence of hybridization between two forms so incompletely isolated that a valid species distinction cannot be drawn between them. This view has been expressed by Dobzhansky (1947, p. 259). Our experience has been that trees with cones of intermediate size are almost without exception readily recognized as belonging to either *P. ponderosa* or *P. Jeffreyi,* but that recognition depends on characters other than cone size, most of them observed to best advantage on living trees. Therefore we are inclined to agree with Goldman and with Bradshaw (1941) as to the doubtful value of cone size by itself as a distinguishing character. The question of the validity of the species distinction between *P. ponderosa* and *P. Jeffreyi* must remain open until more evidence from distributional, genetic, and taxonomic studies has accumulated and been analyzed.

Sudworth (1908) gives Julian and San Luis Rey Canyon, San Diego County, California, as the southern limits of the occurrence of *P. ponderosa.* The authors, who have also studied the yellow pines of this area, believe that the evidence available supports this view, which is also corroborated by the vegetation type maps prepared under the direction of A. E. Wieslander of the California Forest and Range Experiment Station (Wieslander, 1935). Minor southward extensions of the range may be found, but it appears unlikely that *P. ponderosa* occurs in Baja California.

Institute of Forest Genetics, 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.

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SOME NOTES ON THE GENUS *GALVEZIA* DOMBEY, AND ON THE TAXONOMY OF *GALVEZIA JUNCEA* (BENTH.) BALL

Ira L. Wiggins

The genus *Galvezia* (Scrophulariaceae) was described by D. Dombey in Jussieu's Genera Plantarum (p. 119), using the spelling shown above. Jussieu accredited the genus to Dombey in the statement, "Caracter ex D. Dombey mss. & herb. Peruv." Subsequently, for more than a century, English and American botanists attributed the genus to Jussieu and spelled the name "*Galvesia*" instead of "*Galvezia.*" Kellogg (p. 17, 18) correctly, but contrary to common usage, followed the original spelling and gave Dombey as the author of the genus when comparing his *Saccularia Veatchii* with *Galvezia limensis.* Bentham, in De Candolle's Prodromus (p. 296), and Bentham and Hooker (p. 934) used the spelling "*Galvesia*" and attributed the genus to Jussieu. Both John Ball (pp. 152–154) and Asa Gray (1887, p. 311) followed Bentham and Hooker's lead, as did Brandegee (p. 167) and Goldman (p. 364) in using the letter "s" instead of "z" in spelling the generic name.

Standley (p. 1306) correctly attributed the genus to Dombey and used the original spelling. In the same year Johnston (pp. 1160, 1161) used both spellings, writing the generic name "*Galvezia*" on page 1160, but reverting to "*Galvesia*" four times in citing the two varieties and the synonyms accompanying them under *Galvezia juncea.* Two years later Munz (p. 373) used the spelling "*Galvesia.*"

There seems to be no basis for changing the spelling used by Dombey. Following the description in Jussieu's Genera Plantarum appears this sentence, "Nomen a D. Galvez in Hispania Indiarum administro." A check of G. & C. Merriam Company's "Webster's Biographical Dictionary" (p. 573) revealed the name "Galvez" listed five times, always spelled with a "z". There seems to be no possibility that the man whom the genus honored spelled his name "Galves."

In the International Rules of Botanical Nomenclature (Camp, Rickett and Weatherby, p. 26) Section 13, Article 70, reads as follows: "The original spelling of a name or epithet must be retained, except in the case of a typographic error, or of a clearly unintentional orthographic error." No typographic nor orthographic error occurred in the original publication of the name, so the correct orthography is "*Galvezia.*" The citation should read: *Galvezia* Dombey in Jussieu, Genera Plantarum 119. 1789.

Taxonomy of Galvezia juncea (Benth.) Ball

Bentham (p. 41) adequately described a plant collected some-where on the coast of Baja California by Hinds, and called it *Maurandia juncea.* The locality cited in the Botany of the Sulphur read, "From San Diego to the Bay of Magdalena." In the herbarium at Kew are two sheets of the species, both collected by Hinds (or under his direction, for Barclay did much of the actual collecting) and both of which I saw in 1937. Each bears about the same amount of material. The locality given on each label is the same as that cited by Bentham, "From San Diego to Bay of Magdalena." Unless Barclay's personal field notes, which are reputed to have been stored in the British Museum, but which I was unable to consult, yield a more definite station for his collections of *"Maurandia juncea"* I see no basis for assuming that the type locality is " . . . probably at San Quentin." (Munz, p. 377).

The specimens at Kew belong to that phase of *G. juncea* which is almost glabrous, the leaves, stems, pedicels, calyces and capsules being virtually devoid of hairs. On such plants a faint ring of short, fine hairs encircles the stem at each node, sometimes spreading to the upper surface of the basal part of the adjacent petioles.

In 1860 Kellogg (p. 17, 18) described *Saccularia Veatchii,* basing both the genus and the species on material collected on Cedros Island. He recognized the closeness of *Saccularia* to *Galvezia* but defended his stand in the following words: "This remarkable shrub appears to be closely allied to *Galvezia* of Dombey. As at present defined, it however differs in the style, not being thickened at the top, nor emarginate; neither is the stigma two-lobed. Other points of difference of less importance readily suggest themselves, which must be our apology for distinguishing it from that Peruvian genus."

Kellogg described *Saccularia Veatchii* as having stems ". . . glandularly villous and somewhat canescent above . . ." and the leaves as ". . . lanceolate . . . hirsute above the base, glandularly villous on the lamina above, densely glandularly hirsute below; . . .". On the basis of the presence or absence of pubescence, a comparison of Bentham's and Kellogg's descriptions could easily lead one to consider their plants as two distinct, although closely related, species. For a few years they were considered so.

Possibly following a suggestion made by Bentham when he described the species, Asa Gray (1867, p. 377) transferred *Maurandia juncea* to *Antirrhinum* without having seen specimens of the plant from Baja California. He defended his action in the following manner: "I have not seen this; but it seems to be a cogener of the last [*Antirrhinum*] but with smaller flowers and leaves, the uppermost reduced to minute scales. The seeds as described are those of *Antirrhinastrum.*" This combination stood for eighteen years.

The combination *Galvezia juncea* has generally been attributed to Asa Gray on the basis of a paper published in 1887 (p. 311). This, of course, is in error, for John Ball read a paper before the Linnean Society on February 18, 1886 (published April 14, 1886), in which he made the combination (Ball, p. 154). In his paper Ball discussed the relationship between *Galvezia* and *Antirrhinum* and inclined toward following Gray's decision of 1868, namely, to unite the former genus with *Antirrhinum.* But between February 18th and the closing of the printer's forms, Ball received a letter from Gray on which he commented as follows in a terminal note: "Since the above lines were written I have been informed by Dr. Gray that, in the forthcoming Supplement to the American Gamopetalae described in his 'Synoptical Flora,' he has identified Kellogg's *Saccularia* with his own *Antirrhinum junceum,* thus confirming my conjecture on this score. But he further informs me that on examining the living plant of *Gambelia speciosa,* Nutt., hitherto known only from dried specimens, he has found that the projecting palate closes the mouth of the corolla, as in true *Antirrhina;* while it would appear as well from Kellogg's figure as from the dried specimen that the lower lip of *A. junceum,* A. Gr., is nearly or quite plane, as in *Galvesia.* This being the case, it would appear that, although *Galvesia* is nearly allied to some American species of *Antirrhinum,* it may be retained as a separate genus including *G. limensis* and *G. juncea,* the synonomy for the latter being *Maurandia juncea,* Benth. in Bot. Sulph., *Antirrhinum junceum,* A. Gr., and *Saccularia Veatchii,* Kell." (Ball, p. 154).

It seems strange that an error in citing the authority for the combination, *G. juncea,* should have persisted so long, for Dr. Gray himself indicated that Ball had recognized the generic position of *Antirrhinum junceum* (Benth.) A. Gray, when he, Gray, wrote (1887, p. 311), "Excellent specimens, in flower and fruit, have recently been collected by Mr. Orcutt in Lower California where it (*G. juncea*) appears to abound. *As Mr. Ball has indicated* (Jour. Linn. Soc. XXII. 152), *this is a strict cogener* of *Galvesia limensis; . . .*". (Italics, save those of the binominal, mine.) Perhaps the suppression of Ball's name in connection with the combination stems from the fact that Gray placed no author's name immediately after the combination in his paper in 1887. Since Gray was reporting on a number of new species and new combinations, it would have been easy for other botanists to overlook Ball's transfer—and they obviously did so.

There is no doubt that Ball's paper was published several months ahead of Gray's. Although the exact date of publication of Gray's paper is not available, it was not published until sometime in 1887, for directly under the "by line" of Gray's paper as published in the Proceedings of the American Academy, appears the statement, "Communicated December 8, 1886." The date on the title page of that volume is 1887. On the other hand, on the fly leaf of the 22nd volume of the Journal of the Linnean Society is a printed table giving the dates of publication for the various parts included in the volume. "Number 142", the second part of volume 22, included pages 99–168, and was published April 14, 1886. Mr. Ball's paper included pages 137–168. Accordingly, the citation for this species should read: *Galvezia juncea* (Benth.) Ball, Jour. Linn. Soc. 22: 154. 1886.

As mentioned in an earlier paragraph, Bentham described *Maurandia juncea* as glabrous, and Kellogg emphasized the glandular-pubescent character of *Saccularia Veatchii.* Yet Asa Gray (1887, p. 311) apparently had no hesitation about placing the pubescent material from Cedros Island in the same species with the glabrous plants from the mainland of Baja California. I concur in this interpretation, for although the majority of the specimens in the Dudley Herbarium are glabrous except for the faint ring of hairs at the nodes there are some that are uniformly glandular-puberulent on the younger parts. There is one collection taken fourteen miles north of Cataviñá (*Wiggins 4386*), in which the main stems and some of the lateral branches are densely glandular-puberulent, but several other lateral branches, arising from the same nodes as the puberulent ones, are completely glabrous except for the nodal rings! In this specimen the puberulent branchlets seem to have grown slowly, the glabrous ones more rapidly.

Brandegee (p. 167) described *Galvezia glabrata,* which he separated from *G. juncea* on the basis of minute differences (not constant) in the flowers; nearly globose instead of ovoid capsules, and these somewhat pendant instead of erect; and on the larger size of the leaves, these being as much as 3 cm. long in his proposed new species. On the same page he described *G. speciosa* var. *pubescens,* separating it from typical *G. speciosa* (Nutt.) A. Gray, because var. *pubescens* was "hirsute pubescent throughout" instead of glabrous or hirsute-pubescent merely on the flowering parts of the plant.

When Johnston (p. 1160, 1161) reported on his collections from the Gulf of California he reduced *G. glabrata* Brandegee to varietal rank under *G. juncea,* supplanting the epithet *"glabrata"* with *"foliosa."* At the same time he transferred var. *pubescens* from *G. speciosa* to varietal rank under *G. juncea,* making it coordinate with his var. *foliosa.* In remarking about several collections of var. *pubescens* Johnston wrote, "The specimens from Angel de la Guardia present one of those sad cases where two forms grow from one root, for part of the plant, the most in fact, has the characters of the variety *pubescens* while certain branches and leaves are typical of the variety *foliosa.*" This parallels the condition found in *G. juncea* var. *typica* as represented by my collection from Cataviñá.

Munz (p. 377, 378) recognized both var. *pubescens* and var. *foliosa,* but apparently with some reluctance for under var. *pubescens* he commented as follows: "Intergrading with var. *foliosa, Rose 16370* having both sorts on one branch."

Since both glabrous and pubescent twigs, characteristic of var. *pubescens* and the var. *foliosa,* occur on a single plant, the presence or absence of pubescence is worthless for separating varieties in *Galvezia juncea.* The differences in size of leaves and in the shape of the capsule can be utilized to separate the large-leaved variant from var. *typica,* which has smaller leaves and longer, narrower capsules. Both the large- and the small-leaved forms are found with and without pubescence.

In recognizing his varieties *"foliosa"* and *"pubescens"* Johnston discarded the specific epithet *"glabrata"* and substituted the varietal name *"foliosa".* But var. *pubescens* and var. *foliosa,* as Johnston treated them, are one and the same thing, so the first epithet applied in the varietal category, *"pubescens"* must be used under the present rules, even though the epithet *"foliosa"* more appropriately describes one of the salient features of the variety which is separable from var. *typica.*

The following key, together with the citation of references, present a taxonomic resume of *Galvezia juncea* (Benth.) Ball, and the two varieties into which the species seems separable.

Leaves small, usually considerably less than 1 cm. long; capsules ovoid to oblong. la. *G. juncea* var. *typica.*

Leaves larger, usually 1–2.5 cm. long; capsules broadly ovoid to subglobose. lb. *G. juncea* var. *pubescens.*

Galvezia juncea (Benth.) Ball, Journ. Linn. Soc. 22: 154. 1886. *Maurandia juncea* Benth. Bot. Sulphur 41. 1844. *Saccularia Veatchii* Kell. Proc. Calif. Acad. 2: 17. 1860. *Antirrhinum junceum* A. Gray, Proc. Am. Acad. 7: 377. 1868.

Confined to the peninsula of Baja California and adjacent islands along both the Pacific and the Gulf of California coasts.

la. Galvezia juncea (Benth.) Ball, var. typica Munz, Proc. Calif. Acad. IV. 15: 376. 1926.

Along arroyos, on hillsides, and occasionally on the plains, chiefly Lower Sonoran Zone, from about half way between Tijuana and Ensenada southward to the Cape Region and on the adjacent islands. Less common in the Cape Region than the following.

lb. Galvezia juncea (Benth.) Ball, var. pubescens (Brandegee) I. M. Johnston, Proc. Calif. Acad. IV. 12: 1161. 1924. *G. speciosa* var. *pubescens* Brandegee, Zoe 5: 167. 1903. *G. glabrata* Brandegee, *loc. cit.* *G. rupicola* Brandegee, Univ. Calif. Pub. Bot. 6: 360. 1916. *G. juncea* var. *foliosa* I. M. Johnston, Proc. Calif. Acad. IV. 12: 1161. 1924.

Rocky hillsides and along arroyos, Lower Sonoran Zone, Rancho Mesquital southward to the Cape Region and on San Lorenzo and San Pedro Nolasco islands in the Gulf of California.

Dudley Herbarium
Stanford University

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REVIEW

Hepaticae of North America. Part V. By T. C. Frye and Lois Clark. University of Washington Publications in Biology, vol. 6, no. 5. pp. 735–1022, text figs. 94. 1947. $4.50. University of Washington Press, Seattle.

With the appearance of Part V of the "Hepaticae of North America" by Frye and Clark, we have available for the first time in this country a reference work treating all of our liverworts. This final part includes the Frullanioideae, the Lejeunoideae, and the Anthocerotales. The interest of the authors in the first group is evident; the work of Evans underlies the treatment of the

Lejeunoideae; that of Howe was largely relied upon for the Anthocerotales.

In this final part, also, are all of the "extras" that have been referred to from time to time in the earlier numbers of the work. First, are the "Additions" composed of 6 entities that had been omitted previously. The "List of References" contains nearly 600 entries, a sizeable contribution in itself. A short list of "Abbreviations" is included to serve as a key to the citations for those unfamiliar with our geography. As for the "Corrections," one cannot help but wish that they had been printed on only one side of the page so that they could be cut and pasted in place. One of the main contributions in this part is the "Explanation of scientific terms used in descriptions." The 17 pages of this glossary are prefaced by a few well-chosen remarks on the nuisance-value of certain terms that have been in common use—especially diminutives. In the preparation of this glossary, the use of scientific terms as applied to Hepaticae was kept in mind; it is not a mere compilation from other works. Its value is further enhanced by the inclusion of the Latin and Greek words from which the scientific terms have been derived. The volume is concluded with two indices, one to "Synonyms" and one to "Accepted Names." Although more than one index is usually bothersome, in this case it considerably simplifies finding a name in one category or the other and it eliminates the need for setting up the index with two type faces.

The "Hepaticae of North America" is much more than a mere "flora" of the region covered. In addition to detailed descriptions and illustrations of many of the plants treated, the relationships and the developmental trends in many genera are discussed as well as the characters that are used in the keys. Also, discussion of the evidence for placing certain of the entities in synonymy is included. For many groups there are two keys—one for sterile material, the other for specimens bearing mature perianths. One misses in Part V the comparative charts that were included for a number of groups in the first four parts. But, altogether, this is a reference work that will serve to point the way to research in many groups and that will prove invaluable to future students of Hepaticae. The authors deserve hearty congratulations on its completion.—ANNETTA CARTER, Department of Botany, University of California, Berkeley.

NOTES AND NEWS

NATURAL ESTABLISHMENT OF EUCALYPTUS IN CALIFORNIA. Giant eucalyptus trees which dominate the view in much of California formerly were planted as a potential source of hardwood. Now they are chiefly used as wind-breaks, or as roadside plantings, or for landscaping. Their distribution is restricted largely by their susceptibility to freezing (Munns, E. N. Relative frost resistance of Eucalyptus in southern California. Jour. Forestry 16: 412–428. 1918) or by rainfall, and is approximately co-extensive with that of the native live oak in the north, or with the citrus growing areas in the south.

The opinion is sometimes expressed that the eucalyptus has not adapted itself to self-propagation in this region. Observation of *Eucalyptus globulus* in various parts of California, however, shows that in several areas seedlings are present. One grove studied in particular is that in the arboretum on the Stanford University campus. Here, among rather sparsely planted, unattended trees, there is an undergrowth of eucalyptus saplings ranging up to a few meters in height.

Upon examination of the root systems of the saplings it was evident that they were actually seedlings and not adventitious shoots from the root systems of older trees. Further evidence of the seedling nature of the young plants was the fact that six seedlings which were at least two years old were found growing as epiphytes in leaf bases of palms approximately two meters above the ground. In this grove, seepage from an irrigation ditch prolonged the seasonal water supply, while in adjacent drier areas no seedlings were encountered.

Established seedlings have been noted elsewhere in California: in unused fields adjacent to planted groves at Salinas; in a wind-break off of United States Highway 101 at Beresford; along the Bay Shore Highway opposite Burlingame; on hillsides in Marin County; and growing up within Mesembryanthemum plantings in the Presidio, San Francisco. In all of these areas natural conditions of humidity and of drainage favor the establishment of seedlings. Even in southern California where the trees are commonly considered not to be self-propagating, occasional seedlings are found. Charles L. Schneider, College of Medicine, Wayne University, Detroit, Michigan.

Dr. Adriance Foster, Professor of Botany, University of California, and retiring President of the California Botanical Society, returned to Berkeley early in January after carrying on research at the Instituto Agronomico do Norte, Belém, Pará, Brasil, since early in September. Recipient of a Guggenheim Fellowship, Dr. Foster was making anatomical-morphological studies of leaves of the Quiinaceae, and of *Mouriria* and various other genera. In addition, he made several collecting trips in remote parts of Pará and visited Rio de Janeiro and the celebrated Jardin Botanica.

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A WEST AMERICAN JOURNAL OF BOTANY

Contents

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LAMBERT'S "DESCRIPTION OF THE GENUS PINUS," 1832 EDITION

Elbert L. Little, Jr.

Aylmer Bourke Lambert's classic work on conifers, "A Description of the Genus Pinus," with large, natural-size, hand-colored plates, was issued in five editions over a period of years from 1803 to 1842. The irregular contents, including differences among editions and great variation among copies of the same edition, which have been a source of confusion to later authors, have been described in detail by Renkema (19) and by Renkema and Ardagh (20). My note (16, p. 587–588) called attention again to the names of conifers published in the extra, unnumbered pages of some copies of volume 2 of the third or 1832 edition, or "editio minor," an octavo edition in two volumes (13).

Keck (12) has reported two copies of this 1832 edition, at Stanford University and the University of California, which contain among the extra pages the text descriptions and colored plates of two names not previously noted in this edition. The Stanford copy has nine more extra plates without text and five unlabeled colored drawings. On the basis of these two copies, Keck changed the citation of *Pinus Coulteri* D. Don to this edition (previously dated from D. Don, Linn. Soc. London Trans. 17: 440. 1836). For the bristlecone fir, or "Santa Lucia fir," he replaced *Abies venusta* (Dougl.) K. Koch with *A. bracteata* (D. Don) Nutt., based upon *Pinus bracteata* D. Don in this edition. He suggested also that possibly *Abies Smithiana, Pinus Llaveana,* and *Taxus Harringtonia* were properly published by Lambert in this Stanford copy under Article 44 of the International Rules (Ed. 3. 1935).

As it seemed unlikely that the two copies described by Keck could have been published in 1832, a reexamination of this edition has been made to determine the dates of the extra pages. Very few nomenclatural changes are involved, as most names here also have priority from publication elsewhere and appeared again in the folio volume 3 of 1837.

Summary of the Five Editions

A brief summary of the five editions of Lambert's work, condensed from Renkema and Ardagh (20) and showing the relationships of the 1832 edition, is given below. The different editions are not designated by number on the title pages and have not been counted uniformly by later authors. Botanists have cited only the first three editions, as the last two contain no new names. After the first folio volume, all descriptions were by David Don, according to statements in the prefaces. He should be cited as the

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Madroño, Vol. 10, No. 1, pp. 1–32, February 8, 1949.

author of the new names published in volume 2 (1824) and later editions.

Edition 1, folio. Volume 1, 1803. The appendix was published probably in 1807, according to watermark dates of the paper and other records. Volume 2, 1824.

Edition 2, folio. Volumes 1 and 2, 1828. Volume 3, 1837. Volume 3 is cited by some authors as a part of the first edition, which it completed also. A few copies of volume 3 apparently completed the third edition too.

Edition 3, octavo, or "editio minor." Two volumes, 1832. Some copies of volume 2 have 10 to 22 extra pages inserted between pages 144 and 145. By some authors called the second edition.

Edition 4, folio. Three volumes, 1837, according to title pages but dated by watermarks as 1837–42. Essentially a reprint of the second edition.

Edition 5, octavo. Two volumes, 1842. The text forms volume 1, octavo, and the plates form volume 2, folio. A reissue of the 1832 edition with 30 extra pages between pages 144 and 145 and with the plates in a separate volume of larger size.

The great variation in contents among different copies of the same edition, which Renkema and Ardagh reported at length, need not be emphasized again here. They noted (20, p. 441) that each issue of the work appeared to be made up, with many irregularities, from the material available, at the time, to the publishers. Some volumes do not have tables of contents nor numbered plates. In contrast with scientific books of larger circulation, this publication was an expensive work of art with large, natural-size engravings colored individually by hand and was issued in rather small editions to wealthy subscribers. A few plates were lithographed. Renkema and Ardagh did not state the number of copies of each edition but quoted (20, p. 443, 466) notes about the 25 original colored copies of the first folio volume of 1803, which sold for 40 guineas (about $200) each, and uncolored copies (150?) for 10 guineas (about $50) each. Apparently a few copies of the later volumes were assembled individually for or by the purchasers.

Several copies contain unprinted material, including original drawings, and plates from published works by other authors. For example, Renkema and Aradagh (20, p. 447) noted that the Kew copy of the 1832 edition has some letters from George Bennett to Lambert inserted. I have examined the Arnold Arboretum copy of the 1842 edition, which as they reported (20, p. 449; also Cat. Libr. Arnold Arboretum 1: 409. 1914), has five inserted or added original drawings and one inserted plate of *Pinus Lemoniana* Benth. (a synonym of *P. Pinaster* Ait.) from another work (Hort. Soc. London Trans., ser. 2, v. 1, pl. 20. 1835).

There are also "mixed" copies assembed from parts of two editions. A folio at the Linnean Society, according to Renkema and Ardagh (20, p. 463–464), was made up of plates from volume 2, 1824, and both volumes 1 and 2, 1828. I have checked the irregular copy of folio volume 2 at the Arnold Arboretum, which is a mixture of the 1824 and 1828 editions (20, p. 444), with both prefaces but title page dated 1824.

Contents of the 1832 Edition

The 2-volume octavo edition of 1832, according to Loudon (18, 1: 188), was published "in conformity with the spirit of the times" at a reduced price of 12 pounds, 12 shillings (afterwards cut to 8 pounds, 8 shillings). Renkema (19, p. 13) quoted similar current prices from book auctions. More copies of this cheaper and possibly larger edition have come to libraries in the United States than have copies of the more expensive folios.

Several additional species not appearing in the earlier folio editions but repeated in the folio volume 3 of 1837 were included among the numbered pages of the 1832 edition. Volume 1 of the 1832 edition had a new species, ***Pinus sinensis*** D. Don, now combined with ***P. Massoniana*** Lamb. (1803), and four Mexican pines, including three recently described and one as a new name. References to a publication of 1830 were cited under ***Pinus Teocote*** Schiede & Deppe (Linnaea 5: 76. 1830) and under ***P. Montezumae*** D. Don, proposed here as a new name for ***P. occidentalis*** H. B. K. and Schiede & Deppe (Linnaea 5: 76. 1830), not Swartz. ***Pinus patula*** and ***P. leiophylla*** (Linnaea 6: 354. 1831) were cited as "Schiede & Deppe MSS," as an indication that the published article of 1831 was not available at the time of writing.

Renkema and Ardagh (20, p. 447) noted that the unnumbered plates varied greatly in different copies of the 1832 edition and cited copies with 72, 75, 76, 81, 85, 103, 107, and 111 plates. They stated (p. 448) that the plates were re-engravings of parts of the original ones or reductions from them with the folio plates folded or closely trimmed. Renkema (19) also published a photograph illustrating a folded and cut plate. Some copies, such as those at Kew, New York Botanical Garden, and University of California, are the size of folios, composed of the folio plates and the text inlaid, two copies of the text pages being pasted on larger blank sheets.

Between the last page of sheet K 2 (p. 144) and the first one of sheet L 2 (p. 145) there is an unnumbered sheet which apparently did not form part of the original work (20, p. 448). Copies vary greatly in the number of extra pages, from 10 to 22 or none, and in their order. The several species of ***Pinus*** described on the unnumbered, extra pages are not listed in the 4-page synoptical table of species at the end of the volume (p. [185–188]) but are in the nature of appendices which may be taken as "fore-runners" of folio volume 3 of 1837 (20, p. 447). The descriptive and illustrated text ends with page 144, and pages 145–183 are supplementary articles and letters by other persons. Thus, the natural place for insertion of additional species is after page 144, rather than after the unrelated articles of the appendix.

The contents of the extra pages, including plates and drawings, of nine copies in the United States and of this edition as listed by Renkema and Ardagh (20, p. 456–458) are summarized in Table 1, followed by further notes on each book examined. Renkema (19, p. 25) listed also an unnumbered plate of *Pinus nobilis.* My previous note (16, p. 587–588) was based upon four copies. Now I have examined four more and a microfilm reproduction of the extra pages of the Stanford University copy. Two others have been checked for me. With one exception all nine copies with extra pages are different. It would be interesting to know if other libraries possess copies with further variations and additions of possible significance in nomenclature.

New York Public Library. This is the only copy without extra pages which I have seen.

Massachusetts Horticultural Society. According to the published library catalog, this copy, which I have not examined, has in the two volumes 70 plates, 69 colored and the portrait, and therefore no extra plates nor pages. Miss Dorothy S. Mauks, librarian, reports that the copy evidently is not complete.

Academy of Natural Sciences of Philadelphia. Two of the ten extra pages, on *Pinus dumosa* and *P. Douglasii,* were inserted in proper order between pages 82 and 83, after the same species, *P. dumosa* and *P. taxifolia.* The eight extra pages of notes are absent.

New York Botanical Garden. Owned by Columbia University, this copy with 14 extra pages is a folio with pages 37.5 by 27 cm. Mrs. Elsie Phillips kindly has furnished a list of the extra pages and plates. One extra page on the topic, "Observations on the coniferous trees of New Zealand," is lacking.

Gray Herbarium. Among the regular plates in both volumes are three legible watermark dates of 1829 as well as cut dates of possibly the preceding and following years. The back sheet of the plate of *Pinus Sabiniana* bears the watermark date 1831.

Library of Congress. This rebound copy, 28.5 by 18.5 cm., has pages 27.3 by 17.5 cm. The watermarks in both volumes are 1828 and 1829, with the back sheet of the extra plate of *Pinus nobilis* dated 1833. This copy differs from the Gray Herbarium copy only in the order of two pages.

Rancho Santa Ana Botanic Garden. The number and arrangement of the extra plates is the same as in the copy at Library of Congress. Dr. P. A. Munz has checked this copy for me.

Arnold Arboretum. The dark green binding perhaps is the original, except for a new cloth strip on the back. The only watermark dates found, all in the regular plates, were 1828 and 1829.

Boston Public Library. This copy, apparently in its original dark green binding in part leather, has pages 26.5 by 19.5 cm. and is catalogued as quarto. The wide inner margin of nearly 5 cm. on the text pages was made possible by the use of two sets of text sheets. Some plates are lithographed, not engraved, and for plate 65, *Cupressus lusitanica,* an original drawing has been substituted. The original drawings are on double thicknesses of paper, and the back sheets of a few are portions of discarded plates with the plate concealed inside. The plate of *Pinus Coulteri* is taken from Forbes, Pinetum Woburnense (1839).

University of California. Lent for my examination through an interlibrary loan, this copy is a folio with pages 37 by 27 cm., bound in modern green buckram. Volume 2 begins with *Pinus microcarpa,* page 88, instead of *P. Webbiana,* page 77, as in the usual arrangement. Backing sheets of three regular plates of volume 2 bear watermark dates of 1836. Another watermark probably is 1835, and a flyleaf is watermarked 1837. Plate 65, *Cupressus lusitanica,* is lithographed. The drawing of *Pinus Menziesii,* on thinner paper of a different kind, was not fastened to the binding but obviously was pasted in later. This copy has more watermark dates on the extra plates than any other examined, five of 1836 and one of 1835.

Stanford University. I am greatly indebted to Dr. Ira L. Wiggins for a microfilm negative of the pages and plates between pages 144 and 145 of this copy, as well as notes on watermarks and plate numbers. Dr. David D. Keck kindly has furnished information about the plates and watermarks of this copy also. Watermark dates of 1823, 1833, 1838, and 1839 are found in the regular plates. Among the extra plates, two have watermark dates of 1838 and one of 1839. As summarized in Table 1, 11 of the 14 extra plates in this volume are taken from Forbes, Pinetum Woburnense (1839). In addition to 8 plates without text, 3 plates inserted to acompany Lambert's text are also from Forbes: *Pinus Gerardiana, P. monticola,* and *P. Coulteri.*

In comparison, the fifth edition, published in 1842, is a reissue of the 1832 edition but with the number of extra pages increased to 30. As noted by Renkema and Ardagh (20, p. 449–450), the date on the title page was changed, the synoptical table of species was placed after the preface instead of at the end and was followed by a new table of the species and articles of the appendix. The text pages of the Arnold Arboretum copy, which I examined, appear identical with those of the 1832 edition except for pages 81 and 82, where the almost identical extra pages on *Pinus dumosa* and *Pinus Douglasii* have been substituted and glued in. The 14 species described and illustrated in the extra pages had appeared in the folio volume 3 of 1837 and included those in the extra pages of the 1832 edition. Thus, by means of the extra pages the two-volume octavo edition now was expanded to duplicate the third folio volume as well as the first two.

Names in the Extra Pages

That the names in the extra pages of the octavo edition were first published there was suggested to me by a bibliographic manuscript on Lambert's work by Marjorie F. Warner in the Library of the Department of Agriculture, Washington, D. C. My note (16, p. 587–588) accepting these names as of 1832 mentioned contemporary and recent authors citing these extra pages. These contemporary works included Lindley (15), Lawson (14), Loudon (18), Forbes (7), and Hooker (10). Antoine (1) also cited this edition for *Pinus Gerardiana* (p. 29), *P. Sabiniana* (p. 30), and *P. nobilis* (p. 77).

That certain volumes or parts of Lambert's work were issued after the dates on the title pages was demonstrated by Renkema and Ardagh on the evidence of watermark dates in the paper, contemporary publications, and bibliographic sources. In the absence of proof to the contrary, the date on the title page must be accepted (International Rules, Article 45). The manufacturer's watermark dates in the paper, where present, establish the earliest year in which a volume could have been issued. By watermarks with other records the appendix of volume 1 was dated as 1807 and the fourth edition as 1837–42 [Renkema and Ardagh 20, p. 442 and 449; also Cat. Books Brit. Mus. (Nat. Hist.) 3: 1050. 1910]. I have applied the same method in dating copies of the 1832 edition, which has no watermarks on the text sheets but has a few, often partly cut, watermark dates on the reduced or trimmed plates or on additional sheets forming backs of plates. As summarized in Table 1, four copies bear watermark dates after 1832, one in 1833 and the others in 1837, 1838, and 1839. Most watermarks bear the name "J. WHATMAN."

According to evidence from contemporary works, probably most copies which have extra pages with the first six new species were published within a short time after copies without extra pages. Nine of the eleven copies examined contain a minimum of ten extra pages, and Renkema and Ardagh (20, p. 447–448) cited several copies with extra plates. The fact that most species in the extra pages are without plates, while each species in the folio volume 3 of 1837 is illustrated, suggests publication before 1837.

The content of the extra pages offers some evidence on the dates. Two extra pages, apparently the first, were intended as substitutions, not new species. On one extra page *Pinus Douglasii*

Sabine was adopted as a new name for *P. taxifolia* Lamb. (Descr. Genus Pinus 1: 51, pl. 33. 1803), Douglas-fir, of page 82, with a text reference to an extra, though absent, numbered plate (pl. 78). The back of this sheet was a substitute page of notes about *Pinus dumosa* D. Don (Descr. Genus Pinus 2: 7. 1824; not seen), of pages 80–81. The content of the extra page was the same as that of page 81, but the typography differed. *Pinus Gerardiana* (pl. 79) and *P. Sabiniana* (pl. 80) apparently were the first added species as they were the only inserted species with numbered plates and with plates uniformly present. The other four new species were without references to plates, which were lacking in most copies. *Pinus Menziesii* had no illustration, exclusive of drawings, in any copy examined.

David Don published in the extra pages these five new species with authorship *"Douglas. MSS.": Pinus Sabiniana, P. monticola, P. nobilis, P. grandis,* and *P. Menziesii.* Under the first he explained:

> "Mr. Douglas has named the species in compliment to his early friend and patron Mr. Sabine, the late zealous Secretary of the Horticultural Society, to whom I am indebted for the following account of the tree by Mr. Douglas, in whose Herbarium there are several other hitherto unpublished species of this genus, some of which are equally remarkable with the one above described, for the peculiarities to be observed in their habit and structure. In order to secure to Mr. Douglas the credit of these interesting discoveries, I have subjoined descriptions of them."

David Douglas (1799–1834) was botanical explorer for the Horticultural Society of London, now the Royal Horticultural Society (11, 6, 9). As implied by the word "late" in the quotation above, Joseph Sabine (1770–1837) was secretary of the Society until his resignation in the upheaval of 1830 (9, p. 149–150, 190–192). It is unfortunate that Douglas, who left England in 1829 for the last time and met a tragic death in 1834, did not formally publish descriptions of all the new conifers he named and introduced to horticulture. Eighty years later his lost manuscript, "Some American Pines," was discovered and published as an appendix of his journal (6, p. 338–348). Here *Pinus monticola* was described apparently as new. Six other species, among them *P. Douglasii, P. Menziesii,* and *P. nobilis* of the extra pages, had brief Latin diagnoses followed by the incomplete citation, "Sabine in Trans. Hort. Soc. Vol." Obviously Douglas prepared this manuscript before the delayed news of Sabine's resignation reached him, not later than 1832, when he resigned also. After relinquishing his position, Sabine did not publish these new species in the Transactions (6, p. 338), though the quotation above indicates that he assisted Don in getting the names published in Lambert's work. Don's descriptions of these four species are not the descriptions prepared by Douglas. In a recent note (17), prepared in connection with this study, I have compiled a list of Douglas' seventeen new species of conifers.

Pinus Sabiniana was described by Douglas (5) also in an article dated at California, February 4, 1831, read (in his absence) April 3, 1832, and published in 1833. In the text of the extra pages D. Don quoted three paragraphs, slightly modified, from Douglas' manuscript. Lack of reference to Douglas' article indicates that it was then unpublished. In volume 3 of the 1837 folio edition Douglas' article was cited: "Pinus Sabiniana. *Douglas in Linn. Trans.* 16, p. 749." As the 1837 volume now added plates to the descriptions of Douglas' other new species, the last sentence quoted above was changed accordingly: "In order to secure to Mr. Douglas the credit of these interesting discoveries, I have given descriptions and figures of them in the present volume."

As the names in the extra pages appeared also in the third folio volume in 1837, citations before 1837 are more significant than later ones. The earliest reference to names in the extra pages I have located is that under *Abies* in the Penny Cyclopedia in 1833, an unsigned article credited to Lindley (15), whose name was mentioned on page 34 (Jour. Bot. 3: 386. 1865). Here were the new combinations in *Abies* of *A. grandis* (p. 30), *A. nobilis* (p. 30), and *A. Menziesii* (p. 32), all three credited under *Pinus* to Douglas and Lambert, and on page 32, "*Abies Douglasii;* the Douglas Fir (Pinus taxifolia *Lambert Monogr.,* No. 43; Pinus Douglasii, *Id.* t. 47 and 48)." The absence of *Pinus bracteata* from Lindley's monographic treatment indicates that this species was not in Lindley's copy of Lambert's work. Unfortunately, the species of *Pinus* proper cannot be dated by the Penny Cyclopedia because it was issued alphabetically in installments, the article on *Pinus* appearing in volume 18 in 1840. Lawson (14, p. 354) cited the extra pages when he mentioned the figure of the cone of *Pinus Sabiniana* in the "latest edition" of Lambert's work. A few other species of the extra pages were included, but Lawson omitted authors and citations. He noted that *Abies Menziesii* was discovered and named by Douglas.

Bentham (2, p. 404) listed seven species of *Pinus* in a report read January 21, 1834, and published in 1835, on plants raised by the Horticultural Society of London from seeds received from its explorer, David Douglas, in the years 1831, 1832, and 1833. These names given by Douglas, merely mentioned because the living plants were too young for description, were: *Pinus amabilis, P. grandis, P. insignis, P. Menziesii, P. monticola, P. nobilis,* and *P. Sabiniana.* Of these, *Pinus amabilis* and *P. insignis* were *nomina nuda* here. Though Bentham cited no published references, the other five were described in the extra pages of Lambert's work and four had been published elsewhere in 1833.

That *Pinus bracteata* and *P. Coulteri* were not published in 1832 but appeared in extra pages of copies issued sometime later is shown clearly by watermark dates (1837, 1838, and 1839), by historical records of the collector, and by references by contemporary authors. No contemporary citations of these two names as having been published in the octavo edition were found.

Biographical data of Dr. Thomas Coulter (1793–1843), the collector, place the date of discovery of these two species as 1832, the arrival of his collection in England as 1834, and publication of the names as 1836. According to Coville (3), Coulter, who had come to Mexico in 1825 as a physician with an English mining company, arrived at Monterey, California, in November 1831. Remaining there until March 1832 and perhaps collecting with David Douglas, Coulter then made a trip to the mouth of the Gila River in Arizona and returned to Monterey in July. After further collecting there, he brought his botanical collections and manuscripts to Europe by way of Mexico in 1834. The only new species published from Coulter's collection before his death in 1843, aside from some cacti sent to A. P. de Candolle and *Cupressus Coulteri* Forbes (1839), described from sterile young plants, were *Pinus bracteata, P. Coulteri,* and three other California pines by David Don (4) in his paper read June 2, 1835, and published the next year. Don's articles doubtless appeared before the few copies of the octavo edition with extra pages bearing his same two descriptions, even though there were no cross references. The article contains an extra sentence dedicating *P. Coulteri* to its discoverer, "at the suggestion of Mr. Lambert." The other three species in the article, described from cones only, *P. muricata, P. radiata,* and *P. tuberculata* (afterwards combined with the preceding), are not in the extra pages. All five species were included with plates in folio volume 3 of 1837, with D. Don's article cited. The text for *P. bracteata* and *P. Coulteri* in the extra pages of the octavo edition is the same as in the 1837 edition, except that D. Don's article was not cited, and may have been prepared before publication of the Transactions in 1836.

Further information on species in the extra pages is found in letters of David Douglas (11, 6, 9). On October 11, 1830, Douglas (11, p. 147) shipped from the mouth of the Columbia River to England a bundle of six species of *Pinus,* including *P. nobilis* and *P. grandis,* the latter a new species added on his last journey. He arrived at Monterey, California, on December 22, 1830, and in a letter from there dated November 23, 1831, mentioned the arrival of Dr. Coulter after he began the letter. Douglas sailed in August 1832 for the Hawaiian Islands, and while there shipped his Californian seeds and plants to England. The bristlecone fir, discovered in March 1832, was published posthumously in 1836 as *Pinus venusta* in a letter to Hooker dated October 23, 1832 (11, p.

152). In a letter of April 9, 1833, Douglas expressed the hope that Hooker include in the Flora Boreali-Americana *Pinus venusta* and other pines he discovered. Elwes and Henry (Trees Great Brit. Ire. 4: 797. 1909) summarized the accounts of the discovery of the bristlecone fir by Coulter and Douglas. The recently published, detailed biography of Douglas by Harvey contains much information hitherto unpublished and describes the meeting of Douglas and Coulter at Monterey (9, p. 180–184).

J. C. Loudon (18, 4: 2348), who recorded historical data as well as botanical, noted that the bristlecone fir (as *Picea bracteata*) was discovered by Douglas in March 1832 and was found also by Dr. Coulter but was not yet introduced. According to Loudon (18, 4: 2251), *Pinus Coulteri* was discovered by Dr. Coulter, "in what year is not stated," and "at the suggestion of Mr. Lambert, Professor Don named this species after Dr. Coulter (who appears to have discovered it about the same time as Douglas)." Cones and specimens were sent home by Douglas in 1832. Plants were raised from Douglas' seed the following year, and one of these, seven feet tall in September 1837, was illustrated (fig. 2147). Loudon explained that Douglas' material was sent as a variety of *Pinus Sabiniana* but that Don agreed that it was the same as *P. Coulteri.* Thus, the absence of a specific name for this pine by Douglas is clear. However, Lindley considered Douglas' specimen distinct from Coulter's and called it *Pinus macrocarpa* Lindl. (Edw. Bot. Reg. [Misc.] 26: 62. 1840). Douglas' other species in the extra pages definitely were received in time for insertion in the octavo edition as it was being published in 1832, acording to Loudon's records (18). The following were introduced to horticulture in 1831: *Pinus monticola, P. nobilis, P. grandis,* and *P. Menziesii. Pinus Douglasii,* which Menzies had discovered in 1797, was introduced by Douglas in 1826. After his specimens collected in 1826 were lost, Douglas rediscovered *P. Sabiniana* in 1831, wrote the manuscript dated February 4, 1831, and sent the specimens received in 1832.

Names in the Extra Plates

Three copies examined, as shown in Table 1, contain extra plates without text and not listed by Renkema and Ardagh. Some of these plates are the same as in the third folio volume of 1837. As listed by Keck (12), the Stanford University copy contains eight extra labeled plates without text, of which these five were not listed by Renkema and Ardagh for any edition of Lambert: *Cupressus horizontalis, Juniperus chinensis, J. excelsa, Pinus Llaveana,* and *Taxus Harringtonia.* The first plate listed, *Abies Smithiana,* obviously was from some other work, because Lambert never did accept the genus *Abies* in any edition but used *Pinus* in the broader, Linnaean sense to include *Abies* and other genera.

By consulting Stapf's Index Londonensis (21), I readily located the source of these plates as Forbes' Pinetum Woburnense (7), another volume of similar size (27.5 cm., pages 26.5 by 18 cm.) with hand-colored plates and issued in a limited edition of 100 copies, the one examined now in the Library of Congress. The only general works on conifers contemporaneous with Lambert and having colored illustrations of these species were Forbes (7) and Antoine (1). Lambert's third folio volume of 1837 included three, Antoine had four, and Forbes had plates of all eight species. For *Taxus Harringtonia* the only illustration cited was by Forbes. The plates of Lambert and Forbes were listed also by Bohn (8, Appendix, p. vii-x). The microfilm copy of these Stanford University plates confirmed their source as Forbes. These plates from Forbes in the Stanford University copy seem to belong to Lambert's work as they bear the same engraver's name, E. S. Weddell. A few still have Forbes' original plate numbers though partly erased, and many numbers among the regular plates have been erased also. Even the plates of three species illustrated also in Lambert's third folio volume of 1837 (*Pinus Smithiana, P. brutia,* and *Araucaria Cunninghamii*) were taken from Forbes, though another plate labeled in pencil "Pindrow" represents *Pinus Pindrow* of the 1837 volume of Lambert.

Thus, the Stanford University copy is not the first publication of names appearing in any extra plates without text. Citations for the three names mentioned by Keck as possibly properly published in this copy are: *Abies Smithiana* (Wall.) Lindl. Penny Cycl. 1: 31. 1833 [now *Picea Smithiana* (Wall.) Boiss.]; *Pinus Llaveana* Loud. Arb. Frut. Brit. 4: 2267, fig. 2177–2179. 1838 (synonym of *P. cembroides* Zucc. 1832); and *Taxus Harringtonia* Knight ex Forbes, Pinet. Woburn. 217, pl. 66. 1839 [now *Cephalotaxus drupacea* var. *pedunculata* (Sieb. & Zucc.) Miq.]. According to Forbes, *Taxus Harringtonia* was not introduced until 1837 and his sterile figure was from the original plant. Even if they were original, the eight names on extra plates of the Stanford University copy, like original drawings, would not be effectively published (International Rules, Article 36). Particularly in an expensive work of limited circulation and varying contents, insertion of names in a single copy issued afterwards (or two or three copies as in the cases of *Pinus bracteata* and *P. Coulteri*) would not be considered as publication.

Summary of Names in the Extra Pages

Names published in the unnumbered extra pages between pages 144 and 145 in volume 2 of the third, or octavo, edition (1832) are cited below without synonomy under the names now accepted.

Table 1. Contents of Extra Pages and Plates in Copies of Lambert's Description of the Genus Pinus, ed. 3 (octavo), v. 2, 1832.

	Renkema and Ardagh's list	Acad. Nat. Sci. Phila.	N. Y. Bot. Garden	Gray Herbarium	Library of Congress*	Arnold Arboretum	Boston Publ. Libr.	Univ. California	Stanford Univ.
Latest watermark date		1830		1831	1833	1829	1838	1837	1839
No. extra pages	18 (1? blank)	10 (1 blank)	14	16 (1 blank)	16 (1 blank)	18 (1 blank)	20 (2 blank)	18 (1 blank)	22 (3 blank)
No. extra plates	2	2	3	3	3	3	6	11	14
No. original drawings	0	0	0	0	0	0	7	1	5
Text and Plates									
Pinus Gerardiana	[1,] pl.	[3,] pl.	[1,] pl.	[1,] pl.	[1,] pl.	[5,] pl.	[7,] pl.	[7,] pl.	[3,] pl. (1839, Forbes)
Pinus Sabiniana (2 pages)	[2–3,] pl.	[4–5,] pl.	[9–10] pl.	[2–3,] pl. (1831)	[2–3,] pl.	[6–7,] pl.	[8–9,] pl.	[8–9,] pl.	[4–5,] pl.
Pinus monticola	[4]	[6]	[12]	[4]	[4]	[8]	[10,] dr. (after p. 12)	[10,] pl.	[6,] pl. (Forbes)
Pinus grandis	[5]	[7]	[14]	[6]	[6]	[9]	[1,] dr.	[3,] pl.	[10]
Pinus nobilis	[6] (pl.)	[8]	[13,] pl.	[5,] pl.	[5,] pl. (1833)	[10]	[2,] dr.	[4,] pl. (1835)	[9]
Pinus Menziesii	[7]	[9]	[11]	[7]	[9]	[1]	[5,] dr.	[1,] dr.	[12]
Blank page	[8?]	[10]		[8]	[10]	[2]	[6, 12]	[2]	[8, 11, 13]
Pinus Douglasii	[9]	[2] (after p. 82)				[3]	[3,] dr.		[2]
Pinus dumosa	[10]	[1] (after p. 82)				[4]	[4]		[1]
Notes on the Moreton Bay Pine (2 pages)	[11–12]		[3–4] pl.	[9–10]	[7–8]	[11–12]	[19–20] (after p. 184)	[11–12] (after p. 184)	[15–16] (after p. 184)
Observations on the Coniferous Trees of New Zealand, etc. (6 pages)	[13–18]		[2, 5–8]	[11–16]	[11–16]	[13–18]	[13–18] (after p. 184)	[13–18] (after p. 184)	[17–22] (after p. 184)
Pinus bracteata								[5,] pl. (1836)	[7,] pl.
Pinus Coulteri							[11,] pl. (Forbes, after p. [12])	[6,] pl. (1836)	[14,] pl. (Forbes)
Plates and Drawings without Text									
Pinus (or *Abies*) *Smithiana*								pl. (1836, after p. [10])	pl. (1838, Forbes, after p. [14])
Pinus Llaveana									pl. (Forbes, after p. [14])
Pinus bruttia (or *brutia*)							pl. (1838, after p. [10])	pl. (1836, after p. [10])	pl. (1838, Forbes, after p. [14])
Pinus Pindrow							pl. (after p. [12])	pl. (after p. [10])	pl. (after p. [14])
Pinus tuberculata									two dr. (after p. [14])
Pinus muricata									dr. (after p. [14])
Pinus radiata							two dr. (after p. [12])		two dr. (after p. [14])
Araucaria Cunninghamii							pl. (after p. [12])	pl. (1836, after p. [10])	pl. (Forbes, after p. [14])
Juniperus chinensis									pl. (Forbes, after p. [14])
Juniperus excelsa									pl. (Forbes, after p. [14])
Cupressus horizontalis									pl. (Forbes, after p. [14])
Taxus Harringtonia									pl. (Forbes, after p. [14])

* The copy at Rancho Santa Ana Botanic Garden has the same number and arrangement of extra pages as that at Library of Congress but has no watermarks on the extra plates.

In this table the extra pages of each copy (between pages 144 and 145, except as noted) are numbered consecutively in brackets. Colored plates are designated by "pl.," with date of watermark, if present, in parentheses; "Forbes" identifies plates taken from Forbes, Pinetum Woburnense (1839). Inserted colored original drawings are designated by "dr." The order of the list of plates and drawings without text (at left) is that of the Stanford University copy. The copies at New York Public Library and Massachusetts Horticultural Society are without extra pages.

Abies grandis (Dougl.) Lindl. Penny Cycl. 1: 30. 1833. Grand fir. ? *Pinus grandis* Dougl. ex D. Don in Lamb. Descr. Genus Pinus. Ed. 3 (8°), v. 2, unnumbered extra p. between p. 144–145. 1832.

Abies grandis, based upon *Pinus grandis* Dougl., perhaps is not now used as Douglas originally intended, as I reported (16, p. 591–592).

Abies procera Rehd. Rhodora 42: 522. 1940. Noble fir. *Pinus nobilis* Dougl. ex D. Don in Lamb. loc. cit. 1832.

Abies venusta (Dougl.) K. Koch, Dendrol. 2(2): 210. 1873. Bristlecone fir. *Pinus bracteata* D. Don in Lamb. loc. cit., pl. 1837–1839 ?; known only in two copies.

The nomenclature of the bristlecone fir remains as in my previous summary (16, p. 592), now that the two copies of the 1832 edition of Lambert's work containing the name *Pinus bracteata* D. Don have been dated as after 1836. *Abies venusta* (Dougl.) K. Koch should be retained under Article 5 of the Rules because it has become established in usage since Sargent took it up more than sixty years ago (Gard. and Forest 2: 496. 1889). However, if the exact date of publication in 1836 of part 3 of Volume 17 of the Transactions of the Linnaean Society of London should ever be established as before December 1, as is mathematically probable, then it would be necessary to take up the name *Abies bracteata* (D. Don) Nutt. The Library of the United States Department of Agriculture has a list of the dates of volumes, parts, and pages of the Transactions, signed by B. Daydon Jackson and received May 24, 1895, but only the years of publication are given.

Picea sitchensis (Bong.) Carr. Traité Gén. Conif. 260. 1855. Sitka spruce. *Pinus Menziesii* Dougl. ex D. Don in Lamb. loc. cit. 1832.

Pinus Menziesii Dougl. may compete with *P. sitchensis* Bong., as noted previously (16, p. 488). Suringar (22; 23, 1927, p. 49; 1928, p. 54) took up *Abies falcata* Raf. (Autumn 1832).

Pinus Coulteri D. Don, Linn. Soc. London. Trans. 17: 440. 1836. Coulter pine. *Pinus Coulteri* D. Don in Lamb. loc. cit., pl. 1837–1839?; known only in three copies.

Pinus Gerardiana Wall. ex D. Don in Lamb. loc. cit. pl. 79. 1832. Chilghoza pine.

Pinus monticola Dougl. ex D. Don in Lamb. loc. cit. 1832. Western white pine.

Pinus Sabiniana Dougl. ex D. Don in Lamb. loc. cit. pl. 80. 1832. Digger pine.

Pseudotsuga taxifolia (Poir.) Britton ex Sudw. U. S. Dept. Agr. Div. Forestry Bull. 14: 46. 1897. Douglas fir. *Pinus Douglasii* Sabine ex D. Don in Lamb. loc. cit., pl. [47]. 1832.

The nomenclature of this species has been summarized in my previous note (16, p. 594–595). Suringar (23; also Rijks Herb. Leiden Meded. 56: 4. 1928) has discussed the nomenclature at length.

CONCLUSIONS

On the basis of the evidence here presented, most names in the extra pages of Lambert's octavo edition can be accepted as first published there in 1832. *Pinus Douglasii, P. grandis, P. Menziesii,* and *P. nobilis* all were transferred to *Abies* by Lindley in 1833. *Pinus Sabiniana* was published also by Douglas in a separate article in 1833. *Pinus Gerardiana* and *P. monticola* were published again by Lawson in 1836. There is no proof that these seven names were first published after 1832, the date on the title page, and no nomenclatural changes are needed at present in acceptance of this date.

Pinus bracteata and *P. Coulteri,* known from only two and three copies, respectively, and bearing watermark dates as late as 1837 to 1839, definitely were not first published in the octavo edition. David Don published both names in a journal article in 1836. Thus, the evidence does not warrant change of the name of bristlecone fir from *Abies venusta* to *Abies bracteata.*

The Stanford University copy, with watermark dates as late as 1839, contains five additional plates apparently not known in any other copy or edition of Lambert's work. These and six other plates were taken from Forbes' Pinetum Woburnense (1839) and were not first published in this copy.

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United States Department of Agriculture,
Washington, D. C.

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SOME NEW ARACEAE FROM SOUTHERN MEXICO

Eizi Matuda

Monstera roseospadix sp. nov. Planta epiphitica scandens, caulibus glabris crassis 4–5 cm. diam. nodosis; petiolis gracilibus 50 cm. longis usque ad 40 cm. vaginatis, geniculo ca. 5 cm. longo; laminis perfectis, oblongo-ellipsoideis, basi semitruncatis, apice semiacutis, 45–58 cm. longis 25–28 cm. latis; nervis pinnatis numerosis utroque ca. 50; pedunculis 30 cm. cum bractea amplectente albi-virescente 35 cm. longis; spatha viridiflava decidua 28–30 cm. longa cuspidata, 7–8 cm. lata; spadice usque ad 18 cm. longo, 1.5 cm. diam. roseo, floribus hermaphroditis sine perianthius.

Mexico. Chiapas: in wet forest near Finca California, Col. Turquia, Escuintla, at 150 m. altitude, 8 September 1947, *Matuda*

17782 (type, Matuda Herbarium; isotypes, Instituto de Biologia de Mexico, and Chicago Natural History Museum).

When the floral organs mature the spathe falls down and the rose-colored spadix is exposed. The stigma is sessile on a square disk, under which there is a one-celled ovary with 6 to 12 ovules. Ripe fruit has not yet been collected.

The exact affinity of *M. roseospadix* among the species hitherto described from Mexico and Central America is not certain. It is characterized by the geniculate petiole, thin, entire, large leaf, and bright rose, elongated spadix. The adventitious roots are employed as fine withes, *mimbre*.

Monstera chiapensis sp. nov. Planta epiphitica scandens, radicibus aeriis; caulibus crassis 3–3.5 cm. diam.; petiolo ut videtur terete 27–40 cm. longo, longitudinaliter 25–38 cm. vaginato; lamina in sicco chartacea oblongo-ovata 45–65 cm. longa et prope medium 27–35 cm. lata, ad apicem obtusa vel breviter acuta; nervis 12 pinnatis; in vivo foliorum nervis primariis dorso albis incrassatis notabilibus; pedunculo terete 10–13 cm. longo, 1.2 cm. diam.; spatha decidua, non visa; spadice sessile cylindrico apice rotundato 17–20 cm. longo, 2.5–3 cm. diam. lacteo; floribus hermaphroditis sine perianthium.

Mexico. Chiapas: in wet, advanced, tropical forest near Finca California, Col. Turquia, Escuintla, at 150 m. altitude, 29 August 1947, *Matuda 17789* (flower); in wet forest of Finca Esperanza, at 200 m. altitude, about 10 km. northeast of Escuintla, *Matuda 17786* (fruit) (type, Matuda Herbarium; isotype, Instituto de Biologia de Mexico).

In fresh material the dorsal surface of the leaf is noteworthy because of the conspicuous, broad, milky-white principal veins. The stigma is sessile on the ovary; the stigma and ovary are 6 mm. long. The pistil is surrounded by four stamens, each consisting of a thin, broad filament and two oblong, 2-celled anthers (fig. 1c). The stamens are 6–7 mm. long when mature. The fruit contains a single seed which is oblong and 7 mm. long, and has a white testa and black endosperm.

In the genus there are very few species known with entire leaves and ours is most distinct because of its large, entire leaves with broad, white veins on their dorsal surface.

Monstera acacoyaguensis sp. nov. Planta scandens epiphitica glabra, ramulorum internodiis superioribus ca. 7–10 cm. longis et 3 cm. diam. crassis cum radicibus adventitiis semi-compressis non cylindricis; petiolo ut videtur terete 42–52 cm. longo ca. 1.5 cm. diam. et e basi circa 35–40 cm. longi-vaginato, geniculo ca. 4 cm. longo; lamina coriacea rigidula oblongo-ovata 55–60 cm. longa et 32–37 cm. lata, ad apicem semi-acuta, integerrima, irregulariter perforata, nervis primariis 14–16; pedunculo crasso vix ultra 30 cm. longo terete 2 cm. diam.; spatha lactea dense coriacea, decidua, 23–27 cm. longa, 16–18 cm. lata breviter cuspidata, concava; spadice in vivo lacteo, sessili 15–19 cm. longo, cylindrico, ad apicem rotundato, 2.5 cm. diam.

Mexico. Chiapas: in shaded woods or forest, along the Rio Grande, Acacoyagua, near Escuintla, at about 100 m. altitude, 25 May 1948, *Matuda 17853* (type, Matuda Herbarium; isotype, Chicago Natural History Museum).

Monstera acacoyaguensis, because of the general aspect of its leaves, is most often confused with *M. pertusa* which occurs very commonly in the Pacific slope of Chiapas, from 150 m. to 500 m. altitude or more, and is well known to natives as *mimbre* on account of its useful adventitious roots. But our new species is quite distinct because of its longer petiole and the fact that this petiole is sheathed for four-fifths of its length, while in *M. pertusa* it is sheathed for the whole length of the petiole. Also, the adventitious roots of our species are not used as *mimbre.*

Philodendron linearipetiolatum sp. nov. Caulibus ut videtur gracilibus, atque dense foliatis scandentibus, petiolo alato, gracili 7–8 cm. longo, vaginato; lamina laevigata integerrima oblongolanceolata, ad apicem cuspidata, ad basin anguste rotundata, 10–15 cm. longa, 3–5 cm. lata; nervis obsoletis pinnatis utroque 6–8; spatha semi-sessili ochroleuca saepe 10 vel 12 cm. longa, oblongo-elliptica concava ad apicem breviter cuspidata, ad basin rotundato-truncata; spadice breviter stipitato vel sessili, 8–9 cm. longo, 1–1.2 cm. diam. cylindrico (fig. 1a).

Mexico. Chiapas: in wet, advanced forest of Finca Corcega, about 14 km. northeast of Pueblo Nuevo Comaltitlan, 12 May 1948, *Matuda 17781* (type, Matuda Herbarium; isotypes, Instituto de Biologia de Mexico and Chicago Natural History Museum).

In the inner, concave part of the spathe at first appear thin dark red lines, but these, when the flower is mature, exude a dark red, mucous, sticky sap similar to that seen in *P. calderense.* The lower one-fourth of the spadix bears pistillate flowers, while the upper three-fourths is staminate. Fruits have not yet been collected. The winged petiole is prolonged at the base and sheathes the stem at the node. The flower-spathe grows from the upper node, consequently the sheathed petiole which embraces the spathe is always broader than the others (fig. 1a.). *Philodendron alatum* and *P. guttiferum* seem to be related because of their winged petioles, but apparently our new species is well separated from the former of these two Peruvian species by its much smaller leaf, and from the latter by its much shorter internodes which are only 1.5 cm. long. In general, the spathe and floral structure are conspicuously similar to those of *P. calderense* which was collected recently in the same region (*Matuda 17786, 17790*), but our species is readily distinguished by its much smaller flower, as well as by its smaller leaf with winged petiole. The petiole of *P. calderense* in herbarium specimens often appears to have a winged petiole because the sheath of the petiole has opened widely (especially in the case of specimens dried by artificial heat), but the sheathed petiole of *P. calderense* in its natural state is so com-

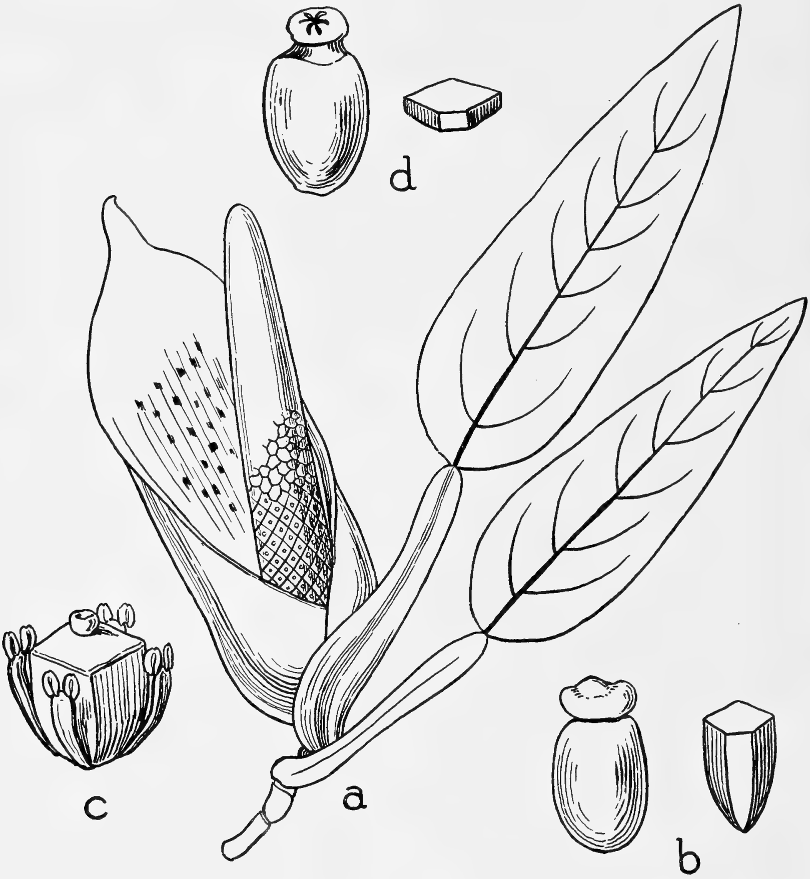

Fig. 1. Mexican Araceae: *a, Philodendron linearipetiolatum* Matuda showing general aspect of flower and leaves with winged petioles, × 2/3; *b, Philodendron linearipetiolatum,* staminate and pistillate flowers, × 9½; *c, Monstera chiapensis* Matuda, floral organ, × 6½; *d, Philodendron escuintlensis* Matuda, floral organ, × 6½.

pletely closed that it seems like a cylindrical tube, and this is the reason that the plant is called *chupa-pito* by natives. *Philodendron linearipetiolatum* is well distinguished by its handsome little leaves with petioles that are winged in the natural state as well as in dried specimens, quite unlike that of any other species known from Mexico and Central America.

Philodendron escuintlensis sp. nov. Planta epiphitica scandens, caule ut videtur crasso 2–3 cm. diam.; petiolo 25–42 cm. longo usque 2/3 longitudinis vaginato; lamina chartacea oblongo-cordata 25–28 cm. longa, 18 cm. lata; nervis primariis utroque circa 14 pallidis elevatis; pedunculo 10/12 cm. longo vel longiore gracili; spatha ochroleuca 20 cm. longa, ad apicem cuspidata, 7–8 cm. lata; spadice sessili 15 cm. longo 1–1.2 cm. diam. cylindrico, e basi 1/3 longitudinis pistillato et 2/3 staminato (fig. 1d).

Mexico. Chiapas: in wet forest of Salto de Agua, 16 km. northeast of Escuintla, at 500 m. altitude, 30 August 1947, *Matuda 17783* (type, Matuda Herbarium; isotypes, Instituto de Biologia de Mexico, and Chicago Natural History Museum); Jilguero, 20 km. east of Escuintla, in advanced forest at 350 m. altitude, *Matuda 17784*.

Only the upper half of the spathe opens when the floral organs are mature, and it closes completely when pollination has been accomplished and remains closed until the fruit is ripe. On the inner parts of the spathe are found many thin, dark, red lines extending in a vertical direction. When the flowers are mature, dark, red, mucous sticky sap exudes from these lines as in the case of *P. calderense* and *P. linearipetiolum,* described above. The adventitious roots produce very fine *mimbre.* In the genus there are many related species similar in leaf-form, but the long petioles and thinner leaves readily distinguish our species.

The writer desires to acknowledge the courtesy and kindly assistance of Dr. Harold N. Moldenke of New York Botanical Garden in preparation of the present paper.

Matuda Herbarium,
Escuintla, Chiapas, Mexico.

THE CHASE OAK, A NEW GIANT HYBRID OAK FROM SANTA CLARA COUNTY, CALIFORNIA

H. E. McMinn, E. B. Babcock, and F. I. Righter

In December of 1947 a letter from Harold S. Chase of Santa Barbara, California to H. E. McMinn of Mills College contained information about an unusually large tree (fig. 1) which had been identified as × *Quercus Morehus* Kell., oracle oak, a hybrid between *Q. Wislizenii* A. DC. and *Q. Kelloggii* Newb. This tree is growing on the Castro Valley Ranch about six miles southwest of Gilroy, California. Since all known specimens of the oracle oak are small trees rarely more than 40 feet high and with a spread of not more than 30 feet, this tree aroused immediate interest.

An invitation by Mr. and Mrs. Chase was extended to the authors to visit the ranch in January, 1948. Some doubt that the giant oak was × *Quercus Morehus* was expressed at that time, but because the tree was associated with a mixture of deciduous, semi-evergreen, and evergreen oaks, further study was postponed until May when the trees were in full leaf. The following measurements were made on this second trip: height 75 feet, widest spread 111 feet, spread at right angles to widest spread 108 feet, circumference of trunk at 3½ feet from ground 17 feet and 4 inches, distance of first branch from ground 4 feet and 4 inches, circumference of first branch 6 feet and 4 inches, spread of first limb 54 feet, diameter of largest healed limb-scar 23 inches.

FIG. 1. The Chase oak. × *Quercus Chasei.* About sixty percent evergreen during the winter. Photograph by Dr. Noble H. Logan.

Within a radius of about 100 yards from the giant oak occurred 106 specimens of *Quercus agrifolia* Née (coast live oak), 17 specimens of *Quercus lobata* Née (valley oak), 6 specimens of *Quercus Kelloggii* Newb. (California black oak), 1 specimen of *Quercus durata* Jepson (leather oak), 3 much smaller specimens similar to the giant oak, and 19 specimens of apparent backcrosses which displayed, in various combinations, characteristics of *Quercus agrifolia, Q. Kelloggii,* and the giant oak. These 19 progeny were scored on the basis of characters (habit of branching, density and color of foliage, and the size, shape, texture, margins, and surface of leaves) which they had in common with each putative parent. The total score for either parent was 10. The results of this population analysis appear in Table I. The hybrid specimens were either evergreen or partially evergreen; none were wholly deciduous.

TABLE 1. ANALYSIS OF QUERCUS POPULATION

Backcrosses	Cumulative Characters Scale 1 - 10	Number of Specimens
Q. Kelloggii × *Q. Chasei*	4 6	1
Q. agrifolia × *Q. Chasei*	5 5	4
Q. agrifolia × *Q. Chasei*	6 4	1
Q. agrifolia × *Q. Chasei*	7 3	7
Q. agrifolia × *Q. Chasei*	8 2	6
		Total 19

The three smaller specimens resembling the giant oak and the 19 specimens of hybrid oaks were on the down hill and leeward side of the large oak specimen, and they most likely represent some of its progeny. Since the giant oak has characteristics of both *Quercus agrifolia* and *Q. Kelloggii,* and since both of these species occur together in the area, and inasmuch as the hybrids in the area have a mixture of characters of *Quercus agrifolia, Q. Kelloggii,* and the giant oak, we are of the opinion that this large oak has resulted from a cross between *Quercus agrifolia,* the evergreen leaved parent, and *Q. Kelloggii,* the deciduous leaved parent, and that it is not the oracle oak, × *Quercus Morehus* Kell.

A review of the literature on hybrid oaks did not reveal any published record of a cross between these two species. However, Carl B. Wolf (Proc. Calif. Acad. Sci. Ser. 4, Vol. 25, No. 5, 177–188. 1944) described the Gander oak as a new hybrid between *Quercus Kelloggii* Newb. and *Quercus agrifolia* var. *oxyadenia*

(Torr.) J. T. Howell. In discussing this hybrid, Wolf stated that he had received from Mr. John M. Tucker an oak specimen collected in the Santa Lucia Mountains of Monterey County, "that appears to be a hybrid between *Quercus Kelloggii* and *Quercus agrifolia,* but we have not been able to visit the area and see the tree growing in the wild, nor has it been possible to obtain acorns for propagation. . . . If it should be demonstrated that it is a hybrid, as suggested above, it could hardly be included in the present concept of × *Quercus Ganderi* unless that concept be enlarged and *Quercus agrifolia* var. *oxyadenia* be reduced to synonomy under *Quercus agrifolia.*"

This hybrid differs from the Gander oak (× *Quercus Ganderi* C. B. Wolf) in developing its acorns during the second year and in its typically larger leaves. It differs from the oracle oak (× *Quercus Morehus* Kell.) in having the axillary tufts of stellate hairs characteristic of its evergreen parent, *Quercus agrifolia* Née.

It would appear then that this new hybrid oak should be named and we hereby propose the name × *Quercus Chasei* McMinn, Babcock and Righter, Chase oak. It is a pleasure to name this oak in honor of Mr. Harold S. Chase, upon whose ranch it grows and who called it to our attention. Mr. Chase is demonstrating on his ranch some of the most modern and practical ideas of range and forest conservation to be found in our western states.

× **Quercus Chasei** McMinn, Babcock, and Righter hybr. nov. Chase oak. (*Quercus agrifolia* Née × *Quercus Kelloggii* Newb.). Arbor magna, corona ampla rotunda. Cortex laevis vel scaber fuscellus vel fuscus. Folia semi-sempervirentia, 5–14 cm. longa, 2.5–10 cm. lata, superne atrovirentia glabra, subter pallida et glabra praeter floccos pilorum axillares; laminis prope planis valde coriaceis irregulariter et insule lobatis; petiolis 9–25 mm. longis primo dense stellato-pubescentibus tandem glabrescentibus. Inflorescentia pariens in ramulis vernalibus. Balani plerumque solitarii vel interdum 2–4 in corymbis, maturescentes in anno secundo. Plerusque intermedia inter parentes putatives. A × *Q. Ganderi* differt in balanis maturescentis in anno secundo; a × *Q. Morehus* in floccis pilorum axillaribus.

Tree up to 75 feet high, with a spread up to 111 feet and a trunk diameter up to 5½ feet, forming a broad, rounded crown. Bark smooth to rough and checkered, grayish to dark brown, young branchlets nearly black, densely stellate-pubescent, becoming lighter and nearly glabrous in age. Leaves about 50 to 60 percent evergreen; petioles ⅜ inch to 1 inch long, at first densely stellate-pubescent, becoming nearly glabrous; the blades flat to slightly concavo-convex, thick and leathery, rectangular-oval to broadly elliptical in outline, 2 to 5½ inches long, 1 to 4 inches broad, dark green and essentially glabrous above, light dull green and apparently nearly glabrous beneath except for axillary tufts and few scattered compound hairs, margins shallowly and irregularly lobed, rarely cut more than one-third way to midrib, the lobes with 1 or 2 fine bristles 1/8 to 1/4 inch long. Staminate and pistillate flowers borne on new spring branchlets. Acorns maturing the second year, solitary or in clusters of 2 to 4; the cup 1/4 to 3/8 inch high, 5/8 to 3/4 inch broad, scales thin, well imbricated; the nut ovoid, about one-third enclosed by cup, 5/8 to 7/8 inch long, finely pubescent without, densely pubescent within.

Type. Castro Valley Ranch about six miles southwest of Gilroy, Santa Clara County, California, October 2, 1948, *McMinn, Babcock,* and *Righter 5561* (Herbarium of the University of California No. 766681). A topotype, showing young acorns, was collected May 8, 1948 (*McMinn, Babcock,* and *Righter 5560*).

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MYXOMYCETES OF MOUNT SHASTA

William Bridge Cooke

Myxomycetes have been collected on Mount Shasta, Siskiyou County, California, during seven summers between 1937 and 1947. No earlier records of these plants from this mountain are known to the writer. Intensive collecting was carried on during the early parts of the summer seasons as the plant materials upon which myxomycetes fruit were becoming exposed by the melting snow pack and during the times when dead and rotten logs of Shasta fir, *Abies magnifica* var. *shastensis,* were still wet. Less intensive collecting was carried on during the remaining months of the summer when most substrata upon which these organisms fruit were very dry. Most of the collections were made in the Shasta fir and white bark pine zones in the vicinity of the Sierra Club's Shasta Alpine Lodge located at Horse Camp which is situated in the ecotone between these two zones.

All the specimens collected were determined by G. W. Martin, of the State University of Iowa, who found among them two previously unknown species. Arrangement of genera in the following table is that found in "The Myxomycetes" by T. H. Macbride and G. W. Martin (MacMillan Company, New York, 1934).

Two species of lichens, a species of *Coniocybe* and material referred by Dr. Martin to *Mycocalicium albonigrum* (Nyl.) Fink

Species	Altitude	Zone	Collection Numbers	Date	Suscept Substratum
Exosporeae					
1. *Ceratiomyxa fruticulosa* (Muell.) Macbr.	8000	Ams	8561	7 July 1937	Shasta fir
	8000	Ams	15673	7 Aug. 1941	Shasta fir
	8000	Ams	18130	29 June 1946	Shasta fir
Myxogasteres					
Physarales					
PHYSARACEAE					
2. *Fuligo intermedia* Macbr.	8000	Ams	10226	21 July 1938	Shasta fir
	8000	Ams	?20127	25 June 1947	Shasta fir
3. *Fuligo septica* (L.) Weber	5000	M.C.	8616	6 Aug. 1937	Epilobium sp. litter
4. *Badhamia decipiens* (Curt.) Berk.	9000	Pa	15707	14 Aug. 1941	Pinus albicaulis
5. *Physarum albescens* Ell.	8100	Pa	10164	30 June 1938	Chrysothamnus Bloomeri var. angustatus
6. *Physarum alpinum* G. Lister	8000	Ams	10145	20 June 1938	Shasta fir
	8000	Ams	10220	18 July 1938	Shasta fir
7. *Physarum auripigmentum* Martin	8100	Ams	20099 (Type)	23 June 1947	Shasta fir
8. *Physarum bitectum* Lister	5700	M.C.	16664	3 July 1942	Veratrum californicum
9. *Physarum rubronodum* Martin	8000	Ams	18126 (Paratype)	29 June 1946	Rotten cotton cloth
10. *Physarum* sp.	8000	Ams	15671-A	7 Aug. 1941	Shasta fir
DIDYMIACEAE					
11. *Didymium dubium* Rost.	8000	Ams	?8545-A	29 June 1937	Lupinus obtusilobus
	5000	M.C.	8572	9 July 1937	Amelanchier pallida
	8000	Ams	10165	30 June 1938	Chrysothamnus Bloomeri
12. *Didymium* sp.	10000	A	8686	15 Sept. 1937	Hulsea nana litter
13. *Diderma ?deplanatum* Fr.	8000	Ams	20102	23 June 1947	Shasta fir
14. *Diderma Lyallii* (Massee) Macbr.	5700	M.C.	16670	3 July 1942	Veratrum californicum

Species	Altitude	Zone	Collection Numbers	Date	Suscept Substratum
15. *Diderma niveum* (Rost.) Macbr.	8000	Ams	10143	20 June 1938	Shasta fir
	8000	Ams	10147	20 June 1938	Shasta fir
	8000	Ams	10186	6 July 1938	Shasta fir
	8000	Ams	18061	28 June 1946	Shasta fir
	7800	Ams	18207	10 July 1946	Pinus albicaulis (live twig)
	8100	Ams	20129	25 June 1947	Shasta fir
16. *Diderma ?spumarioides* Fr.	8000	Ams	18131	30 June 1946	Shasta fir
17. *Lepidoderma carestianum* Rost.	8000	Ams	10107	15 June 1938	Penstemon gracilentus
	8000	Ams	10150-A	23 June 1938	Chrysothamnus Bloomeri
	8000	Ams	10151-A	23 June 1938	Chrysothamnus Bloomeri
	8000	Ams	18170	7 July 1946	Chrysothamnus Bloomeri
18. *Lepidoderma granuliferum* (Phill.) R.E.Fr.	8000	Ams	10150	23 June 1938	Penstemon gracilentus
	8000	Ams	10151	23 June 1938	Chrysothamnus Bloomeri
	8000	Ams	10152	23 June 1938	Gayophytum sp. litter
	8000	Ams	10170	30 June 1938	Penstemon gracilentus
	8000	Ams	10198-A	13 July 1938	Eriogonum marifolium
	8000	Ams	10202	13 July 1938	Misc. litter
	8000	Ams	10204-A	13 July 1938	Lupinus obtusilobus
	8000	Ams	18089	27 June 1946	Lupinus obtusilobus
	8000	Ams	20285-A	10 July 1947	Anemone occidentalis
Stemonitales					
STEMONITACEAE					
19. *Stemonitis axifera* (Bull.) Macbr.	5000	M.C.	18101	28 June 1946	Pinus ponderosa
	6000	Ac	20244	10 July 1947	Abies concolor
20. *Comatricha nigra* (Pers.) Schroet.	8000	A.T.	10289	8 Sept. 1938	Tsuga Mertensiana
	8000	Ams	18194	10 July 1946	Pinus ponderosa boards

Species	Altitude	Zone	Collection Numbers	Date	Suscept Substratum
21. *Comatricha pacifica* Macbr.	8000	Ams	13317	5 July 1939	Shasta fir
	8000	Ams	18015	22 June 1946	Shasta fir
	7800	Ams	18205	10 July 1946	Shasta fir
22. *Comatricha Suksdorfii* Ell. & Ev.	8000	Ams	8621	7 Aug. 1937	Shasta fir
	8000	Ams	10138	20 June 1938	Shasta fir
	8000	Ams	10139-A	20 June 1938	Shasta fir
	8000	Ams	10140	20 June 1938	Shasta fir
	8000	Ams	10247	28 July 1938	Pinus albicaulis
	8000	Ams	15641	29 July 1941	Shasta fir
	8000	Ams	18074	26 June 1946	Shasta fir
	8000	Ams	20059	22 June 1947	Shasta fir
	8000	Ams	20101	23 June 1947	Shasta fir
23. *Comatricha* sp.	7800	Ams	18142	2 July 1947	Shasta fir
LAMPRODERMACEAE					
24. *Enerthenema melanospermum* Macbr. & Martin	8000	Ams	10144-A	30 June 1938	Shasta fir
	8000	Ams	10180	3 July 1938	Shasta fir
	8000	Ams	15566	16 July 1941	Shasta fir
	8000	Ams	18039	24 June 1946	Shasta fir
	8000	Ams	18193	10 July 1941	Pinus ponderosa board
25. *Lamproderma arcyrioides* (Somm.) Rost.	9000	Pa	10251	28 July 1938	Pinus albicaulis
26. *Lamproderma carestiae* (Ces. & DeNot.) Meylan	8100	Ams	10206	13 July 1938	Shasta fir
27. *Lamproderma columbinum* (Pers.) Rost.	8000	Ams	18128	29 June 1946	Shasta fir
28. *Lamproderma Sauteri* Rost.	8000	Ams	8518-B	22 June 1937	Shasta fir (exposed from snow bank 1 day)
	8000	Ams	10106	15 June 1938	Penstemon gracilentus
	8000	Ams	10108	15 June 1938	Sitanion hystrix culms
	5000	C	10121	17 June 1938	Rubus parviflorus
	8000	Ams	10144	20 June 1938	Shasta fir

Species	Altitude	Zone	Collection Numbers	Date	Suscept Substratum
28. *Lamproderma Sauteri* Rost.	8000	Ams	10154	24 June 1938	Chrysothamnus Bloomeri
	8000	Ams	10167	30 June 1938	Chrysothamnus Bloomeri
	8000	Ams	10181	3 July 1938	Penstemon gracilentus
	8000	Ams	14631	8 July 1940	Shasta fir
	8000	Ams	15594	23 July 1941	Shasta fir
	8500	Pa	15708	14 Aug. 1941	Shasta fir
	7800	Ams	18087	27 June 1946	Pinus albicaulis litter
	8000	Ams	18171	7 July 1946	Chrysothamnus Bloomeri
29. *Lamproderma* sp.	8000	Ams	10180	3 July 1938	Shasta fir
Liceales					
Cribrariaceae					
30. *Cribraria argillacea* Pers.	8000	Ams	10264	10 Aug. 1938	Shasta fir
	8000	Ams	18068	26 June 1946	Shasta fir
	8000	Ams	18129	30 June 1946	Shasta fir
31. *Cribraria rufa* (Roth) Rost.	6000	Ac	10246	28 July 1938	Abies concolor
	8500	Pa	14652	12 July 1940	Shasta fir
	8000	Ams	20100	23 June 1947	Shasta fir
	8000	Ams	20374	29 July 1947	Shasta fir
32. *Dictydium cancellatum* (Batsch) Macbr.	8000	Ams	20208	1 July 1947	Shasta fir
	8000	Ams	20209	1 July 1947	Shasta fir
33. *Dictydium* sp.	6500	Ams	8606	30 July 1937	Shasta fir
Liceaceae					
34. *Licea minima* Fr.	8000	Ams	.....	Summer 1938	Shasta fir (cultured at Iowa City from plasmodial collection)
Reticulariaceae					
35. *Enteridium olivaceum* Ehr.	8000	Ams	10142	20 June 1938	Shasta fir
	8000	Ams	10263	10 Aug. 1938	Shasta fir

Species	Altitude	Zone	Collection Number	Date	Suscept Substratum
35. *Enteridium olivaceum* Ehr.	9000	A	13353	26 July 1939	Pinus albicaulis (used as trail sign post)
	7800	Ams	14615	3 July 1940	Shasta fir
	8000	Ams	18038	24 June 1946	Shasta fir
LYCOGALACEAE					
36. *Lycogala epidendrum* (L.) Fr.	8000	Ams	8545-B	29 June 1937	Lupinus obtusilobus
	7800	Ams	14616	30 July 1940	Shasta fir
37. *Lycogala* sp. (immature)	5000	M.C.	15696	8 Aug. 1941	Conifer wood
	8000	Ams	20210	1 July 1947	Shasta fir
Trichiales					
ARCYRIACEAE					
38. *Arcyria denudata* (L.) Wettst.	6500	Ac	20436	15 Aug. 1947	Abies concolor
39. *Arcyria incarnata* Pers.	8000	Ams	18324	21 July 1946	Shasta fir
40. *Arcyria versicolor* Phill.	8000	Ams	10120	17 June 1938	Shasta fir
	8000	Ams	10166	30 June 1938	Shasta fir
	6500	Ac	10192	7 July 1938	Shasta fir
	8500	Pa	10245	28 July 1938	Shasta fir
	8000	Ams	18062	25 June 1946	Shasta fir
	8000	Ams	20123	25 June 1946	Shasta fir
	8000	Ams	20197	29 June 1947	Shasta fir
TRICHIACEAE					
41. *Prototrichia metallica* (Berk.) Massee	8000	Ams	8518	22 June 1937	Shasta fir
	8000	Ams	10139	20 June 1938	Shasta fir
	8000	Ams	10189	7 July 1938	Shasta fir
	8000	Ams	15671	7 Aug. 1941	Shasta fir
	7800	Ams	18204	10 July 1946	Shasta fir
	8000	Ams	20124	25 June 1947	Shasta fir

Species	Altitude	Zone	Collection Numbers	Date	Suscept Substratum
42. *Trichia alpina* (R.E.Fr.) Meylan.	8000	Ams	10227-A	21 July 1938	Anemone occidentale
	5700	M.C.	16667	3 July 1942	Veratrum californicum
	5700	M.C.	16669	3 July 1942	Veratrum californicum
43. *Trichia ?botrytis* (Gmel.) Pers.	8100	Ams	20212	1 July 1947	Shasta fir
	6000	Ac	20243	10 July 1947	Abies concolor
44. *Trichia favoginea* (Batsch) Pers.	8000	Ams	10146	10 June 1938	Shasta fir
	8000	Ams	13275	29 July 1939	Shasta fir
	8000	Ams	20128	25 June 1947	Shasta fir
45. *Trichia varia* Pers.	8000	Ams	15672	7 Aug. 1941	Shasta fir
	8000	Ams	20118	25 June 1947	Shasta fir
46. *Trichia* sp.	7800	Ams	18202	10 July 1946	Shasta fir
47. *Hemitrichia montana* (Morg.) Macbr.	8000	Ams	10141	20 June 1938	Shasta fir
	8000	Ams	18243	14 July 1946	Arctostaphylos nevadensis

had such a striking macroscopic resemblance to myxomycete fruiting bodies that they were collected as Myxomycetes. The former is found on rotting wood and sticks, the latter covered extensive areas on hand hewn boards of Shasta fir.

In the following table, forty-seven entities are listed. Of these, thirty-seven occur in the Shasta fir zone and thirty-one have been found on Shasta fir. In this group of organisms, species are not known to be restricted to host or to substrate. They do not necessarily fruit on the substrate from which they received their nourishment.

Zones in which these species were found have been discussed earlier (Cooke, W. B., The problem of life zones on Mount Shasta, Madroño 6: 49–56. 1941). In the above table these zones are indicated by the following symbols:

Pinus-Libocedrus-Pseudotsuga-Abies zone	
Chaparral association (seral)	C
Pinus-Libocedrus-Pseudotsuga-Abies association	M.C.
Abies concolor zone	Ac
Abies-Tsuga zone	
Abies magnifica var. *shastensis-Tsuga mertensiana* association	A.T.
Abies magnifica var. *shastensis* association	Ams
Pinus albicaulis zone	Pa
Alpine zone	A

A complete series of these species is in the herbarium of the State University of Iowa at Iowa City. Partial sets are filed at the University of California, Berkeley; the New York Botanical Garden; the University of Cincinnati; the Farlow Herbarium, Harvard University; Mycological Collections, Bureau of Plant Industry, Soils and Agricultural Engineering, Beltsville, Maryland; and in the writer's herbarium.

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A NEW POLYGONUM FROM OREGON

William H. Baker

Polygonum cascadense sp. nov. Annuum; caulis 0.4–1.5 dm. altus, internodi breves; folia 5–15 mm. longa, oblanceolata, oblonga, obovata vel lineari-oblonga, sessilia; inflorescentia densissima, 4–5 floribus axillaribus; perianthia alba vel rosaceotincta; costa distincta; pedicellis erectis; stamina 8, antheris purpureis, filamentis basi dilatis; achaenia 3 angulata, 2 mm. longa, ovoidea vel ovoidea-oblonga, laevia, nigrescentia, inclusa vel paulo exserta.

Glabrous or slightly scurfy, wiry, light green annual; stem 0.4–1.5 dm. tall, angled, ridged or roughened between the angles, simple and erect or divergently branching at and above the base,

Plate 1. Polygonum cascadense sp. nov. Photograph of the type specimen before pressing. Approximately 7/8 natural size. (Photograph by Mr. John C. Garman).

internodes short or slightly elongated; nodes somewhat enlarged and covered by the reddish-brown bases of the ochreae; ochreae transparent and lacerate above, 2 mm. long, leaves numerous, quite evenly distributed on the stem, 5–15 mm. long, oblanceolate, oblong, or obovate to broadly linear-oblong, sessile, not greatly reduced upwards, apex acute, margins revolute; inflorescence of usually 4–5-flowered axillary clusters occurring the length of the stem; perianth white or pinkish, each lobe with a broad pink or reddish, or narrow greenish band; pedicels erect, 2 mm. long; stamens 8, included; filaments white, conspicuously dilated at base; anthers purple; styles 3-parted almost to the base, included, 6 mm. long; achene triquetrous, 2 mm. long, ovoid or ovoid-oblong, not constricted at apex, black, smooth, shining, included to slightly exserted.

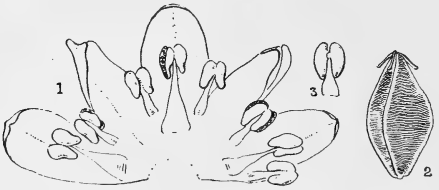

Fig. 1 *Polygonum cascadense:* 1, opened bud with pistil removed; 2, fruit; 3, stamen, dorsal view. All × 13 diam. (Drawings by Helen M. Gilkey).

Type. South slope of Fairview Mountain, Calapooya Range, Lane County, Oregon, 28 September 1947, *Baker 5129* (OSC). Additional collections: OREGON. Klamath County: Crater Lake, *Anderson & Simpson 116* (OSC). Lane County: meadow on South Fork of McKenzie River 22 miles above Bridge, *L. F. Henderson 16698* (Ore.); south slope of Fairview Mountain, Calapooya Range, 17 September 1946, *Baker 3339* (Herb. Baker).

The known range is from McKenzie Pass to Crater Lake in the Cascades and in the Calapooya Range. The plant grows on rocky slopes at 1800 meters elevation on the south slope of Fairview Mountain and the east slope of adjacent Bohemia Mountain; it appears to be late flowering at these stations.

A member of the subgenus Avicularia, the new species has been confused with other members of *Polygonum,* but appears to be most closely related to *P. Nuttallii* Small. From this species it differs in having broader leaves, shortened internodes, more numerous flowers in all the cauline leaf axils, a white or pinkish calyx with a pink, reddish, or greenish band on each lobe, and more obtuse achenes.

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Contents

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THE FERTILE SPECIES HYBRID, PINUS MURRAYBANKSIANA

F. I. Righter and Palmer Stockwell

The species hybrid between the lodgepole pine, *Pinus contorta* var. *latifolia* Englem. (long known as *P. Murrayana* Grev. & Balf.) and the jack pine, *P. Banksiana* Lamb., has proved to be of considerable interest. In the first place, production of this hybrid throws light on the relationship of two economically important North American pines. Secondly, its good form and rapid growth may indicate hybrid vigor, or heterosis.

The history of this hybrid, produced at the Eddy Arboretum, Institute of Forest Genetics, Placerville, California, began in April, 1939, when pollen-bearing strobili of the jack pine were collected from a tree grown in the Eddy Arboretum from seed obtained from Michigan. The pollen was used on June 9 and 12 to pollinate previously bagged ovulate conelets of a lodgepole pine growing at an elevation of 5700 feet in El Dorado County, California, on the west slope of the Sierra Nevada. The breeding techniques used have been described by Cumming and Righter (1948). In May, 1940, both wind-pollinated and hand-pollinated conelets on the El Dorado County lodgepole pine were bagged for protection from insects and squirrels during the period of seed maturation. The following October, 43 wind-pollinated and 34 hand-pollinated cones were harvested from this tree. The wind-pollinated cones yielded a total of 905 seeds with a viability of approximately 30 per cent, and the hand-pollinated cones yielded 700 seeds, approximately 6 per cent of which were viable. Hybrid seeds from the hand-pollinated cones germinated 3 days sooner on the average than seed of equal weight from the open- or wind-pollinated cones, and the hybrid seedlings displayed, from the outset, a faster growth rate than the wind-pollinated seedlings (Righter, 1945). At 3 years of age the average height of the hybrids was 23.8 inches, while the wind-pollinated lodgepole pine averaged 13.3 inches in height. Typical plots of 3-year-old progenies are shown in Figure 1.

At the age of 3 years, 15 hybrid seedlings were paired with 15 wind-pollinated seedlings in a plantation "t" test (Fisher, 1941) consisting of 5 pairs of plots of 3 seedlings each. The average height of the seedlings from the hand pollinations at the age of 7 years was 4.9 feet, while the wind-pollinated seedlings averaged 2.6 feet in height, a highly significant difference.

Some of the hybrid seedlings obtained from the controlled crossing produced strobili of one sex, or of both, when 2 years old (at the beginning of the third growing season). Reproductive activity increased until at 6 years it was possible to place 50 pollination bags, enclosing more than 200 conelets on 12 of the hybrid

Madroño, Vol. 10, No. 2, pp. 33–64. May 11, 1949.

FIG. 1. In the front row with twine tied from top to top are lodgepole pines. In the back row, and similarly marked are the hybrids between lodgepole and jack pine. All are three years old.

seedlings. None of the seedlings from wind pollination produced catkins or conelets until the age of 6 years, when a few strobili of one sex or of both were borne by some of the trees in the plantation test. However, flower production (both sexes) has been reported previously on jack pine at the age of 3 years, and on lodgepole pine at the age of 4 years (Righter, 1939). In another instance ovulate strobili were observed on 2 year old jack pine.

Pollen of the hybrid (fig. 2) was found to be 40 to 50 per cent abortive while that of the parent species is normally only 5 to 10 per cent abortive. Seed-production data, however, indicate that the hybrid is similar to the parents in its output. Thus, an average of 13 sound seeds per cone was obtained from wind-pollinated cones of 2 lodgepole pine trees and an average of 13.1 sound seeds per cone was obtained from wind pollinations and from backcrossing jack pine onto several of the hybrids. This disparity between the production of sound seed and pollen sterility may be explained by two facts. First, from several to many pollen grains usually enter each pollen chamber and are available for fertilizing the egg cell. Second, from 3 to 5 archegonia are normally initiated, but usually only one of these matures and forms a functional egg cell. Thus one viable pollen grain from the several that enter the pollen chamber and one functional egg cell from the 3 to 5 archegonia that are initiated would insure complete fertility (Stockwell, 1939).

The vegetative vigor and reproductive precocity of the hybrid led to an investigation by Buchholz (1945) into the embryological aspects of hybrid vigor in this cross. The same El Dorado lodgepole pine seed tree was used, but the pollen used in making the cross for Professor Buchholz was a mixture obtained from several trees of jack pine growing in the Eddy Arboretum. Buchholz determined that the rate of development of the embryo in the resulting hybrid seeds exceeded that in the natural seeds of the parental species.

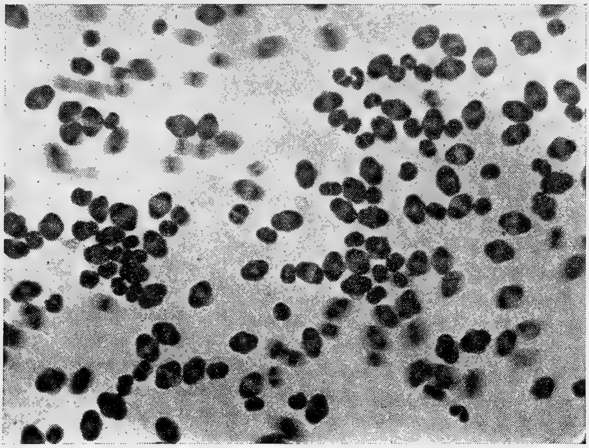

Fig. 2. Pollen of the hybrid between lodgepole pine and jack pine showing approximately 50 per cent abortion.

Additional seeds obtained from the above cross were germinated and the seedlings were compared in nursery tests with the natural progeny of, first, the same lodgepole pine seed-tree and, second, jack pine. Conclusive results with respect to vegetative vigor were not obtained from these tests. Exceptional variation in vigor among individuals in the hybrid plots in both tests indicated that the seed might have been mixed in weighing or that pollination had not been controlled completely. In both tests the hybrids were slightly taller on the average than their competitors, but the differences were not statistically significant.

Both jack pine and the hybrid grow faster than lodgepole pine. Any seed mixture or lack of pollination control, where lodgepole pine was the seed parent, would have resulted in seed of lodgepole pine and the hybrid being mixed and sown together with a consequent reduction in average growth rate. Because of the variability of the hybrids and the fact that their average growth equalled or slightly exceeded that of jack pine it may be assumed that the hybrids at least equal, or probably surpass jack pine in growth rate.

In 1944 the cross was repeated on the same El Dorado County lodgepole pine seed tree with a mixture of pollen from several jack pine trees. Seeds obtained from this cross were tested

TABLE 1. DISTINGUISHING CHARACTERS OF P. CONTORTA VAR. LATIFOLIA, P. BANKSIANA AND × P. MURRAYBANKSIANA.

Distinguishing characters	*P. contorta* var. *latifolia*	*P. Banksiana*	× *P. Murraybanksiana*
Branches	stiff, ascending, straight	flexible, often drooping, sinuate	stiff, ascending, straight
Spring shoots	glaucous	glabrous	± glabrous
Strobili	15–20 mm. long	6–8 mm. long	8–12 mm. long
Open cones	50–70 mm. long; 35–40 mm. diam. recurved	4–5 mm. long; 3–4 mm. diam. incurved	3–4 mm. long; 2.5–3.5 mm. diam. recurved
Cone scales	opening regularly at maturity	opening irregularly and incompletely at maturity	opening regularly and completely at maturity
Apophyses	moderately carinate	usually depressed or plane	usually plane
Prickles	slender, recurved, to 5 mm. long	minute or absent	absent to 1 mm. long

against the natural progeny of the seed parent in a "t" test, consisting of 10 pairs of plots of 10 seeds per plot at a spacing of 12 inches between rows. Germination records were taken every 4 days; there was no statistically significant difference in time of germination between the hybrid and the parental form. At the age of 2 years, the average heights of the hybrids and the natural progeny were 8.9 inches and 6.6 inches, respectively, a highly significant difference.

In 1945, conelets on hybrid seedlings were pollinated with a mixture of jack pine pollen from several trees. Seeds from this backcross were tested in the 1947 nursery against jack pine seeds obtained from the Chippewa National Forest, Minnesota. This test, started on May 7, consisted of 10 pairs of plots, after one pair had been discarded because no seedlings survived in the jack pine plot. There was no difference in time required for germination. Sixty per cent of the hybrid seeds germinated and 27 per cent of the jack pine seeds germinated. At the age of 1 year the average heights of the hybrids and the jack pine seedlings were 3.8 inches and 2.5 inches, respectively, a significant difference. The averages are based on 69 hybrids and 34 jack pine seedlings, or approximately 7 hybrid seedlings and about 4 jack pine seedlings per plot. A number of very weak jack pine seedlings were excluded in computing plot means.

Although the results of these experiments do not constitute conclusive evidence that the backcross is superior to jack pine in height at the age of 1 year, they do indicate that it is distinctly superior on the average to lodgepole pine in vegetative vigor and that it is equal to or possibly superior to jack pine.

Segregation of characters in the progenies of this hybrid will be studied when the seedlings have matured sufficiently to permit analysis.

The two parental species of this hybrid are very similar in all except cone characters. The close relationship indicated by their morphology (table 1) is borne out by the crossing tests. The hybrid is similar vegetatively to the parents; its cone is intermediate.

In order to preserve its identity in the literature as a hybrid and to indicate its derivation, it is proposed that this hybrid be known as × *Pinus Murraybanksiana.* This name was chosen because the lodgepole pine has long been known to western botanists, as *P. Murrayana* and because it would be difficult to coin a satisfactory name from the accepted tri-nomial *P. contorta* var. *latifolia.*

× **Pinus Murraybanksiana** hybr. nov. Arbor hybrida fertilis (*Pinus contorta* var. *latifolia* Engelm. × *P. Banksiana* Lamb.), forma *P. contorta* var. *latifolia* similis; recta, pyramidata-angustata; trunco excurso, ramis verticillatis, adscencis; ramulis multinodis, plerumque glabris, levibus; foliis binis, 4–5 cm. longis, rigidis, obscuro-viridibus; canaliculis resiniferis medianis; hypodermis biformi; vaginis 5–7 mm. longis, pallida-fuscis, membranaceis, erosis, recurvis ultimum, iulis staminiferis 8–12 mm. longis, ochrofuscis; conis sessilibus, inaequalibus, anguste-ovatis, 5–7 cm. longis, fuscis; apophysis planis vel pauciens carinatis, umbonibus planis vel pauciens convexis; spinis brevibus, tenuibus, fragilibus, recurvis; seminibus fertilibus, ca. 3 mm. longis, obscure triangularibus, fuscis; alis angustis, membranaceis, ca. 1.5 cm. longis.

Type. Institute of Forest Genetics, Placerville, California, April 24, 1947, *Stockwell* and *Cumming 2015* (Herbarium University of California, Berkeley, 773157; isotypes distributed). Specimens of parental species: *P. contorta* var. *latifolia, Stockwell* and *Cumming 2013; P. Banksiana, Stockwell* and *Cumming 2014*.

Institute of Forest Genetics, a branch of the California Forest and Range Experiment Station maintained by the Forest Service, USDA, in cooperation with the University of California, Berkeley.

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THE SOLANUM NIGRUM COMPLEX IN PACIFIC NORTH AMERICA

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In the large genus *Solanum,* perhaps the most widespread species-group is that contained in the section Morella, and centering about *Solanum nigrum* L., often known as "deadly nightshade." It consists of weedy perennials or annuals, many of which have become adventive in regions far from their original habitats. In addition, practically every continent and floral region has its indigenous members of the complex. These facts, as well as the great variability of the species, combine to make the group very difficult taxonomically. Many of the more conservative botanists, such as Gray (1886, p. 227) recognize only one species in the entire complex. On the other hand Dunal (1852, pp. 28–387), in his monographic treatment of the genus has recognized no less less than 53 species in this section. An even larger number has been recognized by Bitter (1912, 1913) in his several publications on the genus.

Various members of the complex have from time to time been subjected to cytogenetic analysis. Jorgenson (1928) dealt primarily with the European species, true *S. nigrum* L. and *"S. luteum"* (= *S. villosum* Lam.). He showed that these two species have different chromosome numbers, 2n = 72 and 2n = 48 respectively, and can be hybridized only with the greatest of difficulty. Nakamura (1937) found that the plants growing in Japan and classified as *S. nigrum* actually comprise two distinct species, the typical *S. nigrum* with 72 chromosomes and a diploid with 24 chromosomes, which he named *S. photeinocarpum* Nakamura. Cytological studies by other authors (Tokunaga 1934, Ellison 1936) have confirmed the existence of several different chromosome numbers within the complex.

Our attention was called to this complex by two observations. In the first place, the senior author noticed that the small-flowered straggling perennial which passes as *S. nigrum* in California looked obviously different from the larger flowered, thin-leaved annual which he had previously recognized by that name in the eastern United States. A count of its chromosomes showed that it was a diploid, with 2n = 24 chromosomes. In the second place, the junior author continued an exploration of the complex, only to find that two different chromosome numbers exist among the plants passing as *S. Douglasii* Dunal. Plants from the San Francisco peninsula were hexaploids with 2n = 72 chromosomes, while those from Monterey, the type locality for the species, and

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[1] Parts of this study were carried out by the junior author during the tenure of a Mary S. Muellhaupt post-doctoral scholarship, granted by the Ohio State University.

from locations throughout central and southern California were found to be diploid, with 2n = 24.

These observations led to a cytogenetic study of the complex by the junior author, with special emphasis on the origin of the 72 chromosome form passing as *S. Douglasii.*

This paper aims to present only the taxonomic implications of the cytogenetic investigation the complete results of which will be published elsewhere. From the taxonomic point of view, perhaps the most important fact discovered is that incompatibility as well as weakness and partial sterility of F_1 hybrids are found in crosses between members of the complex having the same chromosome numbers as well as between those with different numbers. This confirms the fact previously established by other cytogeneticists studying the complex, that several distinct species are present in it. On the other hand, hybrids between forms of typical *S. Douglasii* differing in such characters as serration and pubescence of the leaves, as well as size of the flowers, were completely fertile. This indicates that many, if not most, of the species erected by Dunal and Bitter on such trivial characters as these are invalid. Furthermore, the incomplete nature of many of the sterility barriers, as well as the occasional presence of male sterility in wild individuals clearly belonging to a good species and not of hybrid origin, suggests that in this complex some of the diploid entities are species "in the making," which have developed partial but not complete isolating mechanisms separating them from their nearest relatives. This fact undoubtedly contributes considerably to the taxonomic difficulty of the group.

In addition to these cytogenetic observations, the intimate acquaintance which the junior author made with living representatives of this group at all stages of their life history enabled him to observe many diagnostic characters not previously recognized. He showed that the hexaploid passing as *S. Douglasii* could always be distinguished morphologically from the typical diploid species, even before its chromosome number was known. This hexaploid, originally believed to be an endemic of the San Francisco Bay region, was later found to be identical with the common large-flowered *Solanum* of Chile, for which the oldest valid name is *S. furcatum* Dunal. It is an introduced weed in the San Francisco area, as well as at Westport and Trinidad, California, and in a few places on the Oregon coast. Furthermore, the authors have found that the American diploids can be distinguished morphologically from the typical European *S. nigrum,* and so are considered specifically distinct from it. Finally, it was found that the form passing in California as *S. nigrum* var. *villosum* is not the European *S. villosum* Lam., but a very different species, *S. sarachoides* Sendt., native to South America.

Therefore, while the authors are far from possessing enough knowledge to enable them to revise this difficult complex as a whole, they feel justified in placing on record their observations on the identity and relationships of the representatives of the group which they have studied. A few synonyms have been given with the descriptions of some of the species in order to indicate the opinion of the authors as to the correct disposition of these names. However, no attempt has been made to give a complete synonymy of any of them. They may be identified by the following key:

A. Plants conspicuously and persistently villous or hirsute; ripe berries greenish, yellow, or reddish; seeds 1.8–2.2 mm. long.

B. Flowers 3–8 in an inflorescence; apex of pedicel and calyx strongly expanded at maturity, the latter enveloping the lower part of the berry; ripe berry greenish ..... 1. *S. sarachoides* Sendt.

BB. Flowers 1–5 in an inflorescence; pedicel and calyx not or only slightly expanded at maturity; ripe berry yellow or reddish .... 2. *S. villosum* Lam.

AA. Mature growth of plants sparsely pubescent or glabrous; ripe berries black; seeds 1.2–1.8 mm. long, except in the sparingly introduced *S. nigrum* L.

C. Larger inflorescences usually bifurcate, the peduncle deflexed at maturity; flowers relatively large (corolla lobes 6–11 mm. long); filaments unequal in length; mature berries immediately deciduous when ripe, containing 7–34 seeds; straggling perennial .... 3. *S. furcatum* Dunal

CC. Inflorescences rarely bifurcate, the peduncle remaining erect at maturity; flowers large or small; filaments nearly or quite equal in length; mature berries persisting on the plant in the ripe condition (except in *S. americanum*), containing 25–80 seeds; perennial or annual.

D. Flowers large; corolla lobes 6–11 mm. long measured from the base of the corolla; anthers 2.6–4.0 mm. long; style exserted about 2 mm. beyond the anthers; stigma very slightly expanded; bushy perennial .... 4. *S. Douglasii* Dunal

DD. Flowers smaller; corolla lobes 3–7 mm. long; anthers 1.2–2.6 mm. long; style barely exserted beyond the anthers, the stigma enlarged and capitate.

E. Annual or perennial, the leaves firm in texture; inflorescence umbelliform or nearly so; calyx lobes all distinct from each other, reflexed at maturity; surface of berry glossy; stone cell concretions absent or few, rarely more than 3 .... 5. *S. nodiflorum* Jacq.

EE. Strictly annual, the leaves thin in texture; calyx lobes unequal in length, some of them partly fused, not reflexed at maturity

F. Inflorescence mostly umbelliform; anthers 1.4–2.0 mm. long; surface of berry glossy; seeds 1.2–1.8 mm. long; stone cell concretions always present, usually 4 to 8 per berry; berries immediately deciduous when ripe .... 6. *S. americanum* Mill.

FF. Inflorescence always subracemose; anthers 1.8–2.6 mm. long; surface of berry dull; seeds 1.7–2.2 mm. long; stone cell concretions absent, or very small and not more than 1–2 per berry. .... 7. *S. nigrum* L.

The following notes on these seven species are based upon observations of living plants studied both in the wild and in greenhouse cultures at Berkeley, and of the large series of specimens in the Herbarium of the University of California (cited as UC), the Gray Herbarium, Harvard University (GH), the Dudley Herbarium, Stanford University (DS), and the Willamette University Herbarium, Salem, Oregon (Will.). The authors are most grateful to the curators of these herbaria for the loan of these specimens.

1. **SOLANUM SARACHOIDES** Sendt. ex Mart. Fl. Bras. 10: 18. 1846. *S. gracile,* sensu Gray, Syn. Fl. N. Am. 2 (1): 228. 1878, and Small, Man. Southeastern Flora 1114, 1933, not Link.

This species, described from Brazil and native to subtropical and temperate South America, has become widely distributed in the United States. In the flowering condition it is not unlike other members of the complex, but in fruit it is entirely different from any other species found in North America. As the berry ripens its pedicel becomes much swollen near the apex and the calyx enlarges to several times its size at anthesis. The greenish berry contains large seeds, like those of *S. villosum* and *S. nigrum,* but these are fewer in number. *S. sarachoides* is diploid, 2n = 24.

The confusion of this species with the very different *S. villosum* Mill. of Europe seems to be based only on the fact that both species have hairy stems and leaves. Their pubescence, however, is very different in character. The stem and leaves of *S. sarachoides* are green and are thinly hirsute, with spreading, slender trichomes, while the pubescence of *S. villosum* is usually denser and more or less appressed, so that the plant looks grayish to the naked eye. The floral and fruiting characteristics mentioned above and in the key are even more distinctive.

The specimens referred to this species have been carefully compared with the description and illustration of Sendtner (*loc. cit.*), as well as with the photograph of the type specimen (Villa das Minos, Uruguay, *Sellow 281*) preserved in the Gray Herbarium. This type was at Berlin. There is no doubt that the specimens from North America agree exactly with it, as well as with other specimens from South America. *Solanum sarachoides* is a rather common weed in arable land throughout the Pacific states, and apparently was introduced at an early date. There are two specimens in the Gray Herbarium that were collected in 1877, one from between Virginia City and Carson City, Nevada (*Hooker & Gray s.n.*), and one from Multnomah County, Oregon (*Howell 333*). It has been usually identified as *S. nigrum* L. var. *villosum* Mill., or as *S. villosum*. The following specimens may be considered typical.

British Columbia. Vancouver Island, *Macoun 698* (GH); Fraser River, *Condit* in 1909 (UC).

Washington. Klickitat County: near Bingen, *Suksdorf 1480* (GH, UC). Jefferson County: near Port Townsend, *Barber 158* (GH), *Otis 2343* (UC, DS).

Oregon. Portland, *Nelson 1729* (GH); Minto's Island, Salem, *Nelson 2927* (GH). Umatilla County: Milton, *Brown 39* (UC). Union County: Fry's Point, alt. 1000 m., *Sheldon 9036* (GH).

California. Solano County: Vallejo, *E. L. Greene, s.n.* (GH). Mono County: Mono Lake, *Congdon* in 1894 (GH). Humboldt County: Eureka, *Tracy 3074* (UC). San Mateo County: near Moss Beach, *Wiggins 8164* (UC, DS). Los Angeles County: La Verne, *Wheeler 1130* (UC). Orange County: Santa Ana River, *Booth 1344* (UC). Amador County: Ione, *Braunton 1200* (UC).

2. Solanum villosum Mill. Gard. Dict. ed. 8, no. 2. 1768; Lam. Illustr. 2: 18. 1793. *S. luteum* Mill. (*op. cit.*), no. 3, 1768. *S. alatum* Moench. Meth.: 474, 1794; Small, Man. Southeastern Flora 1114, 1933.

This European species is a rather uncommon introduction in the United States. It is characterized by its usually dense, grayish-villous pubescence; rather small, ovate leaves; yellowish or reddish berries; and large seeds. It is a tetraploid, 2n = 48. The only specimen seen from western North America is from a plant cultivated in the University of California Botanical Garden, Berkeley (*McKay* in 1930, UC). A collection from Pensacola, Florida (*Curtiss 6493* GH, UC) consists of typical material from the eastern United States.

3. Solanum furcatum Dunal, Solan. Gen. aff. Syn. 13, n. 52. 1816. *S. chenopodioides* Lam. Illustr. 2: 18. 1793, in part. *S. rancaguense* Dunal, ex DC. Prodr. 13: 150. 1852.

Perennial, mostly straggling or reclining on other plants; the stems long and slender, with internodes longer in proportion to stem diameter than in the other species found in North America; peduncles slender, becoming strongly deflexed as the berries ripen; inflorescence racemose to cymose, the common peduncle often bifurcate at the apex; flowers large, the corolla lobes 6–11 mm. long, the sinuses shallow; filaments 1.0–2.3 mm. long, unequal; style projecting well beyond the anthers, stigma dark, capitate; berries small, deciduous immediately after ripening, mostly with 12–25 seeds and many large stone cell concretions. Chromosome number, 2n = 72.

The fine series of specimens of this species from Chile in the Gray Herbarium all agree in the characteristics given above, although they vary considerably in leaf shape, flower size, etc. They represent collections from all parts of central Chile, and include a duplicate of the type collection (Chili, *Dombey,* as *Witheringtonia rubra*). The following specimens from North America have been seen.

Oregon. Ballast, Linnton, *Nelson 505* (GH, DS). Curry County: The Heads, Port Orford, *Peck 20389* (Will.); near Harbor, *Peck 21262* (Will.); Port Orford, *Keck and Clausen 3428* (DS); Gold Beach, *Hoyt 44* (DS). California. Humboldt County: Trinidad, *Tracy 16749* (UC). Mendocino County: Noyo, *Duncan 215* (DS); Westport, *Paddock 167, 168* (UC). San Mateo County: San Pedro Point, *Brandegee* in 1908 (UC); Mussel Rock, *Paddock 19* (UC).

Solanum furcatum looks superficially like *S. Douglasii* Dunal, but is easily recognizable upon close examination by the characters given in the above key. *S. furcatum* is apparently the commonest species of this complex in Chile. It is apparently the Chilean plant referred to by Lamarck (loc. cit.) in his description of *S. chenopodioides,* and has been given this name by some students of the Chilean flora. Lamarck, however, had two different plants in mind when he described this species. After the original description he cites as a locality first "Ex ins. Mauritiana," then "An *S. chenopodioides* Feuillee obs. 2. t. 14." From this it seems evident that Lamarck was describing primarily the plant from Mauritius. This is even clearer from the amplified description in his Encyclopédie Méthodique (1797, p. 290), in which he characterizes the plant as having 3 or 4 small flowers in an inflorescence. The species which best fits this description is the pantropical weed, *S. nodiflorum* Jacq. The type locality for *S. nodiflorum* is Mauritius, and it is the only species of the section which grows both on that island and in Chile.

In genetic behavior as well as chromosome number, *S. Douglasii* and *S. furcatum* are very different. The junior author was unable to obtain hybrids between them, even though attempts were made in both directions. Seedless, parthenocarpic fruits developed when *S. furcatum* was used as the ovulate parent. However, an artificially produced autotetraploid *S. Douglasii* produced pentaploid hybrids when crossed with the hexaploid *S. furcatum.* These hybrids were vigorous and partly fertile, setting 5 to 8 seeds per berry after artificial selfing.

In North America, *S. furcatum* is certainly a recent introduction. It occurs abundantly in only three restricted localities, all near seaports, namely San Francisco and Westport-Noyo in California, and Port Orford, Oregon. In the Westport-Noyo region the junior author has collected a distinctive narrow-petaled strain

(*Paddock 168,* UC), and one having entire-margined leaves (*Paddock 167,* UC). One or both of the writers have observed *S. furcatum* at all of its known stations in North America except for Linnton, Oregon, and at all it looks and behaves like a recently introduced weed.

4. Solanum Douglasii Dunal, ex DC. Prodr. 13: 48. 1852. *S. nigrum* var. *Douglasii* Gray, Bot. Calif. 1:538. 1876.

From coastal north-central California south to Baja California, eastward through Arizona, New Mexico, and northern Mexico, southeastward at higher altitudes throughout Mexico and probably Central America. This is the common native member of the section throughout the southwestern United States and Northern Mexico, and has been well described in the various floras. Its bushy, perennial habit, large leaves and flowers, and numerous, persistent, many-seeded black berries serve to distinguish it easily from any other species found in this area. It is a diploid ($2n = 24$).

In California, where *S. Douglasii* is native and *S. nodiflorum* an introduction, the two species are quite distinct from each other. Intermediate forms have been found only in one locality, at Hecker Pass northeast of Watsonville, Santa Cruz County. In Central Mexico, however, both species are native, and they are much less well defined. All specimens seen from the tropical parts of Mexico are typical *S. nodiflorum,* while those from the higher plateau, as about Mexico City, seem indistinguishable from the northern *S. Douglasii.* In certain intermediate areas, however, as at San Luis Potosí, several specimens intermediate in character have been collected. Some of these have partly or completely abortive and sterile pollen. A few, however, have normal pollen and occasional plants with abortive pollen occur among those typical both of *S. Douglasii* and *S. nodiflorum.*

This confusing situation is perhaps explained by the hybridization experiments of the junior author. He has found that *S. Douglasii* and *S. nodiflorum* can be reciprocally hybridized rather easily, but that the F_1 hybrids have from 50 to 100 per cent of abortive pollen, and consequently are only partly fertile. Nevertheless, they yield vigorous, partly fertile progeny when back crossed to either parent. On the basis of this evidence one would not expect extensive intergradation between the species unless they had been growing side by side for some time. Nevertheless, once F_1 hybrids and their derivatives became established, they would, because of their vigorous growth and perennial habit, yield a large number of back cross progeny, which would tend to obscure the initial distinctness between the species. *Solanum Douglasii* and *S. nodiflorum* may therefore be looked upon as "borderline species," which are separated by both ecological and genetic isolating mechanisms, neither of which is perfectly developed.

The northernmost station known for *S. Douglasii* is Rockport, Mendocino County, California (*Paddock 165,* UC). It is not known between here and southwestern San Mateo County, where it is rather common. From thence southeastward it is so well known and easily recognized that citation of specimens seems unnecessary.

5. Solanum nodiflorum Jacq. Ic. Pl. Rar. 2: 288. 1786. *S. chenopodioides* Lam. Illustr. 2: 18. 1793, *pro parte. S. photeinocarpum* Nakamura et Odashima, Jour. Soc. Trop. Agr. 8: 54, fig. 2. 1936; Cytologia, Fujii Jubil. Vol.: 58. 1937. *S. nigrum* vars. *Dillenii* and *nodiflorum* Gray, Syn. Fl. North America 2 (1): 288. 1878. *S. nigrum,* sensu Jepson, Man. Fl. Plants Calif. 892. 1925, not L.

Straggling perennial; stems rounded or angled; leaves entire or sinuate-dentate; inflorescences umbelliform; calyx lobes small, thick and reflexed at maturity; flowers small; filaments and anthers variable in length, the latter 1.5–2.4 mm. long; berry shiny black, many-seeded, usually without stone cell concretions, or with 1 to 4 small ones. Chromosome number, 2n = 24.

This and *S. nigrum,* are the two commonest, most widespread and most variable species of the section Morella. It apparently is an ubiquitous weed in the tropics of both hemispheres, although probably native only to the New World. The type locality is the island of Mauritius. In the western United States it is clearly introduced, probably from Mexico. It is common throughout coastal California, having been described in all of the floras as *S. nigrum.* It extends northward into Washington. Its occurence in southern Japan and Formosa has been discussed by Nakamura (loc. cit.) who described it as a new species, *S. photeinocarpum.* From seeds kindly sent by Dr. Nakamura, we have grown plants which are morphologically very similar to those collected in Berkeley. Hybrids between these two forms had better than 50 per cent fertility of pollen and seed.

The typical form of *S. nodiflorum,* with entire leaves, rounded stems, narrow corolla lobes, and short filaments, is the most common one in the tropics. In sub-tropical or warm-temperate regions the more common type has dentate leaves, angled stems and longer filaments. In a weed of this type, however, geographical subspecies or varieties are very poorly defined. In California the dentate leaved form is definitely the more common, but many specimens morphologically indistinguishable from the tropical form have been collected in southern California, where they do not show any difference in habitat preference from the dentate-leaved plants, and where all sorts of intergradations and recombinations of the character differences noted above can be found. After thorough acquaintance in the field with this species in many different countries, one might be justified in recognizing geographic segregates, but at present the wisest course is to recognize that we are concerned with an extremely variable species.

Citation of specimens of this common weed seems unnecessary; nearly all of the specimens from California identified as *S. nigrum* belong to it. In Oregon and Washington there occur puzzling integrades between it and *S. americanum,* but field studies would be necessary to determine the true status of the plants occuring in this region.

6. Solanum americanum Mill. Gard. Dict. ed. 8, no. 5. 1768. *S. pterocaulon* Dunal, Hist. Solan.: 153. 1813. *S. Besseri* Weinm. ex Roem. et Schultes, Syst. 4: 593. 1819. *S. nigrum* sensu Gray, Syn. Fl. N. Am. 2 (1): 227. 1886, and other American authors, in large part, not L.

Similar to *S. nodiflorum,* but always annual; leaves usually larger and thinner in texture; inflorescence usually umbellate but occasionally subracemose; flowers somewhat larger than those of *S. nodiflorum,* the corolla lobes 4.5–7.0 mm. long, from the base of the corolla; calyx thin, green, its lobes short-deltoid, unequal, some of them partly united, not reflexed at maturity; anthers 1.3–2.0 mm. long, the filaments about half as long; berries black, lustrous, many-seeded, with 2–8 stone cell concretions of moderate size. Chromosome number, $2n = 24$.

Throughout the eastern United States, south to northern Florida and Texas, west to the Great Plains, and perhaps Oregon and Washington.

With his original description, Miller does not cite the locality from which his specimens came, nor does he cite any specimens. However, the Latin description is followed by the following remark: "American nightshade like the common sort, with a small purplish flower, and smaller black berries." The flowers of the eastern American plant may be either purplish or white, but the berry is usually smaller than that of European *S. nigrum.* Since Miller characterized his species as "like the common sort," one can infer that he was describing the small herbaceous annual of temperate eastern North America, which resembles the European species considerably more closely than does the larger, sub-perennial plant of the American tropics. It is on this basis that the present authors use the name *S. americanum* for the form of the eastern United States, and *S. nodiflorum* for the tropical weed which has passed as *S. americanum* or *S. nigrum* var. *americanum* in some American floras.

Although some of the specimens from Oregon and Washington identified as *S. nigrum* approach *S. americanum* in some characteristics, others are clearly *S. nodiflorum.* No material seen from west of the Rocky Mountains is unquestionably *S. americanum.*

Typical *S. americanum* from the eastern United States, as represented by both herbarium specimens and greenhouse cultures, is very different from Pacific Coast material of either *S. nodiflorum* or *S. Douglasii.* Furthermore, hybrids between it and these species are partly or wholly sterile. The *S. nodiflorum* × *Douglasii* hybrid has already been discussed under the description of *S. Douglasii.* That between *S. americanum* and *S. nodiflorum* has been produced twice. The first series of hybrids, between a strain of *S. nodiflorum* from Berkeley and one of *S. americanum* from Madison, Wisconsin, were weak dwarfs, which were very hard to keep alive, and flowered abortively when only a few inches tall. They were completely sterile. A second hybridization, between the Berkeley *S. nodiflorum* and *S. americanum* from Ohio, produced vigorous F_1 plants which had about 30 per cent of normal appearing pollen and from 15 to 20 per cent of normal seed set on open pollination. These two species, therefore, are separated by barriers of both hybrid inviability and hybrid sterility, but the barriers in each case are only weakly developed.

One hybridization was made between *S. Douglasii* and *S. americanum,* the parents of the hybrid being from Monterey County, California, and near Columbus, Ohio, respectively. These F_1 plants were vigorous and intermediate morphologically, except that their seeds were smaller than those of either parent. They had about 10 per cent of normal appearing pollen, and set 20 to 25 per cent of the normal number of seeds when artificially selfed. The genetic barriers between the three species *S. americanum, S. nodiflorum,* and *S. Douglasii* all seem therefore to be of about the same degree of development. The genetic evidence, while favoring the status of these entities as "borderline" species, would not prevent their treatment as subspecies of a single species.

The fourth member of this group in the United States, which has not been studied in the living condition but which has the pollen size of a diploid, is *S. interius* Rydb. This form, which was first described from the plains of Nebraska, is in most characteristics intermediate between *S. americanum* and *S. Douglasii.* Furthermore, a study of herbarium specimens suggests that in Nebraska, Kansas, and Texas, *S. interius* grades into *S. americanum,* while in New Mexico there are many intermediates between it and *S. Douglasii.* On the other hand, the seeds of *S. interius* are characteristically larger than those of either *S. americanum* or *S. Douglasii,* while those of the artificial hybrid between the two latter species produced by the junior author are smaller than the seeds of either of its parents. The status of *S. interius* cannot be decided until typical material of it is grown with that of *S. americanum* and *S. Douglasii,* and the necessary hybridizations are made. It is apparently the predominant form of the *S. nigrum* complex in the western Great Plains area.

7. **Solanum nigrum** L. Sp. Pl. 186. 1753. *S. Dillenii* Schultes, Oestr. Fl., ed. 2, 1: 393. 1794; non *S. nigrum* var. *Dillenii* Gray, Syn. Fl. N. Am. 2 (1): 228. 1884.

Annual; stems relatively low; leaves variable in shape, but usually entire or only slightly serrate; inflorescence subracemose;

flowers medium-sized, corolla lobes 5.5–7.5 mm. long; anthers 2.1–2.6 mm. long; berries rather large, with a dull surface, many-seeded, the seeds 1.9–2.3 mm. in diameter; concretions absent. Chromosome number, 2n = 72.

Common and widespread in Eurasia and Africa; sparingly introduced in North America, mostly along the Atlantic seaboard. The plants of this species found occasionally in the central and western states are mostly the strain released by Burbank as the "wonderberry." This has rather large fruits, but is otherwise typical of *S. nigrum.* Its berries, like those of all of our members of this section, are edible and harmless. We find them to have a rather insipid flavor.

The distinctions between true *S. nigrum* and *S. nodiflorum* have been clearly pointed out by Nakamura (1937). *S. americanum* is more easily confused with the European species, since it is also an annual, has corollas of nearly the same size, and sometimes has subracemose inflorescences. The smaller stamens, and smaller seeds are the best diagnostic characters to separate *S. americanum* from *S. nigrum.* Furthermore, the berries of *S. nigrum* completely lack the concretions of stone cells which are found to a greater or lesser degree in all plants of *S. americanum.*

Cytologically, *S. nigrum* is very different from most of the other species of the section, since it is a hexaploid with 2n = 72 chromosomes. The junior author has found, as expected, that the extremely vigorous hybrid between *S. nigrum* and the diploid *S. americanum* has a very irregular meiosis and 86 per cent of abortive pollen. The difference in chromosome number between these two species gives rise to an additional diagnostic character by which they may be distinguished, namely a difference in the size of the pollen grains. When mounted in water and heated so that they become spherical in shape, pollen grains from herbarium specimens of *S. nigrum* measure 24–27μ in diameter, while those of *S. americanum, S. nodiflorum,* and *S. Douglasii* are only 16–20μ in diameter. The pollen of the hexaploid *S. furcatum* is as large as that of *S. nigrum,* but these two species always can be distinguished from each other with ease. Their hybrid, *S. nigrum* × *furcatum,* has been found by the junior author to be highly sterile and to have irregular meiotic divisions, in spite of the identity of the chromosome number of the two parents. This hybrid exhibits the growth habit of *S. furcatum.* The only specimen of true *S. nigrum* seen from Pacific North America is the following: near Forestry Building, Portland, Oregon, August 31, 1927, *J. W. Thompson 3663* (DS).

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TWO PROBLEMS IN SALIX DISTRIBUTION

Carleton R. Ball

Two peculiar problems in the distribution of certain North American species of *Salix* have confronted the writer for several years. The first problem is presented by two unrelated species having an extremely extended, but fairly continuous, distribution from south to north. The second problem is concerned with two unrelated species which have a fairly extensive, but finally discontinuous, distribution from east to west. By "unrelated" is meant that the two members of each pair belong to quite widely separated sections of the genus *Salix*.

The geographical direction of distribution given above is from the region of greater abundance to that of increasing scarcity and final disappearance. It is hoped that some one may throw light on the physiological and/or ecological factors governing these peculiar plant distributions.

A. Extremely Extensive South-North Ranges

The two species of *Salix* with greatly extended south-north distribution are *S. lasiandra* (accompanied by its hairy-twigged variety *lancifolia*) and *S. interior* (with its narrow-leafed variety *pedicellata*). Both species range from the latitude of northern Mexico (30°–32° N.) to the Arctic Circle or beyond (67° N.), or some 2500 miles or more. In each case, the species and its variety occur together throughout almost the entire distance.

1. *Salix lasiandra* Bentham, the Pacific or western shining

Fig. 1. Distribution of *Salix lasiandra* and its var. *lancifolia* (hatching) and *S. interior* and its var. *pedicellata* (fine dotting). Localities of marginal collections indicated by letter "x" and large dots, respectively.

willow, and its hairy-twigged variety *lancifolia* (Andersson) Bebb, occur from northwestern Mexico to Alaska and Yukon. From the hot climate of Baja California and southern California, they pass northward abundantly throughout California, Oregon, Washington, western Nevada, and Idaho. In the south, a long finger of sparse distribution projects eastward across the northern portions of Arizona and New Mexico and the adjoining southern parts of Utah and Colorado (fig. 1).

In Canada, the species and variety extend northward, with decreasing abundance, across British Columbia and mountainous western Alberta and eastward into the prairies as far as east-central Saskatchewan and thence north at least to the west end of Lake Athabaska in northern Alberta. Farther north and west, the species occurs on the lower Stikine River in northwestern British Columbia near the International Boundary north of Wrangell, and again on the headwaters of the Chilkat River at the northern tip of the Alaskan "Panhandle".

Species and variety occur together at several points on the Yukon and Klondike rivers in the Dawson area of Yukon (64° N.). In Alaska proper, the variety occurs alone at Matanuska, at the head of Cook Inlet in south-central Alaska. It has been found also along the Yukon River at Fort Yukon (Arctic Circle), Blackburn, and even Holy Cross (62° N., 160° W.), as well as on the tributary Tanana River at Salcha Slough, Fairbanks, and Nenana.

The distribution from northwestern British Columbia across Alaska and western Yukon is sparse but fairly continuous. Similar continuous distribution from Lake Athabaska northwestward across the wide expanse of the Peace River and Liard River drainage is in doubt, but collecting has not been sufficient to prove its absence.

The total recorded range covers about 35 degrees of latitude (32° N. to almost 67° N.). It extends across the Lower and Upper Sonoran, Transition, Canadian, and Hudsonian Life Zones, and almost touches the Arctic Zone at various points on the Yukon River from Dawson to Holy Cross.

2. *Salix interior* Rowlee, and its slender-leafed variety (*pedicellata* (Andersson) Ball, range northward from the mouth of the Mississippi River (30° N.) across the United States and Canada to slightly beyond the Arctic Circle in Alaska. Westward of the Mississippi, they (and especially the variety), fan out across the Great Plains almost to the foothills of the Rocky Mountains in the United States and Canada. Eastward, the species ranges up the Ohio Valley, across the mountains, down the Potomac Valley to the District of Columbia, and thence northeastward to Delaware, New Hampshire, New Brunswick, and Quebec. Then the line runs west to southern Manitoba and northwestward to Lake Athabaska, the species and variety occurring together in the Prairie Provinces (fig. 1).

In the Mackenzie River (Arctic) drainage basin of southern Mackenzie, the species (and occasionally the variety) occur on the Slave River (Fort Smith), on Great Slave Lake (Hay River), and on the Mackenzie River (Fort Simpson, Fort Wrigley, 63° N., 123° W.). Westward, on tributaries of the Mackenzie, the species has been found at the mouth of the Nahanni River (61° N., 124° W.), at Fort Liard on the Liard River (60° N., 124° W.), and on the Upper Liard River at 60° N. This is at about 128° W. and near the British Columbia—Yukon Boundary.

In Pacific drainage, the species and variety occur in British Columbia, Yukon, and Alaska. In northwestern British Columbia, the species has been found once on the Stikine River, near the Alaskan border north of Wrangell. In Yukon, species and variety occur at several points on the Yukon and Klondike rivers within some 20 miles of Dawson (64° N., 140° W.). In Alaska, species and variety follow the Yukon River westward, occurring at Circle (66° N., 144° W.), on Porcupine River 40 miles above the mouth (67° N., 144° W.), Fort Yukon (66° 30′ N., 145° W.), between Rampart and Tanana, between Fort Gibbon and Tanana (65° N., 152° W.), and at Nulato (158° W.). On the tributary Tanana River, the species occurs at Fairbanks and Hot Springs and the variety at Nenana. Outside the Yukon drainage, the species has been found at but one point in Alaska, namely, Paxson's (Roadhouse), just south of the divide separating the north-flowing Tanana and the south-flowing Gulkana-Copper River drainages.

The range recorded above covers 37 degrees of latitude (30°–67° N.) or some 2600 miles, and 90 degrees of longitude (68° W. in New Brunswick to 158° W. in Alaska). The Life Zones covered are the Carolinian, Alleghanian, Canadian, and Hudsonian, with the Arctic Zone almost reached at points on the Yukon River.

One striking fact regarding both *S. lasiandra* and *S. interior* is that there is little or no more observable variation in characters between plants collected at the two extremes of this range than between plants collected at any one point within the range.

In these vast ranges, wide differences occur in temperature, precipitation, humidity, length of season, and length of day. Yet these two species seem to show complete ability to adapt themselves to these differences without observable change in characters.

B. Extensive, but Discontinuous, East-West Ranges

Different species of *Salix* which occur commonly in our northeastern and north-central States and adjacent Canada penetrate westward to very different distances. Some, like *S. interior* Rowlee, *S. rigida* Muhl. (*S. cordata* Muhl.), and *S. discolor* Muhl., are replaced in the Rocky Mountains and westward by related species. Others, like *S. amygdaloides* Anders., reach but do not pass the Sierra-Cascade barrier. Still others, like *S. Bebbiana* Sargent, *S. candida* Fluegge, and *S. pedicellaris* var. *hypoglauca* Fern., extend practically to the Pacific Ocean. Two species which penetrate only to the front range of the Rocky Mountains, and that only by discontinuous distribution, are discussed below.

1. *Salix serissima* (Bailey) Fernald, related to *S. lucida* Muhl. of the East and to *S. caudata* (Nuttall) Heller and *S. lasiandra*

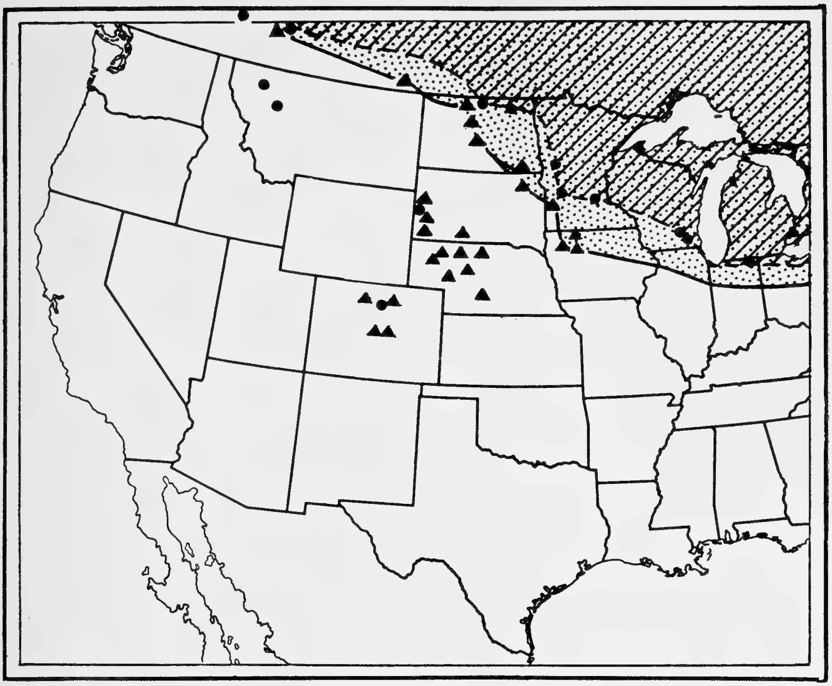

Fig. 2. Southwestern portion of the distribution of *Salix serissima* (hatching and large dots) and of *S. petiolaris* (fine dotting and triangles) in North America, showing relation of the continuous northeastern distribution of these two species to their marginal and discontinuous distributions.

Bentham of the West, occurs commonly from New England and Lower Canada westward. The southern boundary of its range lies along the southern edge of the Great Lakes area to St. Paul and Kandiyohi County, Minnesota, thence northward through Ottertail and Clearwater counties, and westward in North Dakota, in the northern tier of counties (Pembina, Rolette). From here the line runs northwestward to Calgary and the Banff area in southern Alberta. Northward the range extends to Lake Athabaska and southern Mackenzie (fig. 2).

By discontinuous distribution, the species occurs in three separate areas to the south and west of its continuous distribution. The first area includes Flathead (Glacier Park) and Chouteau counties in northwestern Montana, some 150 and 230 miles, respectively, south of Calgary. Far to the west and south of the main distribution are two mountain outposts in South Dakota and Colorado, respectively. In the Black Hills of South Dakota, Professor A. C. McIntosh found it in sedge moor at two localities near Deerfield, Pennington County, in 1928 and 1929. In the Front Range of the Rocky Mountains, Professor Ernest C. Smith collected it at Longs Peak Inn, elevation 9000 feet, on Longs Peak, Larimer County, Colorado, in 1935, 1936, and again in 1943.

The writer previously had presented the known distribution of this species in the United States and Canada in two different papers (Bot. Gaz. 72: 220–22. 1921; Canadian Field Nat. 40: 147–48. 1923). The first paper brought forth a statement from Francis Welles Hunnewell (Rhodora 25: 67–68. 1923) that he had collected *S. serissima* on Longs Peak in 1913 and that the determination had been verified by Dr. Fernald. In the second paper, and again in Deam's Shrubs of Indiana, the writer erroneously credited this collection to Pikes Peak instead of Longs Peak.

The Black Hills locality is about 450 miles from the nearest North Dakota station, and about 500 and 600 miles, respectively, from the two Montana stations far to the northwest. The Longs Peak station is 600 miles from Rolette County, North Dakota, and 600 and 700 miles, respectively, from the two Montana stations. The species has not been found in the intervening expanse of Rocky and Big Horn mountains. Are these few southern plants the remnants of its farthest southern push during glacial times and its wide northern distribution a reoccupation of territory lost during the Glacial Epoch?

2. *Salix petiolaris* J. E. Smith has much the same eastern distribution (fig. 2) as *S. serissima.* It ranges slightly farther south, occupying the northern third of Indiana and the two northernmost tiers of counties in Iowa as far west as the Mississippi-Missouri divide. The line then runs northwest to west-central Minnesota (Chippewa County), northeastern South Dakota (Day County), and adjacent North Dakota (Richland County), and thence passes through McLean, McHenry, and Bottineau counties, of central and north-central North Dakota, and on into Canada. The western border of its continuous distribution is somewhat farther to the south and west than that of *S. serissima.* It is a low clumpy shrub southward, becomes gradually larger northward, and is often a small tree in the Prairie Provinces, where it extends at least to Lake Athabaska.

Correlated with the somewhat greater western extension of its continuous distribution is its broader and deeper discontinuous penetration far to the south and west. Four separate areas are occupied by *S. petiolaris,* as verified by the following collections. 1.) The sandhills of northwestern Nebraska and adjacent South Dakota. Cherry County: Rowley Ranch near Kennedy, 1892, *Smith* and *Pound,* 1910–1914, *Bates;* Bear Creek and Dewey Lake, 1941, *Tolstead;* Oasis, 1912, *Pool* and *Nelson.* Bennett County (southwestern South Dakota adjacent to Cherry County, Nebraska): 1924, *Over.* Sheridan County: near Ellsworth, 1933, *Sandoz.* Brown County: Ainsworth, 1941, *Tolstead.* (The preceding three Nebraska counties are contiguous in north-central Nebraska westward; the following are farther south.) Thomas County: Purdum, 1901, *Baker*. Dawson County: 1943, *Kiener*, Arthur County: 1943, *Kiener*. 2.) The eastern face of the Black Hills of southwestern South Dakota in Custer, Pennington, Lawrence, and Meade counties: Jim Creek (T. 2 N., R. 5 E.) 1913, *Setzer;* Bear Butte Creek (T. 4 N., R. 4 E.), 1919, *Murdoch;* Castle Creek, 1924, *Over;* Castle Creek near Deerfield, 1928, *McIntosh;* near Merritt, 1924, *Over;* Squaw Creek, 12 miles above Game Lodge, 1926, *McIntosh;* Sylvan Lake, 1926, *McIntosh;* Custer, 1928, *McIntosh.* 3.) Estes Park, northern Colorado. Larimer County: Estes Park, elevation 7500 feet, 1933, 1934, *Ernest C. Smith* (seven collections). 4.) The Pikes Peak area in east-central Colorado. Teller County: east of Divide, 1935, *J. H. Christ.* El Paso County: Black Forest, 1935, *J. H. Christ.*

The sandhills area of Nebraska-South Dakota, and the Black Hills area of South Dakota, lie some 300 to 400 miles west-southwest of the margin of the continuous eastern distribution. The two mountain localities in Colorado are about 100 miles apart and 300 to 350 miles southwest of the Nebraska and South Dakota areas and therefore some 600 to 700 miles southwest of the margin of continuous distribution.

In the case of *Salix serissima,* there are four isolated and distant localities of discontinuous distribution, in three States. In the case of *S. petiolaris,* there are two relatively extensive areas and two isolated mountain localities of such distribution, also in three different States.

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SEED GERMINATION IN GILIA CAPITATA AND ITS RELATIVES

VERNE GRANT

The discovery that seeds of *Gilia capitata* Douglas (Polemoniaceae) collected from a recently burned hillside in the California Coast Ranges germinated twice as well as seeds from an unburned site in the same immediate area posed both the practical problem: how to obtain the highest percentage of germination from the seeds available for experimentation; and the theoretical problem: whether fire is a factor in the distribution of *Gilia capitata.* The observation, again, that the closely allied races, *G. chamissonis* Greene and *G. staminea* Greene, are confined in nature to pure sands on the California coast and in the San Joaquin Valley raised the question whether the distribution of these entities is related to the germination requirements of their seeds or the tolerances of their seedlings at establishment. Numerous germination tests, in which temperature, substrate, and other factors were varied, were then undertaken.

Like many other herbaceous elements in the California flora, *Gilia capitata* and its allies germinate with the first heavy rains of the fall. The spiracles of the seed coat imbibe water immediately upon being wetted and form a gelatinous sheath about the seed. Within a few days the embryo emerges and the pair of green cotyledons is soon raised above the ground. The seedlings with their first true leaves pass the winter from November until February or March in a semi-dormant condition; upon the first warm temperatures of spring they then resume growth.

METHODS

Seed collections in bulk and by families (individual seed parents) were made from the following strains of *Gilia capitata* and its close relatives in California: *G. capitata* from an open hillside swept by a surface fire during the year of seed collection, Mayacama Mountains, Napa County; *G. capitata* from the same hillside in a local oak grove not touched by the fire; *G. capitata* from Tomales Bay, Marin County; *G capitata* from Hatchet Mountain, Shasta County; *G. chamissonis* from sand dunes on Point Reyes Peninsula, Marin County; *G. chamissionis* from sand hills of San Francisco; *G. staminea* from sand hills near Antioch, Contra Costa County; *G. staminea* from Mather, Tuolumne County. (The foregoing entities are being treated by the author as subspecies of the polytypic species *Gilia capitata* in a monographic study which will shortly be in press.) In addition, seeds from experimental cultures and artificial hybridizations were obtained, as outlined in a subsequent paragraph.

Seed treatment was varied as follows:

1. Controls. Untreated seeds were planted in sand flats in the greenhouse.

2. Scarification. The seed coats were scratched between two pieces of sandpaper in a petri dish.

3. Stratification at constant temperatures. Flats containing the seeds were watered and stored immediately in a cold room for two, four, or six weeks at 2.5° C. or 5.0° C.

4. Stratification at alternating temperatures. The flats were stratified overnight at 5° C. and brought out into a warm room during the day. This process was continued for two, four, or six weeks.

5. Restratification. The stratified flats, after being removed to the greenhouse for germination, were subsequently returned to the cold room for a second treatment with cold temperatures, followed by a second period in the greenhouse (Quick, 1943).

6. Heating of seeds at 150° C. The seeds were placed in open petri dishes in an electric oven at 150° C. for 5 minutes, then planted in sand in the greenhouse and watered.

7. Heating of seeds at 750° C. The seeds were put in a small wire screen box which was then fastened to the end of a stick. A flash fire of excelsior was built in a fire place. At the height of the blaze the wire box containing the seeds was passed through the flames for three seconds.

8. Planting of whole capsules. The capsules of *G. staminea* and *G. chamissonis* are dehiscent and contain numerous, small seeds which are normally sprinkled out of the open ends with the swaying of the peduncles in the wind. The capsules of *G. capitata* in the Coast Ranges are by contrast indehiscent, 1–3-seeded, and tend to disarticulate and fall out of the calyx at maturity. In an effort to determine the possible adaptive significance of this latter combination of characters, undehisced capsules of *G. capitata* from the Mayacama Mountains were planted in sand in the greenhouse. The germination percentage was calculated on the basis of the estimated number of seeds present.

9. Stratification of whole capsules at 2.5° C.

10. Heating of whole capsules at 150° C.

11. Heating of whole capsules at 750° C.

12. Heating of whole capsules at 750° C. followed by immediate stratification at 2.5° C. in wet sand.

13. Washing the seeds in frequent changes of distilled water before sowing.

14. Sand in 6 inch pots in greenhouse. This was a control for the following three variations in type of substrate.

15. Autoclaved sand in greenhouse.

16. Adobe-clay in 6 inch pots in greenhouse.

17. Adobe-clay in the experimental field, Berkeley. Since the same parent soil was used here as in the greenhouse pots, the chief variable was soil temperature, which in spring of course was much lower outdoors.

The effect of genetic factors on seed germination was inferred in two ways:

The germination percentage of F_1 hybrid seeds was compared with the germination percentage for the parental entities. The seeds of both the species and the hybrids were harvested from plants growing under the same greenhouse conditions, and were planted and stratified side by side in the same flats.

Ten seeds from each of twenty-one randomly selected individual plants in the Mayacama colony of *G. capitata* were sown and their germination percentages were determined. This process was repeated for the seven strains under examination. The variance between strains was then compared with the variance between families.

Environmental Effects on Germination

The principal results are shown in Table 1, where the numbers heading the various columns correspond to the paragraph num-

Table 1. The Effects of Various Environmental Factors on Seed Germination in Gilia capitata and its Relatives. (The numbers heading the columns correspond to the paragraph numbers under "Methods.")

Treatment	1		3,4		8,9		6,10		7,11,12		14		16		17	
	Controls		2.5-5.0°C		Whole capsules		150°C		750°C		Sand, green-house		Clay, green-house		Clay, field	
Strain	% Germination	no. Seeds	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.
Mayacama Mts., unburned area	8	200	32	740	1	275	0	50	0	179						
Mayacama Mts., burned area	24	50	61	948			0	97			2	50	4	50	14	50
Tomales Bay	45	100	88	427												
Pt. Reyes	25	100	77	654							4	50	4	50	10	50
San Francisco			77	293												
Antioch			52	420							8	50	14	50	8	50
Mather	40	100	46	536												
Hatchet Mt.			31	366												

bers for methods of treatment; in certain columns the data for the two different treatments have been combined. The strain of *G. capitata* from the burned area in the Coast Ranges germinates much better than the strain away from the burn in both the controls and the stratified lots. Stratification increases the percentage and uniformity of germination in all strains. No significant difference was found between constant and alternating temperatures, between 2.5° C. and 5.0° C., or between two and six weeks stratification. After six weeks the seeds germinated in the cold room. *Gilia staminea* from four thousand feet elevation in the Sierra Nevada (Mather) appears not to require stratification any more than the lowland strains (cf. also Mirov, 1936).

When whole capsules of Coast Range *G. capitata* are sown, instead of thrashed seeds, the result is zero per cent germination without stratification, and one per cent (of the estimated number of seeds) germination with stratification.

The exposure of either naked seeds or whole capsules to 150° C., a temperature which some grass seeds withstand (Sampson, 1944), evidently injured the seeds for no germination at all was obtained. The temperatures of a flash fire are likewise deleterious to the seeds of *G. capitata* with or without the protective covering of the capsule.

As regards the effects of the substrate, *G. staminea* and *G. chamissonis,* both restricted to pure sands in nature, germinate and become established as well on clay-adobe as on sand.

Treatments which had no apparent effect were: use of autoclaved sand, washing the seeds with distilled water, scarification, and restratification. These experimental treatments have been omitted from Table 1. *Gilia capitata* differs in respect to the results of restratification from certain species of *Phacelia,* in which restratification is effective (Quick, 1947).

TABLE 2. FREQUENCY DISTRIBUTION OF GERMINATION PERCENTAGES BY FAMILIES IN SEVEN STRAINS OF GILIA CAPITATA AND ITS CLOSE RELATIVES. (ABOUT 21 FAMILIES PER STRAIN AND ABOUT TEN SEEDS PER FAMILY.)

Strain	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Mayacama Mts., burned area			2	1	1	4	4	1	6	1	1
Tomales Bay					1			1	3	6	11
Pt. Reyes			1		1		5	2	6	6	1
San Francisco			1	1		2	1	3	5	4	3
Antioch		3	2	2	2	3	5	2	1	1	1
Mather	5	1		2	2	1	3	1	4		
Hatchet Mt.	3	2	5	3	3	2	1	1	1	1	

GENOTYPIC EFFECTS ON GERMINATION

The germination of seeds from different seed parents (viz. families) of the same population is shown in Table 2. Undoubtedly there is great variation from family to family, as an examination of the germination percentages for the Mayacama strain of *G. capitata* will reveal. Analysis of the variance showed that there is significantly more variation between strains than within strains, but that the variation from family to family within one strain is much greater than would be expected if due to chance alone. The non-random variation in germination between families of one strain may be due to differential environmental influences on the seed parents, to genotypic differences between seed parents, or to both sets of factors. Similarly the differences in germination between strains may be due to differences in environment, genotype, or both.

Crosses between four of the strains would seem to indicate that germination behavior has a hereditary basis. The germination of the F_1 seeds is not intermediate with respect to that of the entities, but in most cases is better than either parental type (fig. 1). Whether this is to be taken as a manifestation of that debated quantity known as hybrid vigor depends on one's definition of hybrid vigor. The data suggest at least that germination percentage is in part under genotypic control.

Discussion

Gilia staminea and *G. chamissonis* are inhabitants of relatively loose sandy soils in nature. In cultivation the plants will flower and fruit in pure sand watered only with tap water; they thrive much better, however, if transplanted to richer soils. Germination tests show that the seeds germinate and the seedlings become established on adobe-clay in Berkeley under both field and greenhouse conditions. These facts taken together with the observation that *G. staminea* and *G. chamissonis* do not successfully withstand the competition of more aggressive species, either in

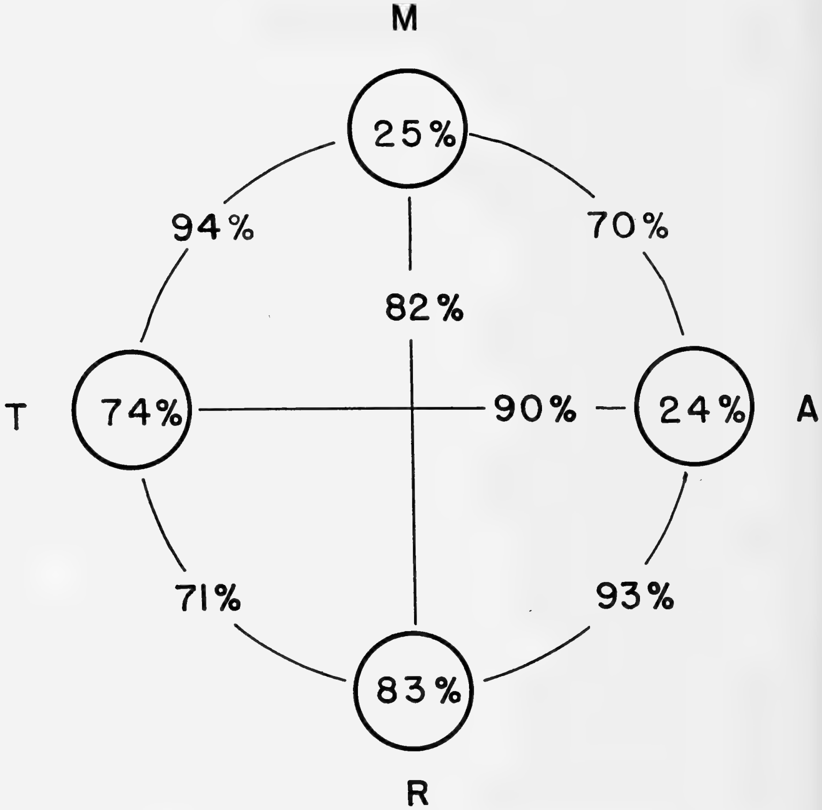

FIG. 1. Percentages of seed germination in four parental strains of *Gilia capitata* and its close relatives, and their F_1 hybrids. The parental strains are represented as circles. M, Mayacama Mountains; A, Antioch; R, Point Reyes Peninsula; T, Tomales Bay. In each case, percentages are based on 140 to 280 seeds.

nature or in the garden, suggest that the micro-distribution of *G. staminea* and *G. chamissonis* within their distributional areas may be the resultant of a tolerance for impoverished habitats and an intolerance of competition.

Gilia capitata occurs on sunny hillsides in the Coast Ranges. It is one of the commonest plants in clearings following a fire. Germination tests indicate that the seeds of *G. capitata* do not endure even moderately high temperatures. Certain other facts about this plant provide a clue as to the possible reasons for its abundance on burned areas; both field observations and garden tests show that *G. capitata* does not tolerate either deep shade or dense growth. With its annual life cycle and its low mineral requirements it is, like *G. staminea* and *G. chamissonis,* primarily a pioneering species on open habitats. Fire, by removing a more mature vegetation, returns the habitat to a stage suitable for colonization by *G. capitata.*

SUMMARY

1. There is marked variation between and within populations of *Gilia capitata* Dougl. and its allies as to percentage of seed germination. Some of this variation is genotypic; some of it is environmentally conditioned.

2. The seeds of both highland and lowland strains of *G. capitata* and its close relatives germinate relatively well when planted in moist sand without previous treatment. Stratification for two weeks at temperatures just above freezing improves germination. Restratification and scarification are ineffective. Brief exposure of the naked seeds or undehisced capsules of Coast Range *G. capitata* to temperatures of 150° C. or higher completely inhibits germination.

3. The micro-distribution of *G. capitata* and its allies is discussed in the light of the germination tests and some other observations. The confinement of *G. staminea* and *G. chamissonis* to sandy soils in nature, and the abundance of *G. capitata* in clearings following fires, may best be explained by regarding these plants as pioneers fitted for open habitats, but not tolerating the conditions of competition and shade in closed communities.

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NOMENCLATORIAL CHANGES IN ARIZONA GRASSES

Frank W. Gould

The grasses of Arizona have long been a source of interest to both taxonomist and ecologist. Early collections and observations by Pringle, Lemmon, Toumey, Griffiths, Thornber, Blumer, and Goodding, and early range studies by national and territorial research units provide a substantial background for current investigations of our rich and diverse grass flora. Much of this accumulated information is being incorporated in a manual of Arizona grasses now being completed by the writer. To make the nomenclatorial changes deemed necessary for the manual more readily available the following new combinations and new names are herein proposed separately.

1. Panicum capillare L. var. **stramineum** (Hitchc. and Chase) comb. nov. *P. stramineum* Hitchc. and Chase, Contr. U. S. Nat. Herb. 15: 67. 1910.

2. Panicum capillare L. var. **hirticaule** (Presl) comb. nov. *P. hirticaule* Presl, Rel. Haenk. 1: 308. 1830.

3. Panicum capillare L. var. **pampinosum** (Hitchc. and Chase) comb. nov. *P. pampinosum* Hitchc. and Chase, Contr. U. S. Nat. Herb. 15: 66. 1910.

4. Sporobolus airoides (Torr.) Torr. var. **Wrightii** (Munro) comb. nov. *S. Wrightii* Munro ex Scribn., Bull. Torrey Bot. Club 9: 103. 1882.

5. **Elymus lanceolatus** (Scribn. and Smith) comb. nov. *Triticum repens* var. *dasystachum* Hook., Fl. Bor. Am. 2: 254. 1840. Not *Elymus dasystachys* Trin. ex Ledeb. Fl. Alt. 1: 120. 1829. *Agropyron dasytachum* Scribn., Bull. Torrey Bot. Club 10: 78. 1883. *Elymus subvillosus* (Hook.) Gould, Madroño 9: 127. 1947.

6. **Elymus Rydbergii** nom. nov. *Agropyron riparium* Scribn. and Smith, Bull. U. S. Div. Agrost. 4: 35. 1897. *Elymus riparius* Gould, Madroño 9: 127. 1947. Not *E. riparius* Wieg., Rhodora 20: 84. 1918.

7. Elymus pauciflorus (Schwein.) Gould subsp. **pseudorepens** (Scribn. and Smith) comb. nov. *Agropyron pseudorepens* Scribn. and Smith, U. S. Dept. of Agric., Div. Agrost. Bull. 4: 34. 1897. *A. tenerum* Vasey var. *pseudorepens* Jones, Contr. West. Bot. 14: 19. 1912.

8. Poa fendleriana (Steud.) Vasey var. **longiligula** (Scribn. and Williams) comb. nov. *Poa longiligula* Scribn. and Williams, U. S. Dept. Agric. Div. Agrost. Circ. 9: 3. 1899.

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University of Arizona, Tucson.

DOCUMENTED CHROMOSOME NUMBERS OF PLANTS

(See Madroño 9: 257–258. 1948.)

SPECIES	NUMBER	COUNTED BY	COLLECTION	LOCALITY
LILIACEAE				
Chlorogalum *_pomeridianum_ (Ker) Kunth.	$2n = 18_{II}$	M. S. Cave, Univ. Calif. Berkeley	_Cave 4901_ UC[1]	Contra Costa Co., Calif.
Odontostomum *_Hartwegii_ Torr.	n = 10	M. S. Cave, Univ. Calif. Berkeley	_Nobs 511_ UC	Placer Co., Calif.
RANUNCULACEAE				
Actaea *_spicata_ L. var. _arguta_ Torr.	n = 8	R. L. Rodriguez, Univ. Calif. Berkeley	_Rattenbury 129_ UC	Contra Costa Co., Calif.
Kumlienia *_hystricula_ (Gray) Greene	$2n = 7_{II}$	Karl M. Jakob, Univ. Calif. Berkeley	_Rattenbury 202_ UC	Mariposa Co., Calif.
CALYCANTHACEAE				
Calycanthus *_occidentalis_ H. & A.	$2n = 11_{II}$	M. S. Cave, Univ. Calif. Berkeley	_Cave 4903_ UC	Alameda Co., Calif.
CRUCIFERAE				
Dentaria *_integrifolia_ Nutt. var. _californica_ Nutt.	n = 22–28	B. Crampton, Univ. Calif. Berkeley	_Rattenbury 128_ UC	Contra Costa Co., Calif.
ROSACEAE				
Cercocarpus betuloides Nutt.	$2n = 9_{II}$	T. Morley, Univ. Calif. Berkeley	_Morley 99_ UC	Alameda Co., Calif.
POLEMONIACEAE				
Gymnosteris *_nudicaulis_ (H.&A.) var. _pulchella_ (Greene) Brand	n = 6	C. McMillan, Univ. Calif. Berkeley	_Mason 13983_ UC	Washoe Co., Nevada
SCROPHULARIACEAE				
Synthyris *_reniformis_ (Dougl.) Benth. subsp. _cordata_ Gray.	n = 12	C. McMillan Univ. Calif. Berkeley	_McMillan 1531_ UC	Marin Co., Calif.

*Prepared slide available.

[1] Symbols used for herbaria are those listed by Lanjouw, Chronica Botanica 5: 142–150. 1939.

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REVIEW

Ethnobotany of Western Washington. By Erna Gunther. University of Washington Publications in Anthropology, Vol. 10, No. 1, pp. 1–62. October, 1945. University of Washington Press. $1.50.

This interesting study was originally intended as an investigation of the relationship of a people and its floral environment. Because of the presence of numerous small Indian tribes, belonging to five linguistic stocks but possessing a general homogeneity of culture and living in an area of relative botanical uniformity, western Washington appeared to be a particularly promising field. By showing specific plants to native informants it was possible to assemble data regarding their names and uses (as materials, medicine, or food) in the aboriginal cultures; additional data were compiled from published sources. It was found, however, that "the environment had changed too much, and the process of acculturation had gone too far" to allow full realization of the author's objectives. Nevertheless, interesting data were obtained concerning the uses of a large number of native plant species, including the following: *Polypodium vulgare, Polystichum munitum, Dryopteris dilatata, Athyrium Filix-foemina, Adiantum pedatum* var. *aleuticum, Struthiopteris spicant, Equisetum* spp., *Taxus brevifolia, Pinus monticola, Picea sitchensis, Tsuga heterophylla, Pseudotsuga taxifolia, Thuja plicata, Typha latifolia, Lysichitum americanum, Xerophyllum tenax, Zigadenus venenosus, Veratrum Eschscholtzii, Allium cernuum, Camassia Quamash, Lilium columbianum, Maianthemum dilatatum, Trillium ovatum, Populus trichocarpa, Salix* spp., *Corylus californica, Alnus oregana, Quercus Garryana, Urtica Lyallii, Claytonia sibirica, Aquilegia formosa, Actaea arguta, Berberis (Mahonia)* spp., *Dicentra formosa, Philadelphus Gordonianus, Ribes* spp., *Physocarpus capitatus, Holodiscus discolor, Spiraea* spp., *Aruncus sylvester, Rosa* spp., *Rubus* spp., *Fragaria* spp., *Geum macrophyllum, Prunus emarginata, Osmaronia cerasiformis, Amelanchier florida, Pyrus diversifolia, Vicia* spp., *Oxalis oregana, Acer* spp., *Rhamnus Purshiana, Epilobium angustifolium, Oplopanax horridum, Heracleum lanatum, Oenanthe sarmentosa, Cornus* spp., *Gaultheria Shallon, Arctostaphylos Uva-ursi, Vaccinium* spp., *Prunella vulgaris* var. *lanceolata, Stachys ciliata, Galium triflorum, Sambucus* spp., *Symphoricarpos albus, Lonicera* spp., *Achillea Millefolium, Petasites speciosus,* and others. The plants were determined by Dr. G. N. Jones and Mrs. M. R. Flahaut, and a partial set of verifying specimens is deposited in the herbarium of the Washington State Museum in Seattle.—L. Constance, Department of Botany, University of California, Berkeley.

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A CYTOLOGICAL STUDY OF CLEISTOGAMOUS STIPA LEUCOTRICHA

Walter V. Brown

Introduction

The genus *Stipa* is of some importance as a range grass in most of the temperate-zone grasslands. One species, *S. leucotricha,* is of considerable economic importance in Texas. This species is common throughout Texas east of the Pecos River and south of the Red River. It occurs in the very southern part of Oklahoma but is absent from the extreme eastern part of Texas and most of the coastal plain. In the Austin region of central Texas it is very abundant and can be described as a weed-type of grass which rapidly occupies disturbed soil and overgrazed pastures. It often continues in the succession from beginning to the end for it is frequently a minor constituent of the dominant grassland climax. However, since little of the central Texas range is occupied by the dominant association because of nearly continuous overgrazing, it usually results that *Stipa leucotricha* is one of the common good native forage grasses in this region. It is eaten by cattle and is highly regarded by many ranchers because of its abundance, long growing season and capacity to cure well on the ground. *Stipa leucotricha* is essentially a winter-growing perennial. Because it grows vigorously from September to June and after each rain during the summer, it may offer forage throughout the year.

Hitchcock (1935) reports that, "Cleistogamous spikelets with glumes obsolete and lemma nearly awnless are borne in basal sheaths just after maturity of the panicle." Dyksterhuis (1945) made a study at Fort Worth, Texas, of these axillary, often subterranean, cleistogenes and of their rôle in nature. He found that these cleistogenes were formed whether or not the normal panicle was produced and also that they were produced by plants kept clipped to one and one-half inches. He states that the species may behave under heavy grazing as a winter annual without producing flowering culms. This is accomplished by fall seedlings of cleistogamous origin producing new cleistogenes in the spring and then succumbing to summer drought. These cleistogenes, then, give this species a great advantage over other grasses, especially in heavily grazed areas, for a crop of seed is assured every year.

The present study began with an attempt to determine the chromosome number of this species from root tip mitosis but for technical reasons the exact number was not determined. While searching for anthers with pollen mother cells in the proper stage of meiosis it became apparent that the florets of the panicle are unusual and so a detailed study was made of these florets.

Madroño, Vol. 10, No. 3, pp. 65–96. August 12, 1949.

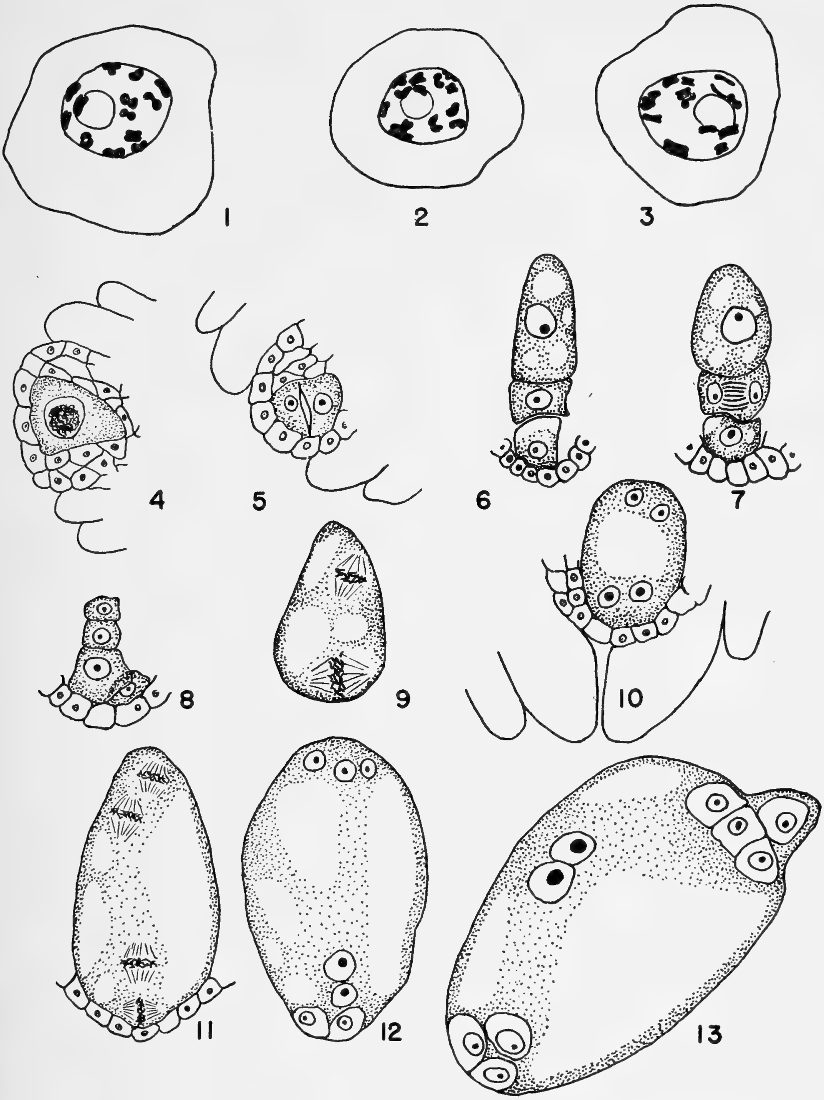
MATERIAL AND METHODS

In this work, panicle florets only were studied. Inflorescences were collected at various stages of development and florets were fixed in absolute-acetic fixative. Young florets were clipped across to permit the penetration of the fixative inside the tube formed by the lemma and palea. Older florets were dissected, and the lemma and palea were removed. Material was embedded in paraffin and sectioned longitudinally at 15 microns. Two methods of staining were employed, Heidenhain's hematoxylin, and a combination of Feulgen and fast green. The hematoxylin stain was more satisfactory.

CHROMOSOME NUMBER AND MEIOSIS

The chromosome number could not be determined from root tip mitoses by the usual method employing Craf Navashin fixative and Heidenhain's hematoxylin stain. A search for meiosis in pollen mother cells yielded no results by the smear method. Fortunately one flower was sectioned in which the pollen mother cells of one anther sac were in the diakinesis stage. There were only eight pollen mother cells in this sac and one was distorted by sectioning. The remaining seven were used in this study. Love, in Myers' text (1947) reports his material, growing under cultivation in California, to have a count of 2n = 28. In the seven pollen mother cells studied the following results were obtained. In each of four cells 13 diakinesis bivalents were found (fig. 1), in two cells there were 11 bivalents and one quadrivalent (fig. 2) and in one cell there were 12 bivalents and two univalents (fig. 3). It is probable that this one plant had a 2n chromosome number of 26 which is different from Love's material. It is evident, however, that meiosis in this particular plant is quite irregular and it may be that different plants of this species have different chromosome numbers. Further study is necessary before a definite basic chromosome number can be assigned to this species.

The presence of occasional quadrivalents and univalents at meiosis in diploid species is not uncommon in the grasses. Myers (1947) lists five species that have been reported to show associations of four or more chromosomes at diakinesis. These conditions have been attributed by the authors to structural hybridity. In the present study it was not possible to determine whether the cause was structural hybridity or the presence of two pairs of homologous chromosomes. No explanation is offered for the occurrence of a pair of univalents in one pollen mother cell. Myers lists 10 species of grasses that have shown occasional univalents at first meiotic division. This list includes both diploid and polyploid species. *Stipa leucotricha* is probably diploid, for other basic numbers that have been reported in the genus are 10, 11, and 12 (Myers 1947).



FIGS. 1–13. Embryo sac development of *Stipa leucotricha.* FIGS. 1–3, Diakinesis in pollen mother cells: 1, 13 bivalent chromosomes; 2, 11 bivalents and one quadrivalent; 3, 12 bivalents and two univalents. FIG. 4, Meiotic prophase in archespore. FIG. 5, Secondary megasporocytes. FIG. 6, Three "spore" stage. FIG. 7, Transverse division of middle "spore". FIG. 8, Enlargement of a micropylar megaspore. FIG. 9, Second division in the embryo sac. FIG. 10, Four-nucleate embryo sac. FIG. 11, Third division in the embryo sac. FIG. 12, Eight-nucleate embryo sac, the synergids with cell walls. FIG. 13, Mature embryo sac with four antipodal cells.

Development of the Embryo Sac

The archesporial cell (fig. 4) lies immediately under the epidermal layer of the nucellus. At this stage the two integuments do not cover the terminal portion of the nucellus. The archesporial cell acts as the megaspore mother cell and meiosis takes place in it. Figure 4 shows a prophase stage of meiosis. The two cells produced are oriented so that the smaller is against the epidermis and the larger is embedded more deeply in the nucellus (fig. 5). Figure 6 shows a peculiar three-celled stage which was seen in a number of ovules. The origin of the middle cell was not determined but it arises from division of either the larger or the smaller cell of figure 5. Figure 7 shows another common occurrence, the lateral division of this middle cell. This lateral division was observed repeatedly and may well be typical of this species. Usually the spore toward the chalaza develops into the embryo sac as in figure 7 but in two cases the micropylar cell was enlarged (fig. 8). At the second division of the developing embryo sac (fig. 9) it is in contact with the epidermis and the nonfunctional spores are undetectable. In the four-nucleate embryo sac stage (fig. 10) the inner integument has grown around the nucellus except for the micropyle. The last embryo sac division results in eight nuclei, four at each end of the embryo sac. Figure 11 shows an orientation of the spindles which would suggest that the two synergids would be sister cells as would be also the egg and micropylar polar nucleus. This situation appears to be the rule in angiosperms for Brink and Cooper (1947) state that " . . . wherever definite observations have been made, the two synergids, on the one hand, and the egg cell and upper polar nucleus, on the other hand, represent sister nuclei, and no reliable observations are at hand to substantiate any other origin." Maheshwari (1948) makes a similar statement.

The mature embryo sac (fig. 12) is of the monosporic 8-nucleate, or normal type, which according to Maheshwari, "occurs in at least 70 percent of the angiosperms so far studied." All Gramineae have this normal type of embryo sac development (Schnarf, 1929). In the Gramineae, however, there is typically a further development of the antipodal cells to form a large tissue within the embryo sac. Shadowsky (1926) studied this tissue in 16 species of grasses in 7 tribes and found considerable antipodal development in all species studied. He classified them as to

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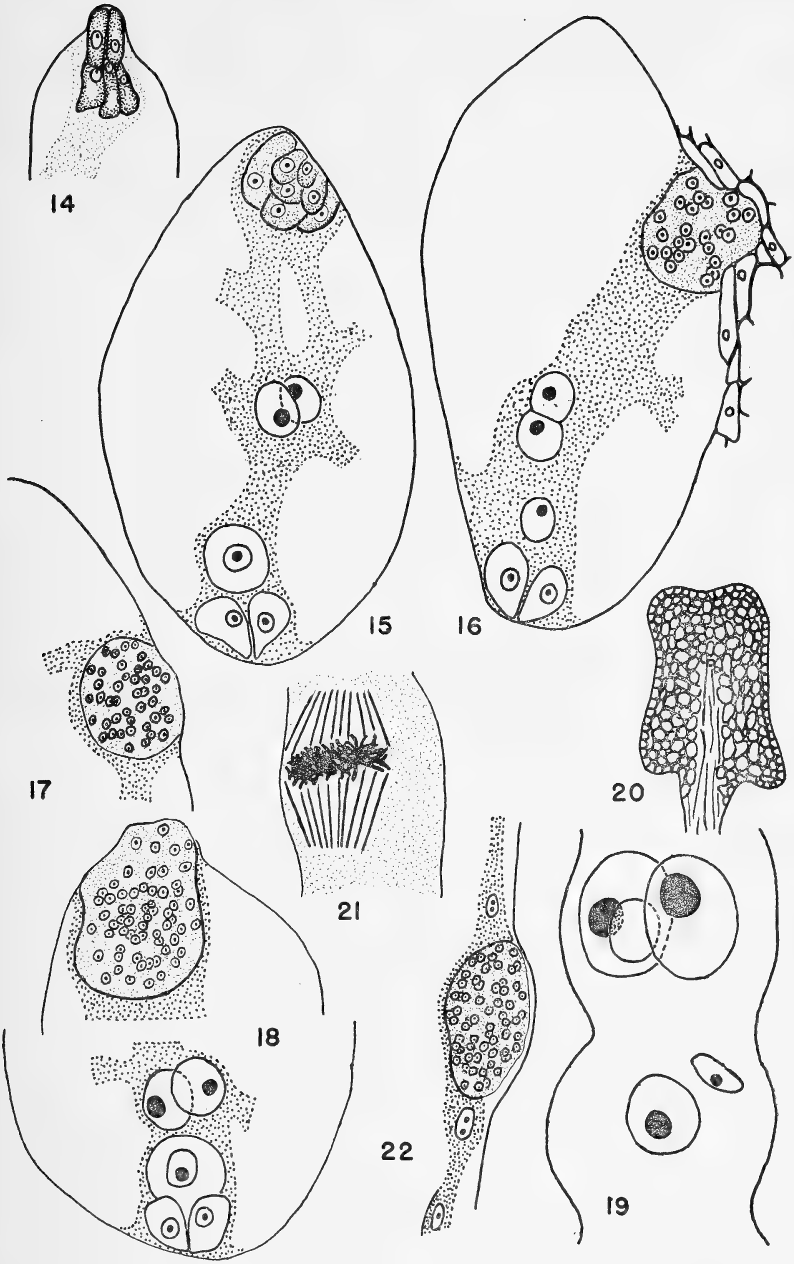
Explanation of Figures 14–22.

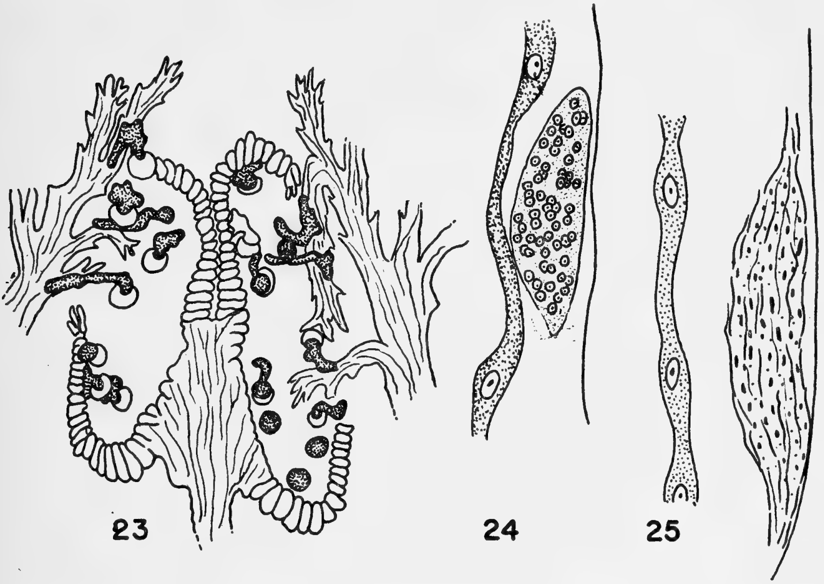
Figs. 14–22. Embryo sac development of *Stipa leucotricha*. Fig. 14, Antipodal tissue of five cells. Fig. 15, Embryo sac with antipodal tissue of seven cells. Fig. 16, Embryo sac with antipodal tissue of 24 nuclei. Fig. 17, Antipodal tissue of 42 nuclei. Fig. 18, Embryo sac at time of fertilization with antipodal tissue at end of sac with 56 nuclei. Fig. 19, Double fertilization. Fig. 20, Section of a sterile anther. Fig. 21, Division of the primary endosperm nucleus. Fig. 22, Antipodal tissue and free nuclear endosperm.



FIGS. 14–22. Embryo sac development of *Stipa leucotricha*.

whether this tissue was at the end or at the side of the embryo sac. In *Stipa leucotricha* growth of this tissue begins immediately after the 8-nucleate stage has been reached, usually by the formation first of one additional cell (fig. 13) which penetrates the chalazal tissue. It is assumed that this fourth cell is derived from one of the antipodal cells although the division was never seen nor could the chromosome number of the antipodal tissue be determined. At the same time the two polar nuclei have made contact with each other to one side of the middle of the embryo sac. These two nuclei remain in close contact in this position until just before fertilization. Figure 14 shows the 5-celled stage of the antipodal tissue, the tissue being still at the chalazal end. Figure 15 is of an embryo sac showing the 7-celled condition. The embryo sac has lengthened at the chalazal end so that the antipodal tissue is becoming lateral in position. Figure 16 shows the antipodal tissue on the lateral wall and penetrating the nucellus. There are 24 nuclei in this mass but cell walls, if they exist, could not be distinguished. The tissue is still covered by the protoplasm of the embryo sac on the inner surface. Figure 17 shows an antipodal mass with 42 nuclei. The embryo sac has increased greatly in size so that this mass is on the wall at about the middle of the sac. Rarely the antipodal mass remains terminal and moves along with the enlarging embryo sac as seen in figure 18. This mass contains 62 nuclei. The maximum number in this species seems to be about 60 nuclei since counts of 62, about 60, and 56 nuclei have been made. This compares with 30 or more in *Zea* and *Euchlaena* (Cooper, 1937), 300 in *Sasa paniculata* (Yamaura, 1933), and the various numbers reported in 16 species by Shadowsky (1926). At the time of fertilization the two unfused polar nuclei move to a position close to the egg cell (fig. 18).

Before fertilization of the egg can be effected, cleistogamous pollination (autogamy) takes place. Figure 23 represents a section of an anther and a few branches of the stigma during this process. Part of the outer wall of each anther sac disintegrates [as Uphof (1938) reports for *Cardamine chenopodifolia*] and a few stigma branches enter. The movement of these stigma branches is not caused by growth. Before the walls of the anther disintegrate these branches are confined between the palea and the anther. The disintegration of the anther walls allows the stigma branches to expand or straighten out and by so doing to enter the pollen sacs. The pollen grains germinate in place and the pollen tubes grow in various directions, some making contact with the stigma but many others never making contact. Pollen tube growth was not studied but was assumed to be normal since double fertilization took place. Figure 19 shows an egg with a male nucleus within it and shows the other male gamete in contact with the two still unfused polar nuclei. The endosperm is triploid as a result of this triple fusion. Figure 21 represents the first division of the primary endosperm nucleus. The exact chromosome number could not be determined. Thirty-four chromosomes were counted and there were a few chromosomes remaining but uncountable. This is a few less than the expected triploid number, 39.



Figs. 23–25. Embryo sac development of *Stipa leucotricha*. Fig. 23, Germination of pollen within anther sacs. Fig. 24, Antipodal tissue and free nuclear endosperm. Fig. 25, Disintegrated antipodal tissue and free nuclear endosperm.

The growth of the endosperm is much more rapid than that of the embryo. When the proembryo consists of four cells the endosperm consists of 28 free nuclei scattered in a thin layer of cytoplasm. Figure 22 shows the appearance of the antipodal mass at this stage. There are about 60 nuclei in this mass which is located on the lateral wall about midway of the sac. The cytoplasm of the embryo sac, endosperm at this stage, covers the inner surfaces only of the antipodal mass. At a later stage, when the proembryo consists of 8 cells and the endosperm of 73 free nuclei, the antipodal mass has assumed a lens shape and is definitely outside of the endosperm cytoplasm as shown in figure 24. The antipodal mass and the number of nuclei (56 in fig. 24) do not increase during or after fertilization. At a still later stage, when the embryo consists of 22 cells and the endosperm of 288 free nuclei, the antipodal mass is considerably flattened, the cytoplasm has largely disappeared and small scattered masses of chromatin are all that remain of the nuclei. Thin cell walls are visible at this time so it is probable that cell walls existed in the antipodal mass at previous stages. This remnant of the antipodal tissue is definitely outside of the endosperm layer (fig. 25).

Discussion

Cleistogamy. The phenomenon of cleistogamy is common in the Gramineae (Chase, 1918). Uphof (1938) in reviewing the subject, devoted two pages to the grasses. In some species, as *Leersia oryzoides,* cleistogamous spikelets are normal in structure, and are produced in normal inflorescences. Other species produce normal chasmogamous spikelets in terminal inflorescences but cleistogamous spikelets in the axils of lower leaves (Chase 1918). Usually these axillary cleistogamous spikelets (cleistogenes of Chase and cleistogames of Uphof) are much reduced spikelets, so greatly modified that they would not be classified in the same genus or tribe if their origin were not known. It is in this group that *Stipa leucotricha* has been included by Hitchcock (1935) and Dyksterhuis (1945). Observations on plants studied in the region of Austin, Texas, in the spring of 1948 show that all stages of development up to milky endosperm take place while the spikelet is included in the upper leaf sheath. Normal anthesis in grasses takes place some time after the inflorescence has emerged from the sheath and so it would be reasonable to assume that an emerging inflorescence of *Stipa leucotricha* would consist of florets in preanthesis. It is here shown that the panicle spikelets were cleistogamous in the plants studied cytologically and those observed in the field in 1948. The presence of axillary cleistogenes in many of the plants studied was confirmed. It is significant that the two years 1947 and 1948 were severe drought years in central Texas whereas the spring of 1949 had more than average rainfall.

Uphof cites many cases in which environmental factors have been shown to produce cleistogamy in plants although no case is cited in the Gramineae. It is evident that some such factors, especially available soil water, are responsible for cleistogamy in *Stipa leucotricha,* since plants of this species that produced chasmogamous florets with open pollination in the spring of 1949, had been in 1948, completely chasmogamous. Nevertheless, even in 1949, there were cleistogamous florets scattered among the chasmogamous. The grass *Bromus catharticus* behaved much the same way and in both cases inflorescences produced late in the spring under dryer, hotter conditions contained a larger proportion of cleistogamous florets or were completely cleistogamous.

Reduction of flower parts, often correlated with cleistogamy, occurs in the florets of this grass. The awn of the axillary cleistogenes is greatly reduced but the condition of other structures has not been studied. In the panicled florets the awn is normal in development but the three anthers are small, less than 1 mm. in length. Usually two of these anthers are smaller than the third and are sterile, producing no pollen (fig. 20). In a few florets one or both of these small anthers produced a few pollen grains in one or both of the anther sacs but this was unusual. The fertile anther itself may produce as few as eight pollen grains though usually more. Such small anthers are found in cleistogamous florets of other grasses; *Bromus catharticus, Triodia pilosa, Chloris andropogonoides,* etc., whereas chasmogamous florets of the same species or related species are much larger.

Embryo sac development. The development of the embryo sac of *Stipa leucotricha* is normal and typical of grasses. Reduction division takes place in the archesporial cell. Although the full course of meiosis was not seen, one early prophase stage has been drawn in figure 4. That reduction does take place in megasporogenesis is established almost conclusively. Figure 9 shows the metaphases of the second division in the embryo sac. In one of these the chromosomes are so spaced that nearly all can be counted. Eleven chromosomes plus a few (2 to 4) were found. In figure 11 the chromosome number could be estimated as between 10 and 15. This was true also in another embryo sac observed in nearly the same stage. Finally, the first division of the primary endosperm nucleus showed 34 plus a few chromosomes (fig. 21).

Double fertilization takes place normally. Brink and Cooper find that in *Hordeum jubatum* the antipodal mass at the time of fertilization occupies about one-quarter of the space in the embryo sac and that during the course of gametic union (two hours or less) this mass increases to over six times its former volume. This is not the case in *Stipa leucotricha.* At fertilization the antipodal mass never reaches a volume one-quarter of that of the embryo sac. Furthermore the antipodal mass of *Stipa* does not increase in volume at all during or after fertilization as Brink and Cooper report in *Hordeum.* In *Stipa* this mass reaches its full development shortly before fertilization and remains of the same volume until its protoplasm disappears. Shadowsky, Brink and Cooper, Schnarf and others have postulated a glandular or food transport function for the antipodals. In *Stipa* it appears more likely that protoplasm is formed and food materials are stored in this tissue during a period when there is no growth of any other structure within the embryo sac except perhaps some cytoplasm and a great deal of vacuole. Following fertilization, however, there is a slow growth of the embryo and a rapid growth of the endosperm. Much of the food for the rapidly growing endosperm is probably derived from the embryo sac cytoplasm, from the contents of the large vacuole and, in the case of grasses, from the antipodal tissue.

It is difficult to assign to the antipodal tissue of *Stipa leucotricha* the rôle of the conducting tissue between the ovule and the embryo sac, as Schnarf has done for angiosperms in general and Shadowski and Brink and Cooper have done for a number of grasses. The antipodal tissue is located on the side of the embryo sac adjacent to the funiculus but removed from it by many parenchyma cells, as Brink and Cooper also show in their figures. However, these authors state that Schnarf attributes a significant nutritive role to the antipodals. They quote three statements to this effect, among them, "the position of the antipodals at the base of the embryo sac, where in general the conducting tissue of the ovule terminates, points to the assumption that the incoming material must pass through the antipodal region." This hardly applies since in many grasses, *Hordeum jubatum* and *Stipa leucotricha* included, the antipodal mass is about midway of the lateral wall of the embryo sac and not at the base of the sac. This antipodal tissue may be glandular as the latter authors indicate but it is not proved. Certainly many plants form endosperm without this tissue, in fact, with no antipodals at all. It is true, however, that in *Stipa* there is not the rapid growth of the antipodals following fertilization. This may be a basic difference between this species and *Hordeum jubatum* for it is at that time, when the antipodals increase to a volume six times their former volume, that Brink and Cooper speak of these "activated antipodals" and "aroused antipodals" with secretory activity. The antipodals of *Stipa leucotricha,* then, are not glandular, as are those of the intergeneric cross of Brink and Cooper. Another difference between *Stipa* and *Hordeum* is that in *Hordeum,* as Brink and Cooper point out, "The antipodals are a prominent and presumably active tissue in normal *H. jubatum* throughout the period when the endosperm is free nucleate. They quickly decline when the rapidly develop-young endosperm becomes cellular." In *Stipa leucotricha,* on the other hand, there is nothing left but cell walls while the endosperm is still free nucleate. From the present study it seems most reasonable to conclude that the antipodal tissue is storage tissue, built up when there is little growth of other tissue within the embryo sac and then used as food by the rapidly growing endosperm.

SUMMARY

The panicled spikelets in all plants of *Stipa leucotricha* that were observed at Austin, Texas, in the spring of 1948, were cleistogamous. These same plants produce axillary cleistogenes also. Of the three anthers produced in each floret, two are generally reduced and sterile while the third is reduced but produces good pollen.

Embryo sac development is of the normal, monosporic 8-nucleate type. The chalazal spore normally functions as the embryo sac mother cell although the micropylar spore may do so occasionally. Commonly three "spores" are produced, the middle one then dividing transversely.

As is characteristic of the Gramineae, a large antipodal tissue is produced in the embryo sac. In this species the maximum number of nuclei is approximately 60. Cell walls could not be observed. The antipodal tissue reaches its maximum size before fertilization and does not increase in size thereafter. By growth of the embryo sac this tissue eventually comes to lie on the lateral wall next to the funiculus. During early stages of endosperm development this tissue lies outside of the endosperm cytoplasm. When the embryo consists of 22 cells and the endosperm of 288 free nuclei the antipodal mass has lost its protoplasm and only thin cell walls (not visible in earlier stages) remain. It appears that the antipodal tissue grows after maturity of the embryo sac when no development, other than the enlargement of the embryo sac, is taking place. After fertilization the antipodal tissue functions as stored food for the rapid growth of the endosperm.

The Plant Research Institute,
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A NEW SWERTIA FROM COLORADO

C. M. Rogers

In 1947 and 1948 several collections of a species of *Swertia* were made in Las Animas and Baca counties in the southeastern corner of Colorado. Study of these specimens shows them to represent a new species.

The plant is found on gently sloping sandstone outcrops and is frequent to common over small areas in several localities. The stations for the new species lie somewhat outside of the range of the genus as delineated in recent revisions of the group (Card, 1931, St. John 1941), the nearest members, geographically, being those found along the eastern slope of the Rocky Mountains about fifty miles to the west. The present species grows at an elevation of 5000 to 5500 feet and is associated with plants which are, by and large, prairie and foothill species, such as *Arenaria Hookeri* Nutt., *Paronychia Jamesii* T. & G., *Astragalus crassicarpus* Torr., *Astragalus gracilis* Nutt., *Gilia spicata* Nutt., *Comandra pallida* A. DC., *Brauneria angustifolia* (DC.) Heller, *Chrysopsis villosa* (Pursh) Nutt., and *Palafoxia macrolepis* (Rydb.) Cory, the last named also having apparently a rather local distribution.

The affinities of the new species lie with that portion of the genus formerly included in the genus *Frasera,* more distinctly with those species segregated as *Leucocraspedum* by Rydberg. It resembles the Californian species *Swertia puberulenta* (Davidson) Jepson in a number of characters and runs to that species in the latest key (St. John, 1941). Some differences between these two species are:

Swertia puberulenta	*Swertia coloradensis*
Inflorescence a thyrsiform cyme; peduncles clustered.	Inflorescence a corymbose cyme; peduncles opposite.
Basal leaves oblanceolate to obovate, 5–10 cm. long, 1–5 cm. broad; cauline leaves narrowly elliptical, 3–5 cm. long, 1.5 cm. broad.	Basal leaves narrowly oblanceolate, (4) 8–10 cm. long, 1 cm. broad; cauline leaves linear-oblanceolate, 4–8 cm. long, 0.6–0.9 cm. broad.
Calyx longer or even twice as long as the corolla; calyx lobes 10–15 mm. long, corolla lobes 7 mm. long.	Calyx and corolla of nearly equal length; calyx lobes mostly 8.5–10 mm. long, corolla lobes mostly 9 mm. long.

Swertia coloradensis sp. nov. Herba perennis, glanduloso-puberulenta; radice lignosa; caulibus pluribus, 15–20 cm. altis, cymis corymbosis; foliis oppositis, albo-marginatis, infimis lineari-oblanceolatis, (4)8–10 cm. longis, 1 cm. latis, foliis superioribus lineari-oblanceolatis, 4–8 cm. longis, 0.6–0.9 cm. latis; bracteis lineari-lanceolatis vel linearibus; pedicellis 8–12 mm. longis; floribus 4-partitis, lobis calycis lineari-lanceolatis 8.5–10 mm. longis, 1.25–1.5 mm. latis; corollis pallide luteolis vel albidus, intus purpureo-punctatis, lobis corollae obovatis, 7.5–9.5 mm. longis, 3–3.5 mm. latis; foveis ellipticis, 1.3 mm. latis, 1 mm. altis, margine fimbriatis, sacculis sagittatis, 0.8 mm. descendentibus; filamentis 5 mm. longis, antheris 2 mm. longis, 1.3 mm. latis; coronis fimbriatis, 1 mm. altis; stylis tenuibus, 3–4 mm. longis; capsulis glabris, coriaceis, modo septo parallelo compressis, ovoideis, 5–7 mm. longis, 3–3.5 mm. latis, seminibus 4, fusco-purpureis, rugulosis, 4–4.75 mm. longis.

Perennial herb with a woody taproot; stems several, 15–20 cm. high; inflorescence a corymbose cyme; leaves and floral bracts opposite, all but the uppermost distinctly white-margined; stems and leaves glandular-puberulent; stems 2.5 mm. in diam. at base, tapering upward to 0.5 mm. below the terminal flowers, first 2–4 internodes 2 mm. or less in length, those of lower and middle stem 20–30 mm. long, gradually decreasing into the inflorescence; lowermost pair of leaves sometimes bladeless, other basal leaves (4)8–10 cm. long, 1 cm. wide, narrowly oblanceolate, obtuse or acute at the apex, narrowed to a winged petiole, cauline leaves linear oblanceolate, 4–8 cm. long, 0.6–0.9 cm. wide, floral bracts gradually reduced, the uppermost narrowly linear-lanceolate to linear, 1–1.5 cm. long, 1.5–3 mm. wide; pedicels 5–15 mm. long, pubescence similar to that of the stem; calyx of 4 slightly unequal linear-lanceolate sepals, 7.5–12.5 mm., mostly 8.5–10 mm. long, 1.25–1.5 mm. wide, narrowed to a sharp point, glabrous or with scattered hairs on the midrib below; corolla of 4 obovate petals 7.5–9.5 mm., mostly 9 mm. long, 3–3.5 mm. wide, tapering abruptly to a short mucro, pale yellowish or whitish, conspicuously purple dotted inside; foveae 2.5 mm. from the base of petals, broadly elliptic, or slightly flattened on the lower side, 1 mm. high, 1.3 mm. wide, extending downward 0.8 mm. into a flat sagittate pouch, margin fimbriate, with narrow divisions ca. 0.5 mm. long; stamens 4, alternate with petals, glabrous, filaments 5 mm. long, slender, slightly broadened near the base, anthers 2 mm. long, 1.3 mm. wide; crown 1 mm. or less high, fimbriate; style slender, 3–4 mm. long, stigmas 2, flabelliform, ca. 0.25 mm. long; fruit glabrous, coriaceous, 2-valved, flattened parallel to the septum, ovoid, 5–7 mm. long, 3–3.5 mm. wide; ovules and seeds 4, 3-angled, 4–4.75 mm. long, rugulose, brownish purple.

Type. Rocky slope, 9 miles east of Troy, near the Baca County line, Las Animas County, Colorado, June 29, 1948, *Rogers 6110* (Herb. Univ. Mich.; isotypes distributed to several herbaria).

Additional specimens examined. Six miles south of Utleyville, Baca County, Colorado, September 8, 1948, *Rogers 6423* (description of fruit from this collection); 2.5 miles west and 2 miles north of Andrix, Las Animas County, Colorado, July 20, 1947, *Rogers 4951;* 8 miles northeast of Kim, Las Animas County, Colorado, May 31, 1948, *Rogers 5840.* (The first set of each of the above collections is deposited in the Herbarium of the University of Michigan.)

University of Texas, Austin.

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STUDIES IN WESTERN VIOLETS, VI

Milo S. Baker

The largest number of *Viola* species in the western part of the United States belong to the *Chamaemelanium* section, most species of which have yellow or yellowish flowers. The largest group of these is the *Nuttallianae,* which contains two large species complexes, the *Viola purpurea* and the *V. Nuttallii* complexes. Each of these groups has representatives over most of the western United States, where they occupy numerous ecological niches. The more versatile of the two is the *V. purpurea* group, which occurs from near the coast of the Pacific to nearly 11,000 feet altitude in the mountains and also across the ranges and flats of the arid Great Basin.

Three species are recognized in the *V. purpurea* complex: *V. quercetorum* Baker and Clausen of the Coast Ranges and foothills of California and adjacent Oregon; *V. purpurea* Kell., with 8 subspecies occupying ecologically very different niches in the Sierra Nevada and the Great Basin; and *V. aurea* Kell., with 3 subspecies in the Great Basin. A more remote relative of the *V. purpurea* complex is *V. pedunculata* Torr. and Gray of the California Coast Ranges, with two subspecies.

The *Viola Nuttallii* complex contains the following species: *V. Nuttallii* Pursh, *V. vallicola* A. Nels., *V. Bakeri* Greene, with two, and *V. praemorsa* Dougl., with five subspecies. More remotely related are the rare endemics, *V. tomentosa* Baker and Clausen, *V. charlestonensis* Baker and Clausen, and *V. utahensis* Baker and Clausen.

The present paper treats the subspecies of *V. purpurea* and *V. pedunculata* and proposes two new combinations in *V. praemorsa.* A forthcoming paper will cover the remaining units of the Nuttallianae.

Cytological investigation of the group was carried on by Dr. Jens Clausen of the Division of Plant Biology of the Carnegie Institution of Washington, at Stanford. We collaborated in working out a tentative classification of the Nuttallianae and in testing it in the field and in the garden. Satisfactory chromosome counts have been secured for all but one of the entities in this group.

I desire to express my appreciation of the kindness of the curators who loaned us material from the United States National Herbarium (US), Gray Herbarium (GH), New York Botanical Garden (NY), Chicago Natural History Museum (F), Stanford University (DS), Pomona College (POM), University of California at Berkeley (UC), California Academy of Sciences (CAS), Missouri Botanical Garden (MO), State College of Washington (WTC), Academy of Natural Sciences of Philadelphia (PH), and Willamette University (WILLU).

Special thanks go to Dr. Jens Clausen and Dr. David D. Keck for invaluable advice and assistance in the preparation of this and the other publications on this group.

For the drawings of pistils, stamen-sheaths and seeds, I am indebted to Mrs. N. Bunyan (née Vanette Ott).

Viola purpurea Kell. Proc. Calif. Acad. Sci. 1: 55. 1855.

Plants with a strong woody taproot from the lignified rootstock but few if any adventitious roots; stems conspicuous even during the flowering season; first leaves ± rounded ± purple-tinted, particularly on lower surface, more succulent and differently margined than the later leaves; herbage microscopically puberulent throughout; peduncular bractlets minute, filiform, subopposite or somewhat separated; flowers bright yellow on the face, purple-tinted on back of the upper petals, varying somewhat in size between subspecies, the spur uniformly short, 1–2 mm. long, the lateral petals clavate-bearded; sepals linear-lanceolate with inconspicuous auricles, glabrate to densely puberulent, or ciliate; style length somewhat various; ovary microscopically puberulent; style with conspicuous flexure near the ovary and a capitate head with retrorse bearding on each side; stigma a minute lip terminating the head; capsule nearly spherical, microscopically puberulent; seeds more nearly spherical than in the other species of *Nuttallianae.* The caruncle does not project beyond the point of the seed but is much the same in all the subspecies except *venosa* and *atriplicifolia* in which it has a peculiarly flattened and fluted appearance when dry. The stamen sheath and its collar-opening is similar in form but varies in size for the different units of the *V. purpurea* complex. It is fully explained elsewhere (Madroño 3: 52, 53, and 57, 1935). (See also figs. 9, 12, 13, 14, pl. 8).

Viola purpurea subsp. **typica** Baker and Clausen, nom. nov. *V. purpurea* Kell. Proc. Calif. Acad. Sci. 1: 55. 1855.

In strong light a depressed plant, in shade more or less erect, 6–19 cm. high; early foliage green but more strongly purple-tinted and more succulent than in the other subspecies, glabrate on upper surface; main stems 1–8, at flowering stage 4–19 cm. long, later in season longer; radical leaves 1–5, orbicular, margination irregular, 1.6–3 cm. wide, 1.8–3.5 cm. long, on petioles 4–11 cm. long (pl. 4), the stipules ± scarious, adnate to petiole, free tip triangular to lanceolate, 2–3 mm. long; upper cauline leaves ovate, more regularly crenate-serrate, becoming microscopically puberulent throughout, the stipules foliaceous, very unequal even for the same leaf, mostly ovate to oblong, coarsely toothed, 1.5–5 mm. wide, 3–14 mm. long; peduncles 3–10 cm. long, exceeding the leaves, the bractlets filiform, mostly above the middle, never near the flowers, 2–5 mm. long; sepals glabrate to ciliate or densely short-puberulent, 1–1.3 mm. wide, 4–6 mm. long; style 2.1 mm. long; capsule 5–6 mm. in diameter; seeds dark brown (table 1).

Kellogg's species is without a type specimen, but there is a water color sketch of a portion of a fresh specimen from Placerville, California, drawn by Dr. Kellogg in 1855 and deposited at the California Academy of Sciences, San Francisco. The marked purple color of this plant identifies it as *V. purpurea* rather than *V. quercetorum* Baker & Clausen. Two markings shown in the drawing mentioned above, however, do not occur in any plants I have examined, namely, the purple color of the stigma and three purple stripes upon the capsule.

In the absence of a type for *Viola purpurea,* I wish to propose as a lectotype the following specimen which comes nearest to my conception of Dr. Kellogg's plant: With scattered yellow pines, along Highway 36, 2 miles west of Paynes Creek, Tehama County, California, altitude 1800 feet, *M. S. Baker 8655* (widely distributed to herbaria in the United States). This collection came from a low elevation for subsp. *typica,* being well within the elevational range of *V. quercetorum,* but a bud fixation showed that it has six pairs of chromosomes, the *V. purpurea* number.

In the field, subspecies *typica* can be distinguished from *V. quercetorum* by its greener aspect, more purple tinting throughout, somewhat smaller flowers, capsules and seeds, less vigorous growth and the somewhat narrower leaves, most noticeably in the small upper ones as illustrated in plate 4.

Viola purpurea subsp. *typica* seems almost invariably to be associated with yellow pine and occupies the Lower Transition Life Zone. It, together with subspecies *mesophyta, dimorpha* and *geophyta* should be known as the yellow pine violet. At the northern end of the Sacramento Valley the lower limit of the

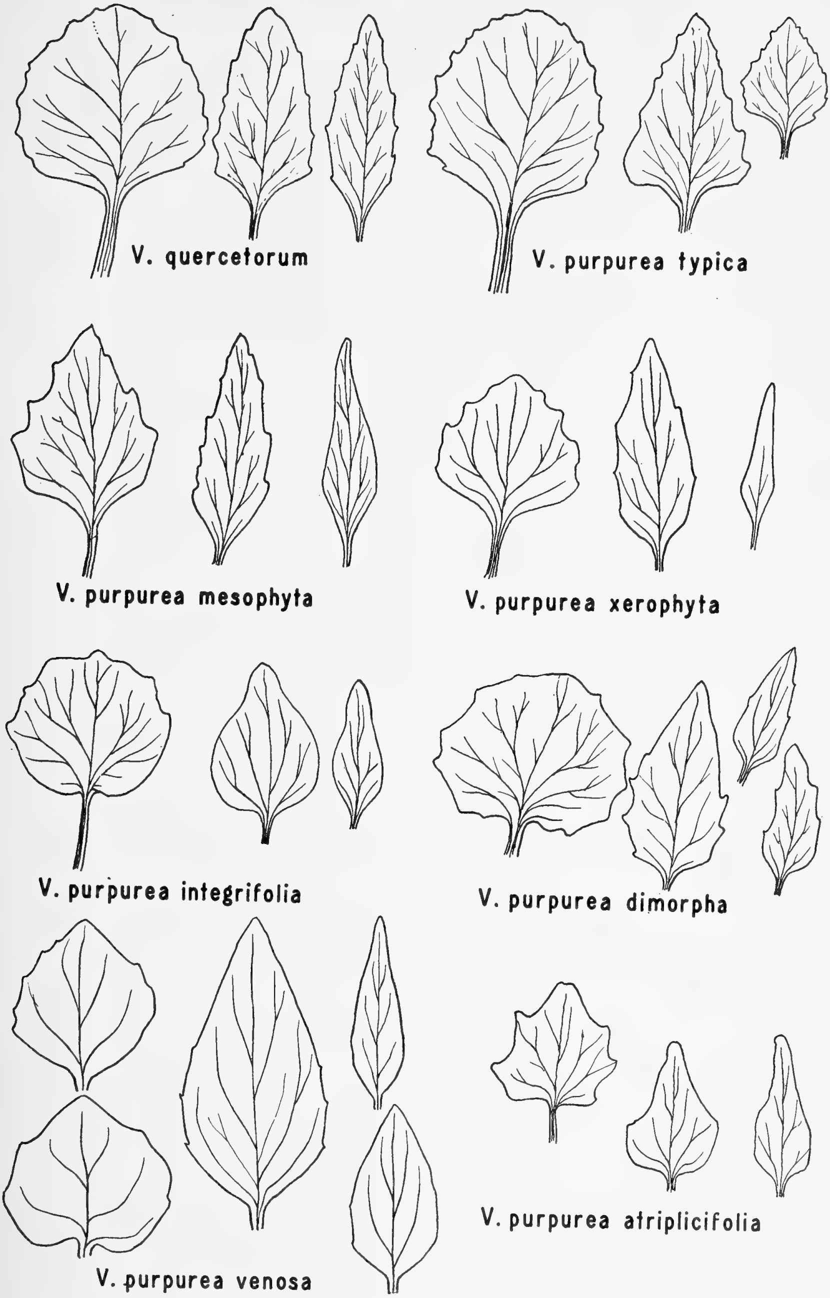

Plate 4. Leaf Outlines of Subspecies of Viola purpurea Kell. Figures at left are earliest basal leaves, those at right, upper leaves. All × 1.

yellow pine belt is around 2000 feet. From here *V. purpurea* subsp. *typica* may extend upward several thousand feet in altitude before being replaced by other subspecies.

A belt of *Viola purpurea* subsp. *typica,* generally just above a belt of *V. quercetorum,* may be found from the Mexican border, through the mountains of southern California and along the western slope of the Sierra Nevada, nearly to the western slope of Mount Lassen, thence northwesterly nearly to Mount Shasta and the Siskiyou Mountains. In the Coast Ranges it is found on Mount Pinos and the higher peaks of the San Rafael Mountains, but thus far has not been collected elsewhere to the north until Lake County is reached. Here it has been found on Mount Sanhedrin and Snow Mountain, and it doubtless grows on Mount Hull and Sheetiron. It has been collected in association with *V. quercetorum* on Elk Mountain at 4100 feet, on Mount Hanna, and at Loch Lomond, Lake County, at 2500 feet, the lowest elevation known for it in the Coast Ranges. At the south end of this lake *V. quercetorum* is abundant, while at the north end typical *V. purpurea* grows but is less abundant. This is one of the few places where the two have been observed growing side by side. No intergrading has been observed, due no doubt to their different chromosome numbers. Doubtless a considerable belt of *V. purpurea* subsp. *typica* may be found on the Yollo Bollys. In the Siskiyous, as well as in the Salmon and Trinity mountains, it has been found at the proper elevation. In the Arid Transition, north and northeast of Mount Shasta and into Oregon, subsp. *typica* is almost wholly replaced by subsp. *dimorpha.*

The altitudinal limits of subsp. *typica* are marked by the collections from Paynes Creek, Tehama County, at 1800 feet, and Cisco Grove, Placer County, at 6000 feet.

VIOLA PURPUREA subsp. **mesophyta** (PECK, M.E.) Baker and Clausen, subsp. nov. Planta silvicola virescens; a subsp. typica differt foliis erectissimis longe petiolatis, imis parvis plus minusve profunde et remote dentatis, superioribus angustis integris usque ad 5.8 cm. longis 1.7 cm. latis.

Erect green plants of coniferous forests, differing from subsp. *typica* in the strictly erect leaves, only the earliest being thick and purple-tinted and the upper being narrower, sharper, and more nearly entire, even the radical leaves (except the very earliest) are thin, elongated, with a sharper more irregular dentation and longer petioles 2.8–13 cm. long, their blades mostly ovate-lanceolate, occasionally ovate, few or none as wide as long (pl. 4), 5–22 mm. wide, 16–35 mm. long, the cauline narrower, undulate-denticulate to occasionally entire, ovate-lanceolate to oblong-lanceolate, occasionally 5 times as long as wide, 5–17 mm. wide, 2–5.8 cm. long, the petioles progressively shorter

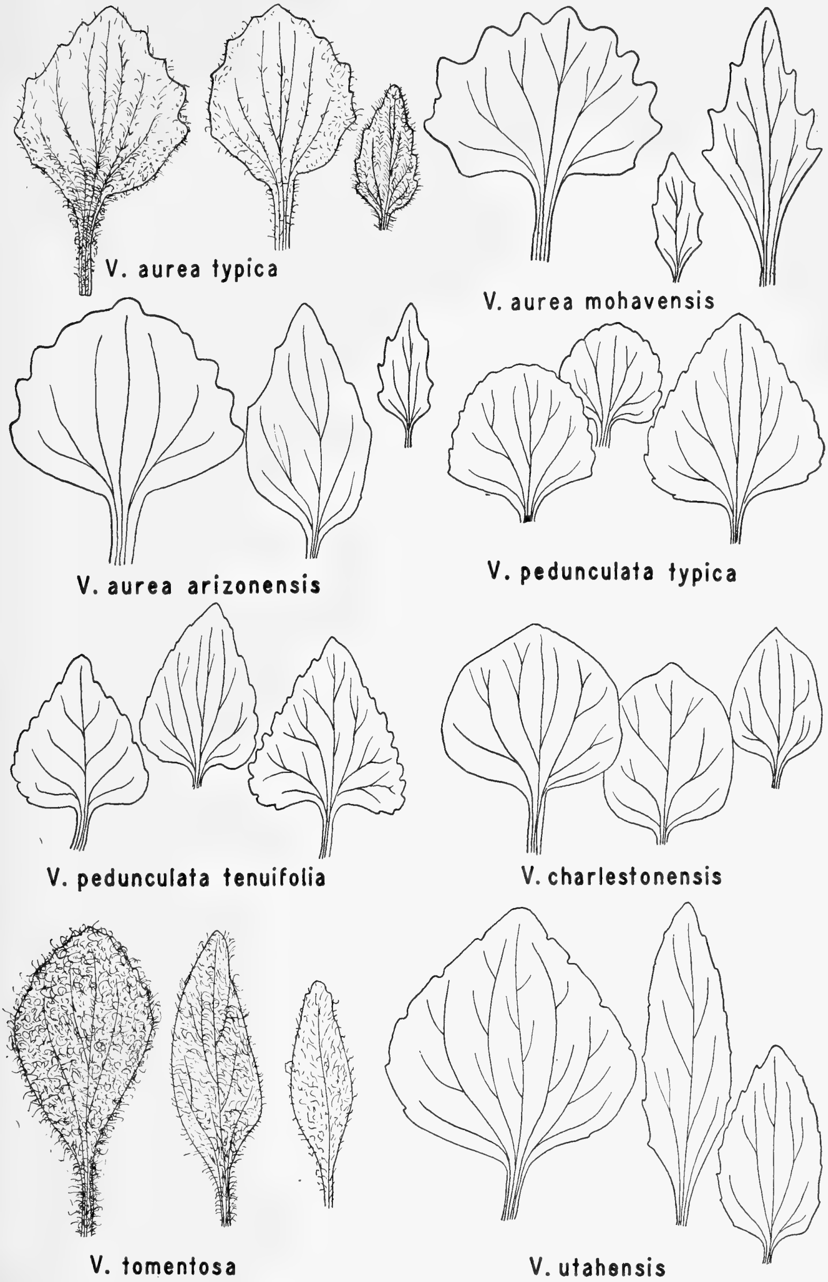

Plate 5. Leaf Outlines of Species of Viola, Section Nuttallianae other than V. purpurea. (*Viola aurea*, illustrated here, will be treated in a forthcoming paper.) Figures at left are earliest basal leaves, those at right, upper leaves. All × 1.

upwards; seeds gray, mottled with brown, dimensions and weight as in table; otherwise as in subsp. *typica.*

Type. In the shade of *Abies magnifica, A. concolor,* and *Pinus Murrayana,* Porcupine Flat, Yosemite National Park, Mariposa County, California, altitude 8100 feet, July 18, 1935, *J. Clausen 1098* (DS; isotypes: UC, POM, MO, US).

This subspecies grows at a higher elevation than subsp. *typica,* living mainly in the upper Transition and Canadian life zones at elevations from 6000 to 10,500 feet. It is found in coniferous forests from the San Jacinto and San Bernardino mountains to the Mount Pinos region, the Tehachapi Mountains, and along the western slope of the Sierra Nevada as far north as the Feather River region of Plumas County. It is thus restricted entirely to California. Its nearest relative is subsp. *xerophyta* from which it can be distinguished by its greener aspect, longer stems, somewhat wider leaves with more rounded apices, and the forest habitat.

Near its northern limit this subspecies and subsp. *dimorpha* overlap to some extent, and might be confused because of the similarity of the uppermost leaves. A glance at one of the earliest radical leaves, however, will immediately clear up the question of identity, for that of subsp. *dimorpha* is truncate at base and the teeth are obscure or rounded, while that of subsp. *mesophyta* has a cuneate base and the teeth are more acute (pl. 4). Moreover, the uppermost leaves of subsp. *mesophyta* are considerably narrower.

At lower levels subsp. *mesophyta* may occasionally be in contact with subsp. *typica,* but the two may be distinguished both by the earliest radical leaves and the upper leaves, which are quite different (pl. 4).

VIOLA PURPUREA subsp. **xerophyta** Baker and Clausen, subsp. nov. Nana alpina canescens cinerescens subspeciei *mesophytae* similis; internodiis brevibus; foliis caulinis undulato-denticulatis, superioribus anguste lineari-lanceolatis.

Alpine dwarf close to subsp. *mesophyta* but smaller, 3–12 cm. above ground, grayer because of denser puberulence, with leaves mostly narrower and stems little developed and mostly buried; taproot large, woody, without adventitious branches from the rootstock; leaves extremely variable in outline and serration but similar to those of subsp. *mesophyta* (pl. 4), the radical few; cauline leaves ovate to ovate-lanceolate or linear-lanceolate, irregularly dentate to lacerate or nearly entire, 7–15 mm. wide, 10–35 mm. long, on petioles 2–6 cm. long, the cauline progressively narrower and more acute and on shorter petioles upwards, undulate, undulate-denticulate, lacerate, or entire; peduncles equaling or much exceeding the leaves; bractlets usually near the middle of the peduncle; flowers small, about 8 mm. in diam-

TABLE 1. CHROMOSOME NUMBERS AND SEED CHARACTERS OF VIOLA, SECTION NUTTALLIANAE.

V. purpurea complex	Chromosome no. n	Weight mg	Length mm	Width mm	Caruncle length mm	Color	Luster
V. quercetorum	12	3.29	269	1.79	0.64	med. brown	medium
V. purpurea							
typica	6	2.34	2.31	1.45	0.56	dark brown	dull
mesophyta	6	2.75	2.53	1.66	0.58	gray and brown	dull
xerophyta	6	2.51	2.31	1.74	0.28	mottled gray and brown	dull
integrifolia	6	3.73	2.86	1.96	0.59	dark brown	dull
dimorpha	6	2.64	2.46	1.80	0.36	med. brown	dull
geophyta	6	2.00	2.37	1.52	0.40	mottled gray and brown	dull
venosa	6	2.70	2.35	1.50	0.96	med. brown	dull
atriplicifolia	6	2.57	2.41	1.66	0.85	light brown	dull
V. aurea							
typica	6	2.15	2.91	1.47	0.85	med. brown	medium
mohavensis	6	2.30	2.73	1.48	0.72	light brown	medium
V. Nuttallii complex:							
V. praemorsa							
typica	18	6.21	3.49	2.09	1.04	light tan	shining
major	24	5.10	3.00	1.83	1.05	med. brown	shining
arida	—	4.08	2.95	1.95	0.90	light tan	medium
oregona	24	3.50	2.88	1.54	0.91	light brown	medium
linguaefolia	18	4.24	3.25	1.81	1.34	med. brown	shining
V. Bakeri							
typica	24	4.19	3.00	1.77	0.68	med. brown	shining
grandis	24	5.16	3.56	1.98	0.62	dark brown	shining
V. Nuttallii	12	3.00	3.00	1.67	1.00	med. brown	shining
V. vallicola	6	1.70	2.19	1.27	0.78	straw color	medium
Other species							
V. utahensis	12	4.40	2.97	1.65	0.77	med. brown	dull
V. tomentosa	6	2.83	2.67	1.52	0.40	light brown	dull
V. charlestonensis	6	5.04	3.42	2.08	0.50	black	shining
V. pedunculata							
typica	6	4.97	2.68	1.84	0.64	dark brown	shining
tenuifolia	6						

eter; collar-opening longer than in the other subspecies, other details of flowers as in the other subspecies; seeds gray, mottled with brown, dimensions and weight as in table 1.

Type. In open ground along the trail from Mineral King to the Little Kern River, a short distance southwest of Farewell Gap, Tulare County, California, altitude about 10,000 feet, July 8, 1930, *M. S. Baker 4375* (UC; isotypes: POM, DS, US).

Professor Edward Lee Greene in 1889 collected in the Tehachapi Mountains, Kern County, a violet that later was published as *Viola pinetorum* Greene. In the opinion of Dr. Clausen, this is a hybrid between subspecies *xerophyta* and *mesophyta,* and therefore the name is not available for either of these subspecies.

This subspecies is in arid alpine regions of California from the San Jacinto and San Bernardino mountains to Mount Pinos, Tehachapi Mountains and the crests of the Sierra Nevada as far north as Sierra County, extending from the Upper Canadian through the Hudsonian and into the Boreal Life Zone. One collection (*Parish 1796*) was made at 5000 feet in the San Bernardino Mountains, but usually it grows above 7000 feet, the highest known elevation being 11,000 feet on Olancha Mountain, Tulare County (*Hall and Babcock 5235*).

Attention should be called to some notable variations in this subspecies. One of these occurs in the Sierra Nevada south of Mount Whitney at Golden Trout Creek and elsewhere in this region. The leaves of this form have a markedly lacerate margin and the foliage is unusually canescent due to a dense coat of hairs approaching a tomentum. The leaves are also much narrowed, some being only one-eighth as wide as long. In the mountains of southern California and the Tehachapi there is another very narrow-leaved and highly canescent form of subsp. *xerophyta.*

The nearest relative is subsp. *mesophyta,* which is an inhabitant of forests on the western Sierra Nevada slope, while subsp. *xerophyta* occupies more open and rocky situations and extends to a higher level.

VIOLA PURPUREA subsp. **integrifolia** Baker and Clausen, subsp. nov. Persaepe nana alpina virescens puberula; caulibus subterraneis; foliis radicalibus orbiculatis irregulariter dentatis, eis summis integerrimis.

Alpine dwarf, mature plants showing on the surface only a clump of leaves a few centimeters high, which completely hide the buried stems; taproot woody, deep-seated, with small secondary roots and an occasional adventitious root from the rootstock; stems one to many, usually deeply buried, developed only slightly above the surface, 2–7 cm. long; herbage microscopically puberulent throughout; earliest leaves horizontal, thick and purple-tinted beneath, green above, undulate or shallowly and irregularly (never deeply) dentate, rotund with subcordate, truncate, or broadly cuneate base, 8–17 mm. wide, 10–18 mm. long, on petioles 3–5 cm. long, the cauline leaves few, smaller, narrower, mostly obtuse with cuneate base, entire, ovate to oblong-lanceolate, 3–10 mm. wide, 9–25 mm. long, on petioles progressively shorter upwards (pl. 4); stipules mostly scarious; peduncles as long as or slightly longer than the leaves, the bractlets mostly near the

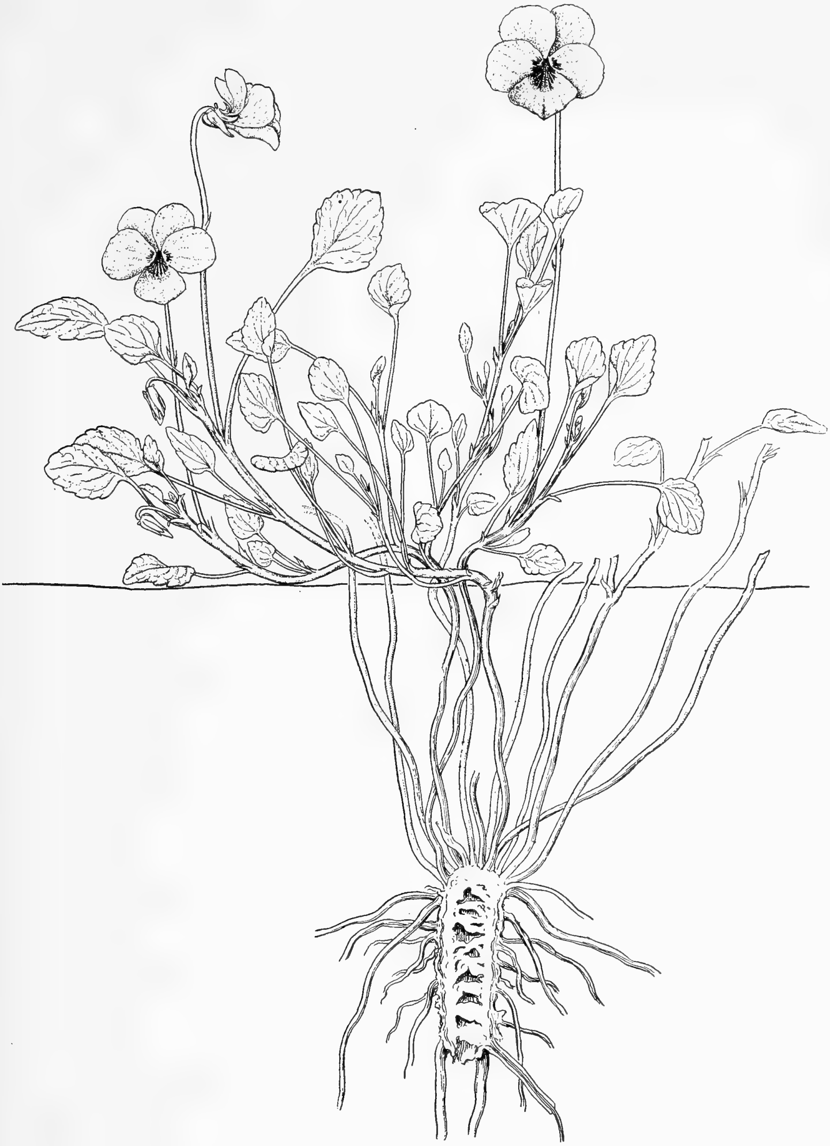

Plate 6. Viola pedunculata Torr. and Gray subsp. typica Baker and Clausen. ×0.6.

flowers; flowers often smaller than in subsp. *typica* but variable in size, 8–10 mm. in diameter; seeds dull dark brown, dimensions and weight as in table 1.

Type. In *Abies magnifica* forest, on the Humbug Road from Prattville to Chaparral, just north of Humbug Summit, Plumas County, California, near the Butte County line, altitude 6500 feet, June 25, 1935, *Keck & Clausen 3769* (UC; isotypes: CAS, DS, US).

In typical form this subspecies is not usually found below 6000 feet altitude and it extends upward to timber line. The highest known station is Castle Peak, Nevada County, at 8900 feet (*A. A. Heller 7089*). The subspecies is adapted to dry rocky or pumice-covered slopes as evidenced by the enormously long woody taproot. A collection from Crater Lake National Park (*Applegate 9764*) shows a taproot broken off at 20 cm. beneath the surface and a much greater length is indicated. The deeply buried buds of this subspecies enable it to withstand the extreme temperatures of high elevations.

Geographically subsp. *integrifolia* extends from Inyo and Mariposa counties north along the arid crests of the Sierra Nevada in California and the high peaks of Ormsby and Washoe counties, Nevada, to Mount Lassen, Mount Shasta, and the alpine peaks of Klamath County, Oregon. In the elevated regions about Crater Lake and south it is quite common. It also extends southward from Siskiyou County into the high peaks of the inner Coast Range where it presents a somewhat different appearance. It has been collected at 7000 feet on Snow Mountain, Anthony Peak, Mendocino County, and at the 6750 foot summit of the Covelo-Williams highway in Glenn County. In the region about this summit it is the only form of *Viola purpurea* and is abundant from 6000 to 7000 feet.

In the northern Sierra Nevada this subspecies replaces subsp. *xerophyta* at alpine levels. Though these forms overlap in the central Sierra Nevada, there is never any difficulty distinguishing them because of the greener aspect and the obtuse leaf apices of subsp. *integrifolia*.

At some points along the western borders of the Great Basin, subspecies *integrifolia* and *dimorpha* are found growing near one another. Except in northern California the entire margins of the

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EXPLANATION OF THE FIGURES. PLATE 7.

PLATE 7. PISTILS OF VIOLA, SERIES NUTTALLIANAE. FIGS. 1–6, *V. Nuttallii* complex: *1, V. vallicola* A. Nels.; *2, V. praemorsa* Dougl. subsp. *oregona* Baker and Clausen; *3, V. Bakeri* Greene subsp. *typica* Baker and Clausen; *4, V. Nuttallii* Pursh; *5, V. praemorsa* Dougl. subsp. *linguaefolia* (Nutt. ex Torr. and Gray) Baker and Clausen; *6, V. praemorsa* Dougl. subsp. *typica* Baker and Clausen. FIGS. 7–12. *V. purpurea* complex: *7, V. quercetorum* Baker and Clausen; *8, V. aurea* Kell. subsp. *typica* Baker and Clausen; *9, V. aurea* Kell. subsp. *mohavensis* Baker and Clausen; *10, V. purpurea* Kell. subsp. *xerophyta* Baker and Clausen; *11, V. purpurea* Kell. subsp. *mesophyta* Baker and Clausen; *12, V. purpurea* Kell. subsp. *typica* Baker and Clausen. All × 10.

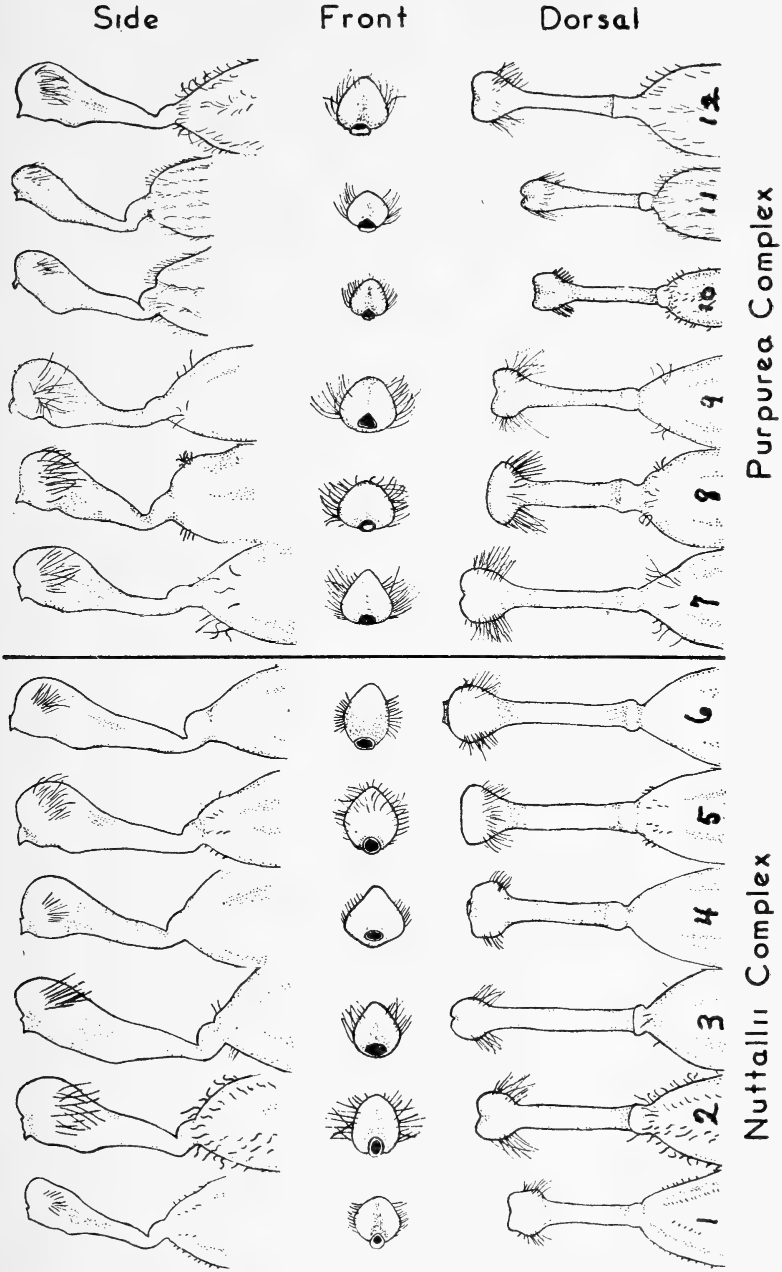

Plate 7. Pistils of Viola, series Nuttallianae.

upper leaves distinguish subsp. *integrifolia*. However, in Shasta, Modoc and Siskiyou counties the upper leaves of subsp. *dimorpha* tend to have entire margins and in such a case the two subspecies are distinguished by the caulescent habit of subsp. *dimorpha*.

Discussion of this subspecies should not be concluded without comment on the peculiar form to be found about Lake Tahoe, Truckee, Hobart Mills, Webber Lake and Gold Lake. Here subsp. *integrifolia* may reach a height of 17 cm. above the soil with stems nearly as long. In the shade of the dense forests of this region the winter buds are not so deeply buried, hence the stems are mainly aerial. The aspect of these plants is wholly different from that of plants at higher elevations.

Viola purpurea subsp. **dimorpha** Baker and Clausen, subsp. nov. Planta silvicola virescens tarde conspicue caulescens; foliis radicalibus orbiculatis basi truncatis, summis saepe integerrimis.

Foliage greenish as in subsp. *typica*, 3–25 cm. high; early leaves rotund, truncate at base, on petioles 2–8.5 cm. long, later leaves narrowly ovate to lanceolate, obtuse to acute, truncate or slightly cuneate at base, repand-denticulate to entire, some, as season advances, 2.5–3 times as long as wide, 7–15 mm. wide, 15–30 mm. long; seeds dull brown, variable in size and form, dimensions and weight as in table.

Type. In yellow pine, white fir and incense cedar forest, near the Mineral-Chester highway, Child's Meadows, Plumas County, California, altitude about 5000 feet, June 26, 1935, *M. S. Baker 8100* (UC; isotypes: DS, CAS, US, NY, GH, F).

This subspecies has a wide distribution in the coniferous forests bordering the Great Basin from Deschutes County, Oregon, southward through Siskiyou, Modoc, Lassen and Plumas counties, California, and along the eastern slope of the Sierra Nevada as far south as Inyo County, California.

It should be borne in mind that subsp. *dimorpha* is a forest or

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Explanation of the Figures. Plate 8.

Plate 8. Viola, series Nuttallianae. Figs. 1–7. Pistils, side, front, and dorsal views: *1, V. praemorsa* Dougl. subsp. *major* (Hook.) Baker and Clausen; *2, V. Bakeri* Greene subsp. *grandis* Baker and Clausen (1 and 2 belong to the *V. Nuttallii* complex); *3, V. tomentosa* Baker and Clausen; *4, V. utahensis* Baker and Clausen; *5, V. charlestonensis* Baker and Clausen; *6, V. pedunculata* Torr. and Gray subsp. *tenuifolia* Baker and Clausen; *7, V. pedunculata* Torr. and Gray subsp. *typica* Baker and Clausen. Fig. 8. Side view of pistil, *V. purpurea* Kell. subsp. *dimorpha* Baker and Clausen. Fig. 9. Stamen sheath, *V. tomentosa* Baker and Clausen. Figs. 10–11. Seeds: *10, V. quercetorum* Baker and Clausen; *11, V. purpurea* Kell. subsp. *atriplicifolia* (Greene) Baker and Clausen. Figs. 12–14. Stamen sheaths: *12, V. Bakeri* Greene subsp. *typica* Baker and Clausen; *13, V. praemorsa* Dougl. subsp. *typica* Baker and Clausen; *14, V. pedunculata* Torr. and Gray subsp. *tenuifolia* Baker and Clausen. Fig. 15. Seed, *V. praemorsa* Dougl. subsp. *typica* Baker and Clausen. All × 10.

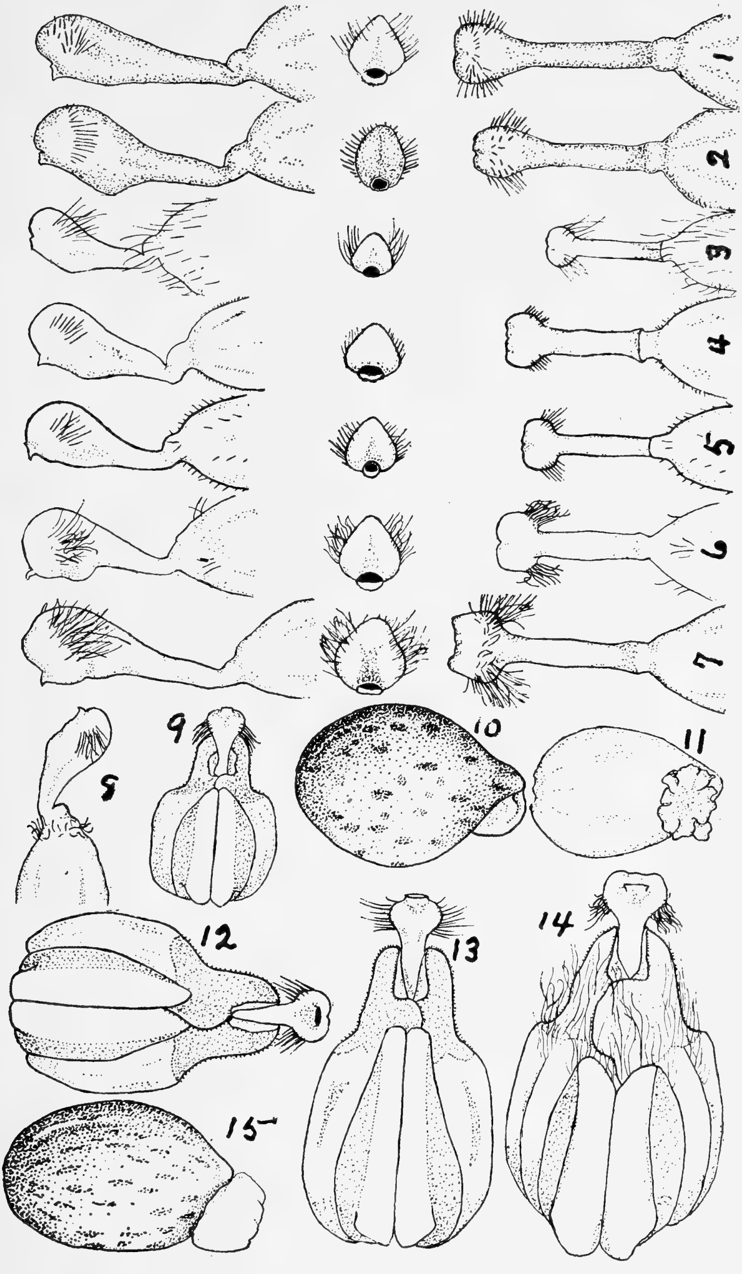

PLATE 8. VIOLA, SERIES NUTTALLIANAE.

shade type, while subsp. *geophyta* inhabits open areas surrounded by forests and is therefore a sun type. Seasonal buds of subsp. *dimorpha* are near the surface, while in subsp. *geophyta* the buds are deeply buried. These two subspecies completely intergrade at several places, however, indicating that possibly they represent but environmental forms of one unit.

Subspecies *dimorpha* shows wide variation. Early in the season the first flowers appear when the plant is extremely small and possesses few other than basal leaves. Later in the season it may be many times higher, with the rounded basal leaves all fallen and only the narrow nearly entire cauline leaves present, thus making the plant appear like an entirely different species. It is to this peculiar characteristic of the plant that the proposed subspecific name calls attention.

At the height of the flowering season subsp. *dimorpha* often closely resembles subsp. *typica* in regions where the ranges of the two overlap. However, subsp. *dimorpha* can be easily distinguished by the truncate or subcordate base of the earliest leaves, and by the narrower, more acute and more nearly entire upper leaves.

Occasionally a plant of subsp. *dimorpha* is found which may be confused with subsp. *mesophyta,* the later leaves being often very similar. In such a case, the early leaves serve to distinguish them, for the radical leaves of subsp. *dimorpha* are truncate or subcordate basally, while those of subsp. *mesophyta* are cuneate basally.

VIOLA PURPUREA subsp. **geophyta** Baker and Clausen, subsp. nov. Planta caespitosa acaulescens usque ad 5 cm. alta plus minusve cinerescens (glabrata usque ad fere canescens); foliis radicalibus orbiculatis basi truncatis, summis plus minusve dentato-serratis; hibernaculis valde subterraneis.

A low-growing geophyte with little stem development and that largely subterranean, caespitose, seldom more than 5 cm. high above ground, scarcely hairy and light green to almost canescent; root system woody, variable, but commonly with one or more adventitious branches from the rootstock; primary stems 1–6, from tip of deep-seated vertical rootstock, 2.5–8 cm. long, erect or ascending; lowest leaves (both radical and cauline) rounded, thick, purplish, coarsely, deeply and bluntly dentate, the blade commonly broader than long, 1–3.4 cm. wide, 1–2.8 cm. long, on petioles 2.5–8 cm. long, the cauline leaves progressively smaller, sharper, and grayer upwards, ovate to ovate-lanceolate, ± sharply but not deeply dentate-serrate; stipules of radical leaves scarious, the free tip nearly obsolete, of cauline leaves mostly scarious and shrivelled but occasionally foliaceous above; peduncles of petaliferous flowers longer than the leaves, those of the more numerous cleistogamous flowers short and ± subterranean, the bractlets scarious, nearly obsolete, near the middle; flowers and capsules smaller than those of subsp. *typica;* seeds dull brown, finely mottled with gray, dimensions and weight as in table.

Type. In volcanic ash, yellow pine and lodge-pole pine forest, 20 miles south of Lapine on the road to Silver Lake, Deschutes National Forest, Klamath County, Oregon, altitude about 4000 feet, June 23, 1935, *Keck & Clausen 3707* (UC).

This subspecies is found in open flats of the coniferous forests along the western border of the Great Basin from Deschutes County, Oregon, southward through northern California and along the eastern slope of the Sierra Nevada as far as Mono and possibly Inyo County. Its buds are protected in winter by a layer of soil several inches in thickness. The older plants form low spreading mounds of what appear to be only leaves topped with a few flowers. Still later in the season the short stems are full of short-peduncled capsules from apetalous flowers. These cleistogamous capsules are seldom as high as the leaves when ripe and often are beneath the soil.

This subspecies is closely allied to subsp. *dimorpha* with which it sometimes intergrades as mentioned above. Both subspecies range from 4000 to 8000 feet in elevation. Three principal differences separate them: subsp. *geophyta* has more deeply buried seasonal buds, very little stem development, and a greater serration of the uppermost leaves.

Subspecies *geophyta* differs from subsp. *atriplicifolia,* which it occasionally contacts on the east and northeast, in growing at a somewhat lower elevation and in having its stems invariably buried, while subsp. *atriplicifolia* varies in this respect. The leaves of the latter subspecies are more sharply, deeply and irregularly notched, resulting in shapes reminiscent of some *Atriplex* leaves.

VIOLA PURPUREA subsp. **venosa** (Wats.) Baker et Clausen, comb. nov. *V. Nuttallii* var. *venosa* Wats. Bot. King's Expl. 35. 1871. *V. aurea* var. *venosa* Wats. in Brewer & Wats. Bot. Calif. 1: 56. 1876. *V. praemorsa* var. *venosa* Gray, Syn. Fl. 2: 200. 1895. *V. venosa* Rydb. Mem. N. Y. Bot. Gard. 1: 262. 1900. *V. purpurea* var. *venosa* Brain. Vt. Agric. Exp. Sta. Bull. 224: 111. 1921. *V. Thorii* A. Nels. Bot. Gaz. 30: 193. 1900. *V. atriplicifolia Thorii* A. Nels. Coult. & Nels. Man. Bot. Rocky Mts. 321. 1909.

Similar to subsp. *typica* except basal leaves slightly smaller, occasionally more deeply and regularly dentate, later leaves somewhat larger, more abundant, narrower and sharper at apex, the margin not so deeply broken, often entire; pubescence usually shorter, often consisting of mere points as if sanded; peduncles in fruit often recurved towards the ground; seeds dull brownish, variable in size, dimensions and weight as shown in table, the caruncle large, wide-spreading but thin, and when dry, flattened and fringed around margin, variable in size, up to 1 mm. in diameter.

The type was collected in the West Humboldt Mountains, Nevada, and the subspecies ranges from Nevada to the Wasatch Mountains, Utah, Colorado (one outlying station at Steamboat Springs, Routt County), thence northward through Wyoming to Montana, and westward through Idaho to eastern Washington. It has not as yet been found in eastern Oregon, but is to be expected there. Its elevational range is from 5000 to 10,000 feet. Except at high altitudes it grows in dense shade of forests or brush. Such shade conserves the necessary moisture to permit a longer seasonal growth, resulting in longer stems and a greater proportion of cauline leaves.

This subspecies is most baffling because of the wide variation in leaf-shape (pl. 4). The two drawings on the left represent two types of basal leaves. There is scarcely a leaf form of the *Viola purpurea* complex of the Pacific Coast that cannot be duplicated in this subspecies. Watson's type is very close to subsp. *typica* or subsp. *integrifolia,* but plants from lower elevations often have large cauline leaves which may be entire or obscurely dentate. Again, the cauline leaves may be small and greatly elongated as at the right in the plate. There is no fixed pattern in leaf outline (pl. 4) nor any other definite character except for the peculiarly flattened and fringed type of caruncle which is the same as that in subsp. *atriplicifolia* (pl. 8, fig. 11).

As shown by the synonymy, this unit has been placed by various authors under five different species, but in my opinion Brainerd was correct in classifying it as a subunit under *V. purpurea.* It has but one constant difference separating it from *V. purpurea* subsp. *typica,* and that is in the form of the caruncle of the seed. A minor difference such as this cannot justify specific separation.

The nearest relative of subsp. *venosa* is subsp. *atriplicifolia.* Both are confined to the Great Basin region and both extend to near timber line. Each has the same peculiar spreading caruncle (when dry) and a similar pubescence. They differ mainly in the leaf outline.

VIOLA PURPUREA subsp. **atriplicifolia** (Greene) Baker and Clausen, comb. nov. *V. atriplicifolia* Greene, Pittonia 3: 38. 1896.

Closely allied to subsp. *venosa* but early leaves more sharply dentate, in some cases nearly lobed, the later leaves triangular, acute, coarsely and irregularly dentate to quite entire; stem development small, never exceeding the height of the radical leaves; seasonal buds vary greatly in depth, being deeply buried at one locality and near the surface at another; in other details as in subsp. *venosa.*

Type. Dry hills near Mammoth Hot Springs, Wyoming, Yellowstone Park, altitude 6500 feet, June 1893. *F. H. Burglehaus* (US).

This subspecies has a wide distribution, mostly at fairly high elevations from 6000 to 10,000 feet (rarely as low as 5000 or even 4500 feet), from Wyoming to Idaho and southeastern Washington, southward through eastern Oregon and Nevada to Ashland Butte, the Warner Mountains of California and the eastern slopes of the Sierra Nevada as far south as Inyo County, California.

A shade form of this subspecies deserves comment for it presents a very different appearance from the plants of more open ground. The early, largely radical, leaves have greatly elongated petioles (in an extreme case 16 cm. long), and the somewhat elongated stems are feeble, bearing tiny leaves. The early leaves lack the distinct notching of the sun form; instead their irregular notches are greatly rounded, suggesting an undulate margin. Moreover, their blades are much larger, being up to 2–3 cm. in width and length, yet the cauline leaves are not larger but may be very narrow and much overtopped by the elongated basal leaves. The following collections represent this seldom collected shade form: Wallowa Mountains of northeastern Oregon, *Cusick 3074;* Ashland Butte, Jackson County, Oregon, *Applegate 5462, 5498;* western slope of the Warner Mountains, Modoc County, California, *Applegate 7960.*

VIOLA PEDUNCULATA subsp. **typica** Baker and Clausen, nom. nov. *V. pedunculata* Torr. and Gray, Fl. N. Am. 1:141. 1838.

VIOLA PEDUNCULATA subsp. **tenuifolia** Baker and Clausen, subsp. nov. A subsp. *typica* differt foliis tenuibus, superioribus vix longioribus quam latis; sepalis longioribus angustioribus acutioribusque; corollis flavis haud aurantiacis parvioribus; stylo breviore 2.1 mm. longo.

Subspecies *tenuifolia* differs from subsp. *typica* in having thinner, smaller, more acute leaves of deltoid outline, most of them being longer than wide (pl. 5). The leaves of subsp. *typica* are ovate, obtuse, and approximately as broad as long. The flowers of subsp. *tenuifolia* are often smaller than those of subsp· *typica,* sometimes not larger than those of *V. quercetorum.* At the type locality, the flowers are yellow, not orange as in subsp. *typica.* The sepals are narrower, longer, and more acute. The style is only 2.1 mm. long, while that of subsp. *typica* is 2.9 mm. Style length is one of the most dependable characters in the Nuttallianae. Also the style is conspicuously bulged downward just back of the stigmatic lip.

Type. Associated with oak and digger pine, along highway to Tres Pinos, 4 miles easterly from Pinnacles Lodge, San Benito County, California, altitude 1100 feet, April 5, 1939, *M. S. Baker 9267* (UC; isotypes: DS, POM, US, F, NY, GH).

This subspecies was found to be abundant in the Pinnacles region in rocky uplands rather than in good deep clay or bottom land soil such as that on which subsp. *typica* is found. It was found growing in scattered colonies nearly to the top of Chalone Mountain, which is 3287 feet high.

Throughout most of its range *Viola pedunculata* exhibits very constant characters. In this area, however, subsp. *typica* does not occur but is to be found contiguous to subsp. *tenuifolia* on its south, west and north borders.

In 1902 C. A. Purpus collected *V. pedunculata* at Springville in Tulare County. Because this species had not before been reported outside the coastal area the data on the Purpus specimen were questioned. In March, 1943, Miss Ella Carter collected material from the Crawford Ranch, six miles below Trimmer Springs in Fresno County. Both of these collections are the subsp. *tenuifolia* and there seems no reason to further question the Purpus collection. These occurrences add another species to the growing list of Coast Range plants that have disjunct ranges between the Coast Ranges and the southern Sierra Nevada foothills.

In the Tertiary there was an arm of the ocean extending into the San Joaquin Valley in the region where this violet has been collected. This may explain its presence as small relict colonies in an arid region where it is possibly doomed to final extinction.

VIOLA PRAEMORSA Dougl. subsp. **linguaefolia** (Nutt. ex Torr. and Gray) comb. nov. *V. linguaefolia* Nutt. ex Torr. and Gray, Fl. N. Am. 1: 141. 1838.

VIOLA PRAEMORSA Dougl. subsp. **major** (Hook.) comb. nov. *V. Nuttallii* var. *major* Hook. Fl. Bor. Am. 1: 79. 1830.

Kenwood, California

NEWS AND NOTES

DISPOSITION OF THE WILLIS LINN JEPSON ESTATE. The estate of Willis Linn Jepson who died on November 7, 1946, was recently accepted by the Regents of the University of California for the Department of Botany on the Berkeley Campus. The will provides an endowment fund of $320,000 and stipulates that it be used for the care and maintenance of the Jepson herbarium (estimated at 40,000 specimens) and library, the completion of the "Flora of California," the revision of the "Manual of the Flowering Plants of California," and the furtherance of studies on the flowering plants of California and adjacent areas. The research funds are to be administered for the Regents by a committee whose initial membership, as set up in the will, comprises Dr. Alva R. Davis, Professor of Botany and Dean of the College of Letters and Science as chairman, Dr. Helen Mar Wheeler, Research Associate in Botany, and Dr. Lincoln Constance, Professor of Botany. One of the foremost tasks of this committee will be to see that this invaluable material, the basis for Dr. Jepson's published works, is properly mounted and housed. —L. CONSTANCE.

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CONTRIBUTIONS TO THE OAK FLORA OF CENTRAL AMERICA

Cornelius H. Muller

Recent botanical exploration in the Central American republics has emphasized the incompleteness of our knowledge of the oak flora of that region. As pointed out in "Additions to the Oak Flora of El Salvador" (Tucker, John M., and Cornelius H. Muller, Madroño 8: 111–117. 1945), a collection of twenty-three numbers necessitated considerable change in some of the concepts embodied in "The Central American Species of Quercus" (Muller, Cornelius H., U.S.D.A. Misc. Publ. 477: 1–216. 124 pl. 1942). More recently additional specimens from Honduras, Guatemala, Costa Rica, and El Salvador have revealed an unexpected wealth of information on the oaks of these countries. It had been thought that the floras of Guatemala, Honduras, and Costa Rica were fairly well known, while El Salvador and Nicaragua were admittedly poorly represented in collections.

The recent field work of Dr. Louis O. Williams and his associates (notably Antonio Molina R.) at the Escuela Agrícola Panamericana, Tegucigalpa, Honduras, has yielded some seventy-five collections of *Quercus* made in Honduras as well as a similar quantity in Guatemala and Costa Rica. It is significant that the most interesting plants were found at high elevations beyond those usually reached by earlier collectors. In Honduras the principal novelties were found in cloud forest areas on two peaks in the Departmento de Morazán, one above and southwest of San Juancito and the other on Mount Uyuca. Dr. Williams has expressed the opinion (in correspondence with the author) that it is not very likely that the collection of the oak flora of Honduras will be "even approaching completion for some years to come" because of the great number of isolated mountains that are difficult to reach.

The degree of apparent endemism exhibited by some of the cloud forest species in Honduras is truly remarkable. The two localities mentioned above occupy peaks of similar elevation (about 2,000 m.) only about twenty-five kilometers apart. On both peaks cloud forest is well developed over small areas, but only five species of *Quercus* are known to be common to the two localities, namely *Q. aáata* C. H. Mull., *Q. pacayana* C. H. Mull., *Q. eugeniaefolia* Liebm., *Q. trichodonta* Trel., and one undescribed species. In addition Mount Uyuca yielded *Q. oocarpa* Liebm., while in the San Juancito locality were found two new species. The degree of distinctness of two of the novelties is quite unusual. If equally distinct narrow endemics may be expected in similar proportions on the other peaks of cloud forest elevation, the com-

Madroño, Vol. 10, No. 4, pp. 97–128. November 3, 1949.

plete exploration of the Central American oak flora has only begun.

The number of novelties and significant extensions of range thus far encountered in Dr. Williams' collections seem to justify a review of the Honduran species at this time. All but six of the species previously known from Honduras are here treated. These six are *Q. Pilarius* Trel., *Q. corrugata* Hook., *Q. segoviensis* Liebm., *Q. tristis* Liebm., *Q. Skinneri* Benth., and *Q. tenuiaristata* Trel., all of them species of moderate elevations, chiefly in the Departmento de Comayagua. Included also are isolated records from Guatemala, El Salvador, and Costa Rica.

The author is deeply indebted to Dr. Williams for the privilege of studying his collections and for his generous cooperation in making repeated visits to the principal localities at the author's request.

The specimens cited are deposited in the herbarium of the author except where otherwise indicated; duplicates have been retained in the herbarium of the Escuela Agrícola Panamericana at Tegucigalpa, Honduras. Duplicate specimens of almost all of the numbers cited are to be found also in the herbaria of the Chicago Natural History Museum and the Arnold Arboretum.

SUBGEN. LEPIDOBALANUS (ENDL.) OERST.

QUERCUS INSIGNIS (?) Mart. and Gal., Bull. Acad. Brux. 10^1: 219. 1843.

This species is here tentatively reported for the first time from Honduras and Costa Rica. It has previously been described as "occasional" in the British Honduras—Guatemala boundary region and more common in the southern Sierra Madre Oriental of Mexico, whence it was originally collected in Vera Cruz. Few species of *Quercus* bridge the Isthmus of Tehuantepec, all of them the "tropical" species of the lowlands of the Atlantic slope. It is possible that the sterile specimens here cited represent some other species, but they belong to no species previously known in these areas.

HONDURAS. Dept. Comayagua: a single tree 42 m. tall, bole 1.2 m. above buttresses, along Rio Tepemechin near Lake Yojoa, altitude 600 m., August 2, 1947, *Shank 12822*.

COSTA RICA. Prov. Puntarenas: tree 27 m. with shaggy bark, Agua Buena, altitude 1100 m., January 24, 1948, *Shank 13954*.

Quercus tomentocaulis sp. nov. Arbor usque ad 80 m. alta; ramuli 2–4 mm. crassi dense fulvo-tomentosi; stipulae persistentes; folia tarde decidua, chartacea, 8–14 cm. longa, 2–5 cm. lata, oblanceolata vel anguste elliptica apice acuta basi cuneata vel rotundata crenata supra sparse villosa vel glabrata subtus villosa costis utrinque fulvo-tomentosa, venis utrinque 12–16 supra impressis subtus prominentibus; petioli 5–7 mm. longi, dense fulvo-tomentosi.

Tree to 80 m. (!) tall; twigs 2 to 4 mm. thick, coarsely fluted, densely yellow- or fulvous-tomentose, persistently gray-tomentose the second season with lenticels not evident; buds not seen; stipules persistent until the second season, 7 or 8 mm. long, ligulate or somewhat spathulate, dorsally rather densely appressed-hirsute; leaves evergreen, rather thin and chartaceous, usually 8 to 12 or sometimes 14 cm. long, 2 to 4 or 5 cm. broad, broadly oblanceolate to narrowly elliptic, cuneate to narrowly rounded or rarely broadly rounded at base, apically somewhat attenuate, regularly antrorsely crenately low-toothed except in the basal one-third, the teeth obscurely mucronate, margins somewhat crisped, moderately cartilaginous and slightly revolute (some leaves teratologically markedly revolute), upper surface dull green, sparsely villous with inconspicuous simple or few-rayed stellate hairs, promptly glabrate except the buff-tomentose midrib and the principal veins or a few hairs persistent on the blade, lower surface lighter green, persistently sparse-villous with mostly stellate hairs, especially on the veins, the midrib obviously tomentose; veins 12 to 16 on each side, very regular, branching and obviously anastomosing near the margin but ultimately passing into the teeth, somewhat impressed above but raised within the depressions, very prominent beneath (including also the reticulum); petioles 5 to 7 mm. long, densely fulvous-tomentose like the twigs and midribs; catkins and fruit not seen. (Pl. 9.)

HONDURAS. Dept. Morazán: cloud forest area, altitude 2000 m., mountains southwest of San Juancito, May 21, 1947, *Williams* and *Molina 12756* (type, in herbarium of the author; isotypes, in herbarium of the Escuela Agrícola Panamericana, Tegucigalpa); altitude 1800 m., February 20, 1948, *Williams* and *Molina 13725;* tree to 80 m. tall, rain forest, altitude 1800 m., north slope of Mount Uyuca between La Labranza, Tatunbla and Q. de Granadillo, November 4, 1948, *Molina 1431.*

COSTA RICA. Prov. Cartago: timber tree cultivated by C. H. Lankester, Las Concavas, Cartago, March 7, 1948, *Williams* and *Molina 13803.*

Quercus tomentocaulis is similar in appearance to *Q. Davidsoniae* Standl. of Panamá and Costa Rica and to *Q. insignis* of México and British Honduras. The persistently tomentose twigs and persistent stipules of *Q. tomentocaulis* readily distinguish it from *Q. Davidsoniae.* From *Q. insignis* the species is distinguished by its shorter petioles, smaller leaves with usually more prominent teeth and pointed apices, and its stipules usually persisting more than one year. The openly dispersed spreading hairs of the lower leaf surface further characterize the species. Until flowering and fruiting characters are known, it is undesirable to assign *Q. tomentocaulis* with finality to any known series of species, but a relationship to *Q. Davidsoniae* and to *Q. insignis* may be suggested.

The discovery of the several specimens of *Q. tomentocaulis* ex-plains the baffling polymorphy ascribed to *Q. Davidsoniae* (Muller, l.c., p. 20). In keying out *Q. Davidsoniae* it was necessary to place that species under both "twigs of the season persistently and densely fulvous-tomentose" and "twigs of the season glabrate or sparingly pubescent." The type (from Panamá) falls in the latter class, but at least some of the Costa Rican specimens are persistently tomentose. These latter should probably be included in *Q. tomentocaulis* which the Honduran specimens have demonstrated to be a recognizable entity. It should be noted also that the Costa Rican material cited under *Q. Davidsoniae* included some with leaves pubescent on the veins beneath. As the specimens are not now at hand, it is not possible to say if this pubescence is correlated with the persistence of twig tomentum. However, such variations are almost universally correlated in *Quercus*. Reference to persistent pubescence of twigs and veins should be deleted from the description of *Q. Davidsoniae*.

QUERCUS OOCARPA Liebm. Overs. Danske Vidensk. Selsk. Forhandl. 1854: 184. 1854.

This is the second authentic collection of this species from Honduras, the first having been taken from the Departmento de Comayagua in 1936.

HONDURAS. Dept. Morazán: slender tree 7 m. tall, cloud forest, altitude 2000 m., Mount Uyuca, May 9, 1947, *Williams* and *Molina 12617*.

Quercus Molinae sp. nov. Arbor usque ad 10 m. alta; ramuli diametro 2 mm. pilis brevibus fulvo-tomentosi; stipulae persistentes; folia sempervirentia membranacea 12–21 cm. longa, 3–7 cm. lata, anguste oblanceolata apice attenuato-flagellata vel acuminata basi anguste rotundata ad apicem versus falcato-dentata utrinque costis strigosis exceptis glabrata; venis utrinque 10–14 supra impressis subtus prominentibus; petioli 2–3 mm. longi, strigosi.

Tree 10 m. tall; twigs about 2 mm. thick, obscurely fluted, persistently short buff-tomentose or sparsely so, the surface glaucous or gray; buds elongate, sparsely ciliate or glabrous, terminal buds not seen; stipules persistent, about 10 mm. long, ligulate, sparsely buff-tomentose dorsally; leaves persistent, very thin and membranous, 12 to 18 or even 21 cm. long, 3 to 5 or even 7 cm. broad, narrowly oblanceolate, very narrowly rounded at base, attenuately flagellate at apex, coarsely and falcately several-toothed above the middle, margins minutely cartilaginous and strigosely sparse-ciliate, upper surface dull green and glabrous except for the sparsely strigose midrib, the principal veins rarely strigose, lower surface similar except for occasional axillary tufts, the midrib and veins more definitely strigose; veins 10 to 14 on each side, branching and obscurely anastomosing but passing into the teeth where these are present, slightly impressed above, rather prominently raised beneath; petioles 2 to 3 mm. long, strigose or dorsally glabrous and dark brown; catkins and fruit not seen. (Pl. 10.)

HONDURAS. Dept. Morazán: cloud forest area, altitude 2000 m., mountains southwest of San Juancito, May 21, 1947, *Williams* and *Molina 12753* (type, in herbarium of the author; isotypes, in herbarium of the Escuela Agrícola Panamericana, Tegucigalpa).

It is a pleasure to name this species in honor of Antonio Molina R., one of the collectors who assembled this important collection of plants.

Quercus Molinae is clearly related to *Q. aáata* but differs in the shape, thin texture, and marked toothing of its leaves and the much greater prominence of its twig pubescence. In general appearance *Q. Molinae* is much like *Q. Pilarius* Trel., but it is amply distinguished from that species by its exceedingly thin leaf blades with midribs and veins clearly strigose even in age and its persistently appressed tomentose twigs. From *Q. oocarpa* the new species may be distinguished by its entirely glabrate lower leaf surface, its less copious pubescence, and its narrower leaves with attenuate apices.

The excessively attenuate development of the leaf apices forms "drip tips" in *Q. Molinae* even more pronounced than those described in *Q. esesmilensis* (Tucker and Muller, l.c., p. 117) and clearly bears out the collectors' designation of the habitat as "cloud forest".

QUERCUS COPEYENSIS C. H. Mull., U.S.D.A. Misc. Publ. 477: 30. 1942.

Although *Q. copeyensis* has previously been known only from Costa Rica and Panamá, the species may now be recorded from Honduras. The Honduran material greatly clarifies the specific limits of the species by offering mature fruit and by exhibiting variations in leaf size and shape that clearly link to this species some anomalous specimens from Costa Rica that were reluctantly referred to *Q. aáata* (Muller, l.c., p. 27, 28, pl. 25).

In a recent paper, Little (Carib. For. 9: 345–353. 1948) called attention to these atypical specimens of *Q. aáata* and suggested their transfer to *Q. copeyensis.* He further offered an emended description of *Q. copeyensis* to accommodate the large-leafed form. The removal of these specimens from *Q. aáata* leaves that species homogeneous in form from Guatemala to Costa Rica, while their inclusion in *Q. copeyensis* is easily justified by the large series of specimens now available.

HONDURAS. Dept. Morazán: tree 8 (15) m. tall, cloud forest area, mountains southwest of San Juancito, altitude 2000 m., May 21, 1947, *Williams* and *Molina 12759;* November 6, 1947, *Williams* and *Molina 13342, 13344, 13357;* February 20, 1948, *Williams* and *Molina 13697;* tree 20 m., cloud forest on Mount Uyuca, altitude 2000 m., August 7, 1947, *Molina 465.*

Costa Rica. Prov. Alajuela: Palmira, June 11, 1941, *Smith 2756;* July 1, 1941, *Smith 2879.* Prov. Heredia: Cerro de las Caricias, north of San Isidro, March 11, 1926, *Standley* and *Valerio 52178.* Prov. Cartago: tree 6 × 120 ft., dominant of temperate rain forest, altitude 8300 ft. along the continental divide, Cordillera de Talamanca, 36 mi. south of Cartago, February 16, 1943, *Little 6002, 6004, 6008;* tree 8 m. tall, in barranco, altitude 2800 m., slopes of Volcán Irazú, near San Rafael de Cartago, March 14, 1948, *Williams* and *Molina 13845;* tree 25 m. tall, altitude 2900 m., slopes of Volcán Irazú near Hotel Roberts, March 14, 1948, *Williams* and *Molina 13854.*

Quercus aáata C. H. Mull., U.S.D.A. Misc. Publ. 477: 27. 1942.

One collection of *Q. aáata* from the vicinity of San Juancito, Honduras, was made in 1932.

Honduras. Dept. Morazán: tree 5 m. tall, cloud forest, altitude 2000 m., Mount Uyuca, May 9, 1947, *Williams* and *Molina 12634;* tree 8 to 30 m. tall, cloud forest area, altitude 2000 m., mountains southwest of San Juancito, May 21, 1947, *Williams* and *Molina 12758, 12782, 12796;* March 25, 1948, *Williams* and *Molina 13770, 13974, 13975, 13985.*

Quercus polymorpha Schl. and Cham., Linnaea 5: 78. 1830.

This species has not previously been reported south of Guatemala where it is rather widespread but apparently not abundant. Its greatest development occurs in central and northeastern México.

Honduras. Dept. Morazán: tree to 20 m., in canyon, altitude 1000 m., between Talanga and Izotes, April 1, 1947, *Williams* and *Molina 12278.*

Quercus oleoides Schl. and Cham., Linnaea 5: 79. 1830.

Although frequently collected in Honduras, this species has not previously been encountered in the Departmento de Morazán. It is quite common in Honduras in dry valleys and on dry hills, principally between 800 and 1000 m. elevation. The species is a fair indicator of elevation, although it occurs both above and below the altitudes mentioned.

Honduras. Dept. Morazán: tree 4 to 10 m. tall, dry rocky hillside, altitude 850 m., oak-pine forest 2 km. northwest of Zamorano, July 19, 1946, *Williams* and *Molina 10046* and *10054;* tree 15 m. tall, along San Antonio road, October 21, 1946, *Shank 10782;* tree 5 m. tall, pine-oak forest, altitude 1200 m. at Agua Amarilla, December 1, 1946, *Williams* and *Molina 11030.*

Subgen. Erythrobalanus (Spach) Oerst.

Quercus hondurensis Trel., Mem. Nat. Acad. Sci. 20: 140. 1924.

This species is widely distributed in Honduras but is here reported for the first time from the Departmento de Morazán, where the collectors inform me it is very common at about 1000 to 1500 m. elevation.

Honduras. Dept. Comoyagua: tree 5 m. tall, pine forest, altitude 1400 m., mountains above Flores, April 8, 1947, *Williams* and *Molina 12301.* Dept. Morazán: tree 15 m., pine-oak forest, altitude 1500 m., near Hoya Grande, August 17, 1947, *Williams* and *Molina 13275.*

Quercus yoroensis Trel. in Yuncker, Field Mus. Publ., Bot. Ser. 9: 282. 1940.

This species was reduced to synonymy under *Q. hondurensis* (Muller, l.c., p. 49) because the single collection upon which the typical form of *Q. yoroensis* was based seemed to be only a leaf variant of *Q. hondurensis. Quercus yoroensis* var. *aguana* Trel. in Yuncker (l.c.) was likewise based upon a single collection and exhibited a leaf shape more similar to *Q. hondurensis.* This seemed to add weight to the conclusion of synonymy. An additional four collections taken at some distance from the type locality and exhibiting quite constantly the differences upon which *Q. yoroensis* may be distinguished from *Q. hondurensis* make their separation imperative.

The relationship of *Q. yoroensis* to *Q. hondurensis* is obvious in the small annual fruit, the persistently tomentose twigs, and the similar arrangement of the leaf pubescence in the two species. However, the smaller, broadly rounded leaves of *Q. yoroensis* consistently distinguish that species from *Q. hondurensis.*

Honduras. Dept. Morazán: tree 5–10 m., oak-pine forest, dry rocky hillside, altitude 850 m., 2 km. northwest of Zamorano, July 11, 1946, *Williams* and *Molina 10047;* July 19, 1946, *Williams* and *Molina 10069;* tree 10 m., pine-oak forest, altitude 1500 m., near Lo de Ponce, February 20, 1948, *Williams* and *Molina 13745.* Dept. El Paraíso: tree 5 m., pine-oak forest, altitude 1400 m., in vicinity of Manzaragua, April 4, 1948, *Williams* and *Molina 14006.*

Quercus sapotaefolia Liebm., Overs. Danske Vidensk. Selsk. Forhandl. 1854: 185. 1854.

Typical specimens of this species are not common among Honduran collections. The species has previously been reported but once from the Departmento de Morazán, although it is said to be quite abundant in some places there.

Honduras. Dept. Comayagua: tree 5 m. tall, pine forest, altitude 1400 m., mountains above Flores, April 8, 1947, *Williams* and *Molina 12300;* tree 15 m. tall, altitude 870 m., slopes of mountain above Flores, April 8, 1947, *Williams* and *Molina 12310.* Dept. Morazán: tree 3 to 15 m. tall, rocky slopes, altitude 1550 m., in oak-pine forest near Hoya Grande, July 14, 1946, *Williams* and *Molina 10039;* tree 10 m. tall, altitude 1500 m., in oak-pine woods above Hoya Grande, May 11, 1947, *Williams* and *Molina 12668.*

QUERCUS AMISSAELOBA Trel. in Yuncker, Field Mus. Publ., Bot. Ser 17: 357. 1938.

In an earlier treatment (Muller, l.c., p. 53) this species was reduced to synonymy under *Q. sapotaefolia* on the basis of its being a stump-sprout or a juvenile form with "scarcely two leaves of the same size and shape". The collection of identically the same polymorphic form at some distance from the type locality and the evidence of maturity and fruition observed by the collector require a reversal of that opinion. The irregular form of the leaves, their obscure lobing, and their usually acute apices serve to distinguish this species from *Q. sapotaefolia* to which it is obviously closely related. The species is quite common in oak-pine woods. It is a fair indicator of elevation.

HONDURAS. Dept. Morazán: slender tree to 15 m. tall, dense pine forest, altitude 1300 m., near Agua Amarilla, December 8, 1946, *Williams* and *Molina 11168.*

QUERCUS EUGENIAEFOLIA Liebm., Overs. Danske Vidensk. Selsk. Forhandl. 1854: 185. 1854.

This species has not previously been known north of Costa Rica. It is quite common in cloud forests in the Departmento de Morazán where, because of its great size and abundance, it is outstanding.

HONDURAS. Dept. Morazán: tree 5 to 10 m. tall, cloud forest, altitude 2000 m., Mount Uyuca, July 8, 1946, *Williams* and *Molina 10018;* May 9, 1947, *Williams* and *Molina 12635;* tree 35 m. tall, cloud forest, altitude 2000 m., mountains southwest of San Juancito, May 21, 1947, *Williams* and *Molina 12733;* November 6, 1947, *Williams* and *Molina 13336* and *13354;* February 20, 1948, *Williams* and *Molina 13702;* March 25, 1948, *Williams* and *Molina 13779;* tree 10 m. tall in oak-pine forest on La Montañita, altitude 1800 m., June 7, 1947, *Molina 40.*

QUERCUS BORUCASANA Trel., Mem. Nat. Acad. Sci. 20: 161. 1924.

This species has been known previously only from Costa Rica where it is confined to elevations above 1800 m. It may now be reported from Guatemala where it grows at elevations above 2100 m. The recurrence in Guatemala of the clearly typical form of *Q. borucasana* aids materially in maintaining this problematic species.

GUATEMALA. Dept. Zacapa: tree 30 to 40 ft. tall, near summit of Volcán Gemelos, Sierra de las Minas, January 26, 1942, *Steyermark 43300* (Herb. Chicago Nat. Hist. Mus.). Dept. Huehuetenango: cloud forest on Cerro Canana, between Cuchumatanes and Canana, Sierre de los Cuchumatanes, July 18, 1942, *Steyermark 49034* (Herb. Chicago Nat. Hist. Mus.).

QUERCUS CRISPIFOLIA Trel., Mem. Nat. Acad. Sci. 20: 147. 1924.

This imperfectly known species is at present represented by fragmentary type material from Chiapas, Mexico, and sterile collections from Guatemala. Extension of the range to El Salvador was anticipated (Muller, l.c., p. 32) on the basis of the reference of *Q. amphioxys* Trel. to synonymy under *Q. crispifolia.* Additional material from El Salvador strengthens the opinion that only one species is involved.

El Salvador. Dept. San Salvador: western slopes above Finca Florencia, altitude 1680 to 1890 m., Volcán San Salvador, January 31, 1946, *Carlson 412* (Herb. Univ. Calif. ex Field Museum); from Finca Las Brumas, altitude 1680 m., to the peak of the volcano, altitude 2010 m., Volcán de San Salvador, February 3, 1946, *Carlson 486* and *487* (Herb. Univ. Calif. ex Field Museum).

Quercus trichodonta Trel. in Yuncker, Field Mus. Publ., Bot. Ser. 17: 358. 1938.

This species was placed in synonymy under *Q. Skinneri* (Muller, l.c., p. 69) because the only known collection appeared to differ from typical *Q. Skinneri* only in its shorter petioles. Such a form occurs sporadically in the Mexican population of the species where it had been separated as *Q. chiapasensis* Trel. Several additional collections from Honduras now clearly indicate that *Q. trichodonta* is not merely a sporadic phenotype of *Q. Skinneri* and that it deserves specific rank. In addition to its leaf shape and short petioles, *Q. trichodonta* differs from *Q. Skinneri* in its tardily glabrate or persistently fulvous-tomentose twigs, petioles, and midribs and in its much smaller fruit maturing in one year. These characters were not evident in the type collection of *Q. trichodonta.*

The rather full series of specimens now at hand clearly connects *Q. gracilior* C. H. Mull. (l.c., p. 77) with *Q. trichodonta* under which it must be reduced to synonymy. The range of *Q. trichodonta* extends from 1000 to 2000 m. in elevation, a considerably greater difference than is ordinarily tolerated by *Quercus* species at this latitude.

Honduras. Dept. Morazán: tree to about 75 m., rain forest, altitude 2000 m., Mount Uyuca, August 20, 1946, *Williams* and *Molina 10392;* December 5, 1946, *Williams* and *Molina 11143a;* March 2, 1947, *Williams* and *Molina 12101;* May 9, 1947, *Williams* and *Molina 12636.* Dept. Santa Barbara: Montaña Santa Barbara, near Lake Yojoa, above Sauce, altitude 1000 m., August 7, 1948, *Williams* and *Molina 14521.* Dept. Comayagua: tree to 20 m., broad-leaf forest in barranco, altitude 1200 m., near Trincheras, April 30, 1947, *Williams* and *Molina 12550.*

Quercus acatenangensis Trel., Mem. Nat. Acad. Sci. 20: 163. 1924.

Although very abundant through much of Guatemala, *Q. acatenangensis* has not previously been reported from the Departmento de Sololá.

Guatemala. Dept. Sololá: tree 6 m., moist banks below Los Encuentros, altitude 2500 m., June 25, 1947, *Williams 13149.*

Quercus Lowilliamsi sp. nov. Arbor usque ad 40 m. alta; ramuli diametro 2–3 mm. pilis flavidis primo stellato-tomentosi demum glabrati; stipulae caducae; folia decidua coriacea 12–23 cm. longa, 3–6 cm. lata, anguste oblanceolata basi cuneata apice attenuato-acuta aristataque integra vel ad apicem versus aristato-dentata domatiis exceptis glabrata; venis utrinque 12–15 paulo prominentibus; petioli 7–12 mm. longi, glabrati; fructus annuus brevipedunculatus; cupula 12 mm. lata; squamae stricte appressae; glans 12 mm. longa, 10 mm. lata, subrotunda quarto longitudine in cupula inclusa.

Tree 40 m. tall; twigs 2 to 3 mm. thick, coarsely fluted, densely fulvous-tomentose, quickly glabrate or tardily so about the apex or in protected grooves, dull brown with inconspicuous lenticels, becoming russet the second season with numerous small prominent pale lenticels; buds tan-brown, fulvous-tomentose about the apex, otherwise glabrous and glossy (mature buds not seen); stipules promptly caducous; leaves deciduous, rather thick and coriaceous, 12 to 18 or even 23 cm. long, 3 to 5 or 6 cm. broad, narrowly oblanceolate, narrowed at both ends, basally cuneate or rarely narrowly rounded, attenuately acute and aristate at apex, aristately few-toothed about the apex or quite entire, upper surface dull dark green and glabrous, lower surface light green and glossy, glabrate except for tufts of fulvous tomentum in the axils of the principal veins, margins minutely cartilaginous; veins 12 to 15 on each side, sometimes with evanescent intermediates, branching widely and obviously anastomosing toward the margin, somewhat raised on both surfaces (including the reticulum) but quite prominent beneath; petioles 7 to 12 mm. long, at first fulvous-tomentose but soon glabrous like the twigs, dorsally flattened and winged by the decurrent blade; staminate catkins 3 to 4 cm. long, loosely flowered on a loosely tomentose peduncle, the anthers much exserted from the villous calyx; pistillate catkins densely fulvous-tomentose, 2- or 3-flowered on peduncles 5 or 10 mm. long, the young cups subcylindric, the scales densely fulvous-tomentulose; fruit annual, solitary or paired on stout peduncles about 3 mm. long, small; cups about 12 mm. in diameter, goblet-shaped with obviously constricted bases, scales tightly appressed, minutely gray-tomentulose except the strict brown glabrous margins; acorns about 12 mm. long, 10 mm. broad, subrotund, at first minutely silky-pubescent, tardily glabrate, light brown, about one-fourth included. (Pl. 11.)

Honduras. Dept. Morazán: cloud forest area at 1800 to 2200 m. altitude in mountains southwest of San Juancito, May 21, 1947, *Williams* and *Molina 12760* (type, in herbarium of the author; isotypes in herbarium of the Escuela Agrícola Panamericana,

PLATE 9. QUERCUS TOMENTOCAULIS MULLER (WILLIAMS AND MOLINA 12756).

PLATE 10. QUERCUS MOLINAE MULLER (WILLIAMS AND MOLINA 12753).

PLATE 11. QUERCUS LOWILLIAMSI MULLER (WILLIAMS AND MOLINA 12760).

Tegucigalpa); November 6, 1947, *Williams* and *Molina 13325* (from which the fruit is described); February 20, 1948, *Williams* and *Molina 13701* and *13721;* March 25, 1948, *Williams* and *Molina 13782* (from which the catkins are described).

Quercus Lowilliamsi is a member of the series *Acutifoliae* Trel. and is apparently most closely related to *Q. conspersa* Benth. From this polymorphic species the proposed new species is distinguished by its densely tomentose twigs at vernation, its leaves markedly narrowed basally, the blades lacking in glandular puberulence beneath, and its annual fruition. In so large and intricately related a series as the *Acutifoliae,* it is not often that a species so abundantly distinct as *Q. Lowilliamsi* is encountered.

It is a pleasure to name this species in honor of Dr. Louis O. Williams in recognition of his excellent collection of Central American oaks and his generous cooperation in their study.

QUERCUS CONSPERSA Benth., Pl. Hartw. 91. 1842.

This common Guatemalan species has previously been reported from Honduras, Departmento de Tegucigalpa (now Morazán). The specimen here cited from Hoya Grande is atypical in having entire leaves lacking any resinous puberulence on their lower surfaces, a common variation in the species as it occurs in Guatemala. A single such specimen was found.

HONDURAS. Dept. Morazán: tree 15 m. tall, pine-oak forest, altitude 1500 m. near Hoya Grande, August 17, 1947, *Williams* and *Molina 13276;* tree 10 m. tall, altitude 1500 m., lower slopes of Mount Uyuca, February 18, 1948, *Williams* and *Molina 13676.*

University of California,
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A NEW SPECIES OF CHENOPODIUM FROM MEXICO

HOWARD S. REED

Chenopodium pueblense sp. nov. Herba erecta aliquanto farinosa 3–10 dm. alta e radice fibrata cauli saepe striato foliis pallide viridibus rhomboideo-ovatis vel deltoideis grosse dentatis venis prominentibus supra glabratis infra paulo farinosis apice acutis basi cuneatis 5–8 cm. longis 3–4 cm. latis inferioribus gradatim deciduis, petiolis gracilibus; floribus farinosis in spicis ramosis terminalibus vel in axillis foliorum superiorum glomeratis sepalis carinatis staminibus 5 vel 6 brevibus vix exsertis antheris flavis stylis duobus vel tribus exsertis seminibus sanguineis punctatis turbinato-complanatis. E civitate Puebla, Mexico. Nomine vulgari Cuahzontli.

Erect annual from a small, fibrous root system; stem 3–10 dm. high, sparsely farinose, often striate, the short branches ascending; leaves alternate, 5–8 cm. long, 3–4 cm. broad (figs. 2a, 2b, 2c), the petioles slender, usually shorter than the blades but often equal, the blades coarsely dentate, pale green, glabrate on the upper, finely farinose on the lower surface, rhombic-ovate to deltoid, the apex acute, the base cuneate, the lower teeth generally larger, making the blades sub-hastate, the veins prominent, the lower leaves progressively deciduous; leaves of the branchlets small, 1–2.5 cm. long, the margins dentate or repand; seedlings 8–10 cm. high, with leaves 2–3 cm. long, deep green, deltoid, repand, the apex blunt, sparsely farinose (fig. 2e); flowers glomerulate on terminal or axillary, branched spikes, all farinose (figs. 1, 2d); calyx-lobes carinate (fig. 2f) closely investing the fruit, copiously farinose; stamens 5 or 6, short, scarcely exserted, the anthers yellow; styles 2, occasionally 3, exserted (fig. 2f); seeds horizontal, flattened-turbinate, Acajon red (Ridgeway, pl. 13), diameter 1.3 to 1.1 mm., pericarp readily separable, the surface punctate, the elevated margin obtuse (fig. 2g), the embryo completely encircling the endosperm.

Fig. 1. *Chenopodium pueblense* Reed: left, inflorescence; right, upper part of mature plants (Photo by D. T. MacDougal).

Type. Plant cultivated in Berkeley, California, from seed collected by Professor Carl O. Sauer, at Calpán, Puebla, Mexico, altitude 2460 m., *H. S. Reed 2038,* May 6, 1948 (Herb. Univ. Calif. no. 794980).

The species seems not to occur outside of cultivation. Young plants are cooked and eaten as greens, the immature inflorescences, when the seeds are in the "milk" stage (fig. 1), are dipped in egg-batter and fried. The Aztec name *cauhzontli* is apparently derived from *cuauhtli* (or *quauhtli*), eagle and *tzontli,* hair of the head.

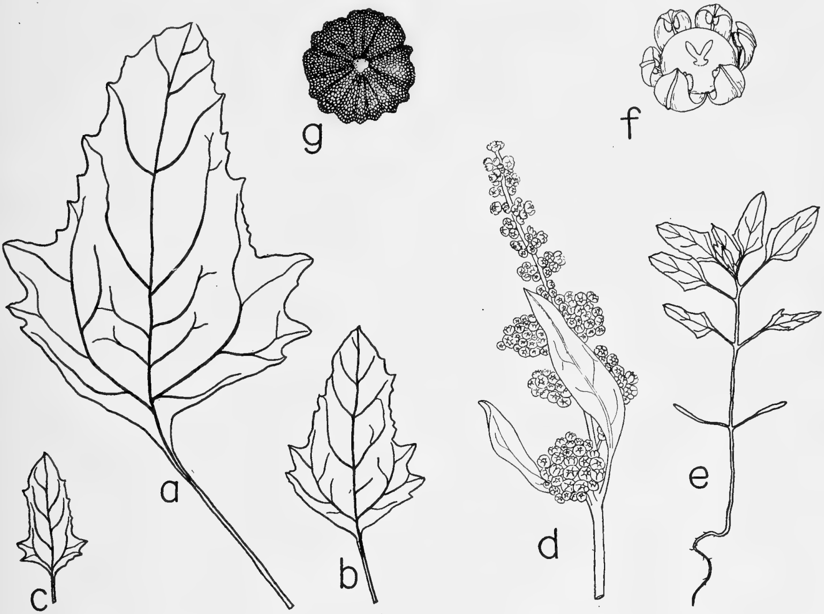

Fig. 2. *Chenopodium pueblense* Reed: *a,* basal leaf of mature plant, × 0.4; *b,* midstem leaf of mature plant, × 0.4; *c,* branchlet leaf of mature stem; *d.* terminal inflorescence showing glomerulate, branched spike; *e,* seedling; *f,* flower; *g,* seed, × 9.

The vegetative characters of *C. pueblense* have certain resemblances to those of *C. Quinoa,* a plant cultivated for food in parts of South America. The seeds of the latter species however, are ivory white and larger than those of the former. The Aztec name it bears is strong evidence, moreover, that *C. pueblense* is indigenous to Mexico.

In 1947, Dr. D. T. MacDougal carried out several tests on the rate of swelling and germination of seed which had been grown in his garden at Carmel in the previous summer. The seeds, which had been stored for a few weeks at room temperature, germinated rapidly when placed on pieces of porous tile in a warm moist chamber. The red color of the seeds disappears during the early stages of germination. At the time of emergence of the cotyledons, the seed coats have lost all of the red color.

In an experiment which is typical of many others, 194 seeds were placed in a moist chamber at 32° C. One seed had germinated in four hours, 50 seeds in eight hours, and the entire lot in 48 hours. The importance of this power of rapid germination can be appreciated when one realizes that, in its habitat, rain falls in showers (often torrential) of a few hours' duration. If the seeds are on the ground where they can absorb water, they could germinate quickly and get established before the ground became too dry for successful growth.

A sample of seeds which Dr. D. T. MacDougal planted in 1946 at Carmel, California, produced numerous plants which matured seed. The following spring he planted some of the 1946 crop of seeds in his garden and produced a second crop. Among these plants was one which attained a height of 3.34 m. (10 feet, 11 inches). The chromosomes in seedlings derived from this plant were 2n = 36. I owe the determination to Dr. J. A. Jenkins. The plant appears to be a tetraploid.

I wish to express my gratitude to Mr. Charles L. Babcock who prepared the Latin description of the species.

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TAXONOMY AND EVOLUTION OF VASEYANTHUS

Howard Scott Gentry

Vaseyanthus is a small genus in the Cucurbitaceae endemic to the arid and semiarid California Gulf Region of northwestern Mexico. It is generically characterized by the conic ovary of one to three cells, one or two of which commonly abort to leave a one-seeded fruit. The androecium and the few, erect to ascending, ovules place *Vaseyanthus* in the tribe Sicyoideae as outlined by Cogniaux (1916, p. 1). The closest relation is with *Echinopepon* Naudin (1865, p. 17), by reason of the several-celled ovary with erect to ascending ovules, rather than with *Brandegea* Cogn. (1890) and *Sicyos* L. (1753, p. 1013), both of which have single-celled ovaries with one pendulous reflexed ovule. The genera *Marah* Kell. (1854) and *Echinocystis* Torr. & Gray (1840, p. 542), although usually thought of as being associated with this group of genera, appear not to be closely related because of their highly flexuous anthers of reduced number, hypogeous germination, and large round seeds. Generically *Vaseyanthus* is separated from its nearest relative, *Echinopepon,* by the globose body of the fruits with thick, indurate, vescicular pericarps, the reduced number of cells and ovules, and a strong tendency towards reduction in the number of stamens. This genus, as represented by four entities, exhibits a relatively mild state of specific development.

Weak speciation suggests a young genus, but this is not borne out by later considerations.

The genus was initiated by Alfred Cogniaux (1891), who based it on *Vaseyanthus Rosei,* a smooth-fruited oddity. Only the year before he had described *Echinocystis Brandegei,* defining by its characters a new section, *Pseudo-Echinopepon* (1890). Although the latter has an echinate fruit, it is certainly congeneric with *Vaseyanthus Rosei* and it is surprising that such a keen student of the Cucurbitaceae did not recognize the relationship. Doubtless, he was misled into forming a generic category by the unusual non-echinate fruits of the latter.

J. N. Rose (1897, pp. 119–120) made the next taxonomic moves by bringing *Echinocystis Brandegei* and *Echinopepon insularis* of Watson (1889, p. 51) into the genus. He failed, however, to recognize the congeneric position of *Echinopepon Palmeri* Wats. (l. c., p. 52) and relegated it to *Brandegea,* where it certainly does not belong.

I. M. Johnston (1924, pp. 1180–1182), with his series of collections, was the first to recognize the close relationships of the described species. He interpreted the lot as a monotypic genus with two varieties, *Brandegei* and *inermis,* under *Vaseyanthus insularis.* Unfortunately, however, he failed to identify his smooth-fruited variety, *inermis,* as Cogniaux's primary species, *V. Rosei.* Johnston placed *V. Rosei* in synonymy under *V. insularis Brandegei* (Cogn.) Jtn. Cogniaux, however, described the fruit as "laevis", and a photograph of the type in the Gray Herbarium (La Paz, *Palmer 102* in 1890) shows the typical non-echinate fruit. Since the first epithet for a given category must retain priority, Johnston's name stands and the type species is now properly a synonym under *V. insularis inermis* Jtn.

The selection of the echinate-fruited *Vaseyanthus insularis* as the varietal carrying name makes an unusual form of this complex stand as the type specimen. An isotype of *Vaseyanthus insularis* (*Palmer 409* in 1887 from San Pedro Martir Island) is an unusually coarse-stemmed and broad-leaved form with shallow leaf-lobing, apparently grown under unusually moist conditions or in the shade. Priority, however, again dictates its retention as an inclusive name for the complex.

The fruits of the genus are small, ranging from 8 to 15 mm. in diameter exclusive of the prickles, which are from 1 to 7 mm. long. The body of the fruit (fig. 1) is globose, or ellipsoidal (in case the upper ovule develops), or somewhat oblique (in case only one of the lateral basal ovules develops). The body of the fruit is capped with a prominent, smooth, tapering beak, persistent in some varieties, but tardily deciduous in others. The ovule is attached to the bottom of the cell by a short funicle at the base and is erect or nearly so. The smaller size of the upper ovule in *Vaseyanthus insularis* (Wats.) Jtn. (fig. 2) is indicative of its strong abortive tendency. The stamens are united to form an androecium, but the anthers are distinct, varying in number from 3 to 5, and are deeply crescentic or horseshoe-shaped, the whole making a short compact column with the common connective hidden in the center.

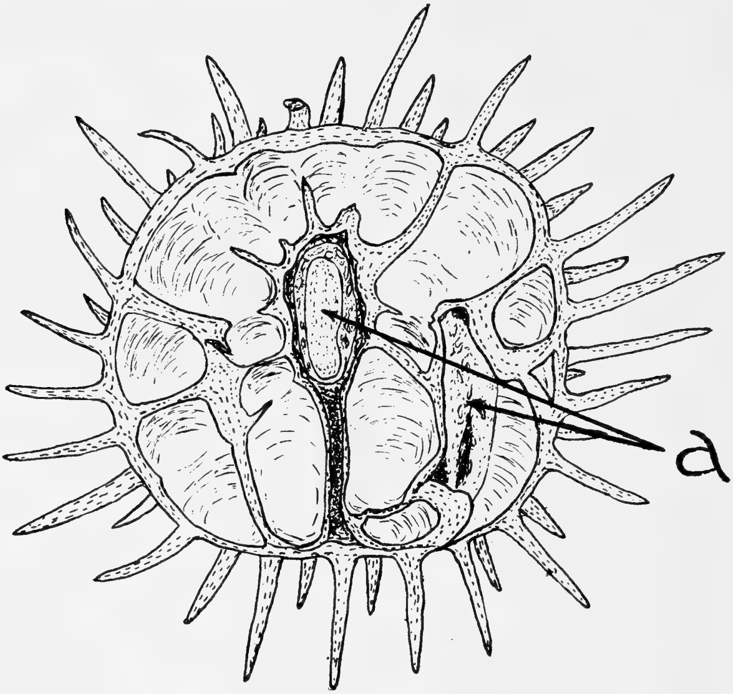

FIG. 1. Mature fruit of *Vaseyanthus Brandegei* (cross section): *a*, seeds in separate cells surrounded by empty vescicles. × 6.

In the following disposition of the variants, I have taken considerable pains to perceive reliable criteria for phenotypic segregation. I do not follow the tenet that morphologic intergradation *ipso facto* reduces closely related species to subspecific status or synonymy. I have attempted to segregate the variants according to phenotypic populations as expressed in two or more discernible and consistent morphological features. Where these features are strong, I have recognized species; where weaker, varieties. In making the segregations, I have also been influenced by the geographic, and more particularly by the physiographic, distributions of the *Vaseyanthus* populations. As will be demonstrated, the distributions corroborate the taxonomic segregates and have given assurance for the taxonomic definitions.

The most expressive features for taxonomic segregation of the populations are found in the characters of the following organs:—(1) The fruits—whether they are echinate or smooth, the length, and, to a lesser degree, the density of their prickles; whether tardily dehiscent or not dehiscent; their sizes and shapes.

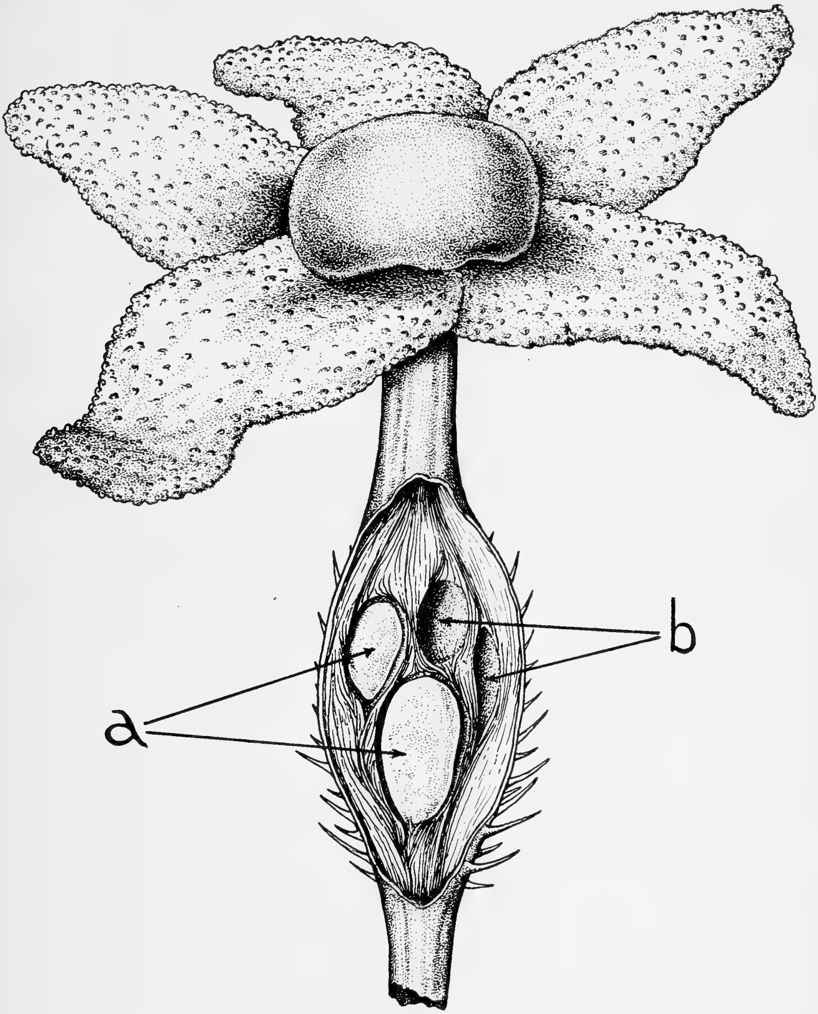

Fig. 2. Gynoecium of *Vaseyanthus insularis: a,* young ovules; *b,* developing vescicles. ×28. (Drawn from isotype.)

(2) The position and number of the seeds, whether proximal or distal. In the latter case, the development of the upper ovule appears to effect an irregular transverse rupture, with the fruit at length separating into two partly open disseminules. (3) Whether the beak or rostrum is persistent or at length deciduous;

its shape. It never appears to separate as a calyptra, for, in cases where it is shed, it does not leave a dehiscently opened fruit, but is choked off by the hardening walls of the basal body of the fruit. (4) The number of stamens, whether constant or variable within a population, appears to have taxonomic value in some cases. (5) The leaves, though highly variable within a population, may within limits, substantiate evidence for segregates as primarily expressed by fruits and stamens. The entities overlap in degree of leaf-dissection, in the character and density of trichomes, in expansion, and in thickness. Much of the variation may be determined by seasonal environmental differences. A moist fertile soil produces a wide, soft, shallowly-lobed leaf of sparse pubescence, while a moisture-impoverished season or situation appears to produce a small blade with dense scabrous trichomes. In spite of these variable factors, however, a certain coordination of leaf characters appears perceptible within the intervariant limits of the phenotypes.

The cupulate or shallowly campanulate corollas with their spreading lobes are rather uniform throughout the genus. They are minute, delicate, and do not lend themselves readily to study in dried specimens. The lobes are broadly linear to triangular, commonly knobby-glandular, the glands colorless or tinged with pink, the latter apparently a physiologic stage not correlative with populations.

With the above characters it would appear feasible to make an adequate taxonomic account of the genus. The 28 available collections seem, however, quite insufficient for a complete treatment. Until more collections are gathered and genetic studies made, perhaps the following segregation of the variants will suffice to prepare the genus for inclusion in Wiggins' forthcoming flora of the Sonoran Desert. It is based on herbarium material loaned by the Herbarium of the University of California in Berkeley and by the Dudley Herbarium of Stanford University, to the curators of which the author expresses his thanks for their cooperation. In addition, the specimens in the herbarium of the Allan Hancock Foundation at the University of Southern California have been studied.

VASEYANTHUS Cogn. Zoe 1: 368. 1891.

Small, slender, herbaceous perennial (or annual?) vines with palmately lobed or dissected leaves and small globose or ellipsoid, smooth or echinate fruits. Stems sulcate, commonly pustulate on the angles, pubescent or glabrous, the internodes relatively short; tendrils petiolate, usually bifid; leaves petiolate, commonly hispid-pubescent and variably scabrous with conic trichomes; flowers small, 5-merous, monoecious; calyx-tube generally cupulate or campanulate, the lobes minute; corolla cupulate with spreading lobes; staminate flowers racemose, simple or compound, long-pedunculate; anthers 3–5, linear, horseshoe-shaped on a column of united filaments; pollen large, smooth, depressed-globose, obscurely 5–6-sulcate; pistillate flowers small, pedunculate, solitary in same axils as the male flowers; calyx and corolla adnate; ovary conic to ovoid, 2–3-celled, long-rostrate; style short, stigma thickened, discoid; ovules one in each cell, erect to ascending, or rarely even horizontal, attached near base of cell, the upper ovule commonly aborting; fruit narrowly ovoid to globose, thickly long-rostrate, the rostrum persistent or deciduous, the body dry, indurate, vescicular, indehiscent or rarely dehiscent, armed or smooth, 1–3-seeded; seeds erect or ascending, obovate or ovoid, somewhat compressed. Type species: *Vaseyanthus Rosei* Cogn.

It is not known if the genus is wholly perennial or partly annual. There are no roots or root-crowns present in the specimens studied. One collector of *Vaseyanthus insularis* has noted, "Vine from a perennial tap-root" (*Annetta Carter et al. 2001*). Cogniaux described *V. Brandegei* as having fibrous roots.

KEY TO THE SPECIES AND VARIETIES

Mature fruits 1 cm. or more in diameter; prickles 4–7 mm. long; stamens 5; leaf lobes rounded to acute, often mucronate (Cape District) .... 1. *V. Brandegei*
Mature fruits less than 1 cm. in diameter; prickles 2–3 mm. long or lacking; stamens 3–5; leaf lobes not rounded, mucronate to aristate .... 2. *V. insularis*
  Fruit echinate
    Leaves thickish, densely pubescent or scabrous, the lobes mostly triangular, acute, mucronate (peninsular and insular) .... 2a. *V. insularis var. originalis*
    Leaves thin, sparsely pubescent to glabrate, the lobes mostly lanceolate, acuminate, aristate (mainland and San Pedro Nolasco Island .... 2b. *V. insularis var. Palmeri*
  Fruit not echinate (peninsular and insular) .... 2c. *V. insularis var. inermis*

1. VASEYANTHUS BRANDEGEI (Cogn.) Rose, Contr. U. S. Nat. Herb. 5: 119. 1897. *Echinocystis Brandegei* Cogn. Proc. Calif. Acad. Ser. 2, 3: 59. 1890. *Vaseyanthus insularis Brandegei* (Cogn.) Jtn. Proc. Cal. Acad. Ser. 4, 12: 1182. 1924.

Relatively coarse herbaceous vines with deeply lobate leaves and strongly echinate, globose, indurate fruits; stems coarse, strongly ribbed, hispid, glabrate; tendrils bifid, stoutly long-pedunculate, sparsely hispid near the base; leaves rather thick, orbicular in outline, 2–5 cm. broad, rather densely and strongly hispid below and above, and somewhat muriculate above, 5–7-lobed, with open rounded sinuses, the lobes lanceolate or ovate, or spatulate, mostly rounded, but sometimes acute, often mucronate; petioles from somewhat shorter than to longer than the leaf-lobes, curved-hispid; male flowers in compound racemes, the peduncles mostly shorter than the leaves; flowers numerous;

pedicels glabrous, persistent; corollas white, 5–6 mm. broad; stamens 5; ovary densely echinate, ovoid, with a slender beak; fruit globose, with thick vescicular walls, strongly echinate, pericarp and prickles at base sparsely pilose; body of fruit 12–20 mm. in diam., 2-celled, 1–2-seeded, 1 seed often aborting; prickles mostly 5–7 mm. long; seed compressed, dark brown, obliquely and broadly oval, narrowed at base.

Type locality: "ad Todos Santos" in the Cape District of Baja California, Mexico.

I have not seen the type, its whereabouts being unknown to me. Other specimens examined are: Guadalupe (southern Magdalena Plain), Jan. 17, 1890, *Brandegee s. n.;* San Jose del Cabo, Jan.–March 1901, *Purpus 490;* Espíritu Santo Island, April 1892, *Bryant 230;* San Diego Island, May 27, 1921, *Johnston 3929,* "trailing over cobble stones on beach"; 4 miles south of Guadalupe, March 21, 1935, *Whitehead 840,* "Along beach on sand dunes"; 15 miles south of Rancho Venancio (southern Magdalena Plain), March 21, 1935, *Shreve 7195;* Los Muertos, Cape District, March 5, 1937, *Rempel 78.*

These collections indicate a littoral species, but they do not constitute positive evidence for excluding it from the interior. In this series there is little apparent gradation in the size of the fruits, length of prickles, and number of stamens towards the *V. insularis* complex. The character of the leaf, though not so easily described, shows a definite homogeneity apart from the smaller and more acutely lobed leaf of *V. insularis.* In the lack of intergrades, therefore, the population of *V. Brandegei* appears to have a firm basis for specific segregation.

The existence of *V. Brandegei* on the southern end of the Magdalena Plain I attribute to post-Tertiary migration, subsequent to the joining of the Cape Island and the peninsula in Quaternary times. Hence, *V. Brandegei,* a postinsular endemic, is now migratory.

2. VASEYANTHUS INSULARIS (Wats.) Rose, Contr. U. S. Nat. Herb. 5: 120. 1897. *Echinopepon insularis* Wats. Proc. Am. Acad. 24: 51. 1889.

Originally described as annual but probably perennial; stems slender, striate, pustulate on the angles, scabrous-pubescent, curly-pubescent, or puberulent to glabrous; leaves cordate in outline, 2–7 cm. long, 2.5–8 cm. wide, sparsely or densely hispid above and below, in age or adversity becoming scabrous with conical processes, shallowly or deeply 5–9-lobed, the lobes triangular to lanceolate, denticulate, acute to acuminate, mucronate to aristate, the basal sinus broad and open; petioles equaling or much exceeding the blades; male inflorescence racemose with short lateral branches, shorter than or much exceeding the leaves; calyx shallowly campanulate, the teeth green, minute;

corolla 5-cleft, 4–5 mm. broad; stamens 3, 4, or 5, deeply bent; female flowers short-pedunculate, somewhat larger than the male; fruits conic to ellipsoid, the long beak mostly smooth, tardily deciduous or persistent, the body of the fruit globose to ellipsoid, 7–9 mm. in diam., indurate (but slightly so in 1 variety), spongy or vesicular, smooth or covered with straight stiff prickles 1–3 mm. long, 1–2-celled, 1–2-seeded; seed erect, smooth, oblong-obovate in outline, subcompressed, with a broad flat base, 4–5 mm. long.

2a. V. INSULARIS var. **originalis** nom. nov.

Leaves thick, relatively densely pubescent, commonly divided half way to the base or less, the lobes triangular to lanceolate, denticulate to irregularly sub-lobed; body of the fruit globose or oblong, short-echinate; beak apparently finally deciduous, broad at the base, its ovule usually aborting.

Type. San Pedro Mártir Island, *Edward Palmer 409* in 1887.

Specimens examined include an isotype and the following: La Paz, Oct. 1, 1890, *Brandegee 230;* North San Lorenzo Island (Las Animas), June 23, 1921, *Johnston 4195,* "Common, trailing over cobblestones on beach"; Small bay north of Puerto Escondido, ca. 23 km. south of Loreto, Nov. 20, 1947, *Carter et al. 2001,* "Vine from perennial tap root; flowers white; trailing over rocky beach well above high tide line"; San Francisquito Bay, March 30, 1947, *Harbison 41638.* This last is atypical in having nearly glabrous stems and fruits, which condition suggests *V. insularis* var. *Palmeri,* but the small angulate-lobed leaves, the lobes with obtuse tips, is quite unlike that variety.

2b. V. INSULARIS var. **Palmeri** (Wats.) comb. nov. *Echinopepon Palmeri* Wats. Proc. Am. Acad. 24: 52. 1889. *Brandegea Palmeri* (Wats.) Rose, Contr. U. S. Nat. Herb. 5: 120. 1897.

Stems sparsely puberulent to glabrous; petioles slender; leaves thin, sparsely to somewhat densely pubescent, rarely scabrous, commonly divided to below the middle of the blade, the lobes lanceolate, commonly saliently toothed, acute to acuminate, aristate; body of fruit globose, the pericarp sparsely puberulent; prickles 2–3 mm. long, glabrous or glabrate; beak narrow, acute, persistent.

Type. Guaymas, Sonora, *Palmer 304* in 1887.

Besides an isotype studied, the following collections have been examined: collector?, sheet in Herb. of T. S. Brandegee, U.C. Herb., Guaymas, 1893; Guaymas, Sonora, Dec. 17, 1939, *Drouet & Richards 4034,* "trailing over rocks at base of cliffs on mountain"; January 26, 1927, *Marcus E. Jones 22982;* Bahía San Carlos, February 8, 1940, *Dawson 1073;* San Pedro Nolasco Island, April 17, 1921, *Johnston 3132,* "In a gulch near sea, covering rocks and shrubs with a very dense thick mat of stems growing interlaced with no. 3131, a smooth-fruited plant."

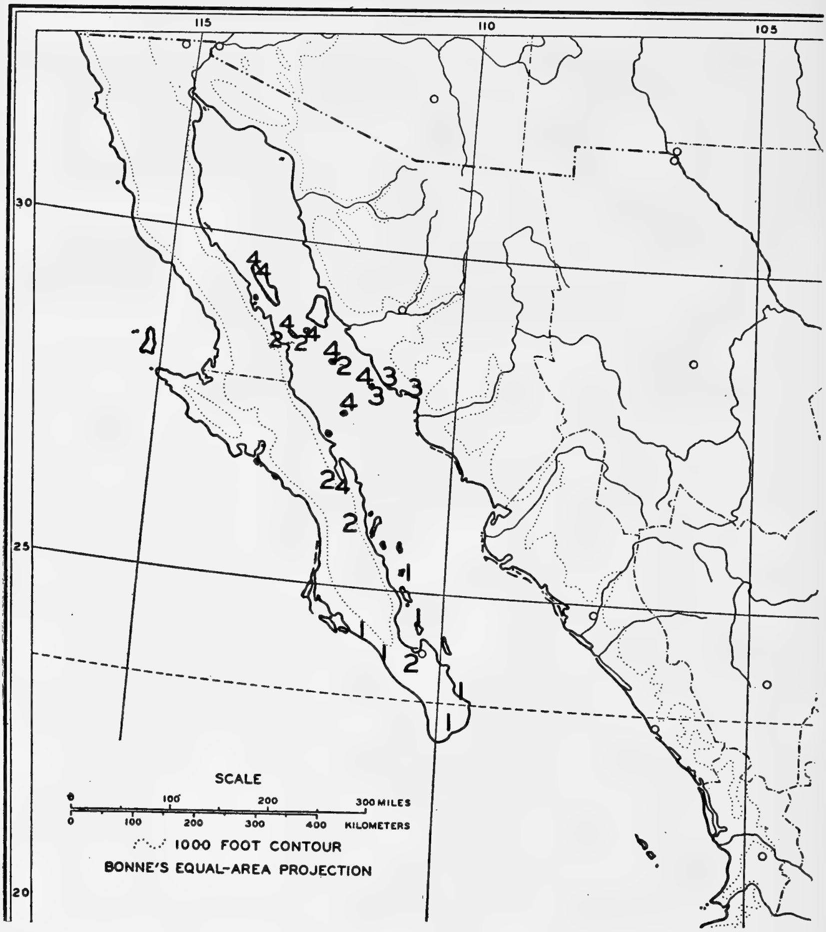

Fig. 3. Distribution of *Vaseyanthus* in the California Gulf Region: 1, *V. Brandegei;* 2, *V. insularis originalis;* 3, *V. insularis Palmeri;* 4, *V. insularis inermis.*

Although not so easily defined, this segregate may be more strongly divergent from *V. insularis* var. *originalis* than is the following smooth-fruited variety.

2c. V. insularis var. inermis Jtn. Proc. Cal. Acad., ser. 4, 12: 1182. 1924. *Vaseyanthus Rosei* Cogn. Zoe 1: 368. 1891.

Stems and leaves scabrous-pubescent; leaves small, the dried blades mostly less than 3 cm. broad, broader than long, rarely divided half way to base, commonly shallowly 7–9-lobate, the lobes broad, angulate, obtuse to acute, mucronate to aristate; body of fruit unarmed, either obliquely globose with a persistent attenuate beak and 1-seeded, or obliquely ellipsoid, and 2-seeded, tardily and irregularly dehiscent around the middle.

Type. Isla Partida (north or south one?), Gulf of California, *Johnston 3224,* April 22, 1921.

An isotype examined notes the variety as "Common on slopes facing sea, especially in steep draws; trailing over shrubs and rocks". It has unusually large leaves, up to 5 cm. broad, with shallow triangular lobes. Another collection by Johnston, without number from the same island, has deeply cut leaves with linear-lanceolate, acuminate lobes. The remaining sheets are rather uniform in their small leaves with shallow triangular lobes: Mejia Island, April 30, 1921, *Johnston 3355,* "trailing over low bushes in an open wash"; Puerto Refugio, Angel de la Guarda Island, January 26, 1940, *Dawson 1024;* Tortuga Island, May 11, 1921, *Johnston 3606,* "Forming dense masses on shrubs, mainly on north and east parts of island. These growths conspicuous from gulf;" San Pedro Nolasco Island, April 17, 1921, *Johnston 3131,* "Growing in dense masses over shrubs and rocks in a gulch near sea"; Tortuga Island, March 17, 1937, *Rempel 221;* Baja California, *Purpus s. n.;* south end of Bahía Concepción, Dec. 1, 1946, *Wiggins 11508* (in part).

The maintenance of this variety rests solely on the non-echinate character of the fruits. Johnston, who studied the plant in the field, has stated (l. c. p. 1181) that plants with smooth fruits in some localities may grow intertwined with those of echinate fruits (e.g. *Wiggins 11508*) and without intergrades, or in other localities he noted vines with fruits furnished with many prickles as well as vines with fruits having very few. I have been unable to perceive other correlative characters to strengthen the variety. The difference may be based on a segregating Mendelian factor and the variety may be really only a form, but without genetic evidence, I defer the obvious taxonomic move. Its distribution appears to be coextensive with *V. insularis* var. *originalis.*

Evolution

The area occupied by *Vaseyanthus* lies in the heart of the unique California Gulf Region. This area, physiographically, has been highly modified during the Tertiary Period, and the relative occupancies of land and sea today bear but little resemblance to what they were in early Tertiary. According to geologic studies (see Schuchert's synthesis, 1935), a sea invasion of the trough got under way in the Oligocene. Previous to that and subsequent to the Cretaceous seas, the present gulf was apparently terra firma. In early Miocene times, the gulf reached to about the latitude of Angel de la Guarda and Tiburón islands. By late Miocene, the gulf appears to have reached its greatest extent, occupying the Colorado Desert and adjacent western Sonora and Arizona. As the peninsula and mainland became more distantly separated, the salt water barrier surrounded the mid-gulf islands, most of which appear to date from the late Miocene, while the islands near the Cape District and the Cape District itself appear to be older. During late Pliocene and Pleistocene, the modern peninsula arose. Also the shore lines of both coasts advanced with the growth of piedmont attritions, constricting the gulf and leaving it outlined as of today.

It is logical to infer that the growth of the gulf caused extensive disjunctions in plant populations. In species of general distribution, for example, there would have resulted rather numerous isolated populations on the respective islands, on the peninsula, and on the mainland. In a recent paper (1949), I have pointed out the importance of land and sea ratios to the development of the flora in the California Gulf Region. Since isolation has long been a recognized factor in speciation, we may well examine the distribution of *Vaseyanthus* in the light of the physiographic factor. But first let us discuss the dispersal facilities of the genus, since it is possible that the distribution of *Vaseyanthus* is due mainly to its dispersal efficiency and the present occupancies are a modern pattern.

The fruits of *Vaseyanthus* appear well equipped for dissemination by water, wind, or animal transport. They are tough, light in weight, and provided with prickles. Their roundness also conceivably makes them susceptible to rolling by strong winds. The seed is safely (?) protected in a strong vehicle. Altogether, the fruit appears admirably designed to spread the genus widely, but this obviously has not happened. The dispersal facilities appear to have been limited by environmental factors or possibly, by the plant's own physiologic ineptitude, since the related genus, *Echinopepon,* with fruits less proficiently adapted for dispersal, nevertheless at present exploits a wider horizon. The members of *Vaseyanthus* are in large part surrounded by salt water. But, if salt water be a serious barrier, plants on the Cape District have a long northward land path open to them, while those on the mainland theoretically could have extended north or south. Both the occasional seasonal hurricanes and the extinct mammal populations could have served to effect at least sporadic dissemination of seeds in the geologic long past. The areal occupation of the genus does not appear to have been limited by lack of a dispersal mechanism. Although fit for local perpetuation, the fruit characters do not explain the restricted distribution.

Since the genus is now within an area receiving summer rainfall, it is probable that existence is dependent upon some of the conditions inherent in that type of environment. It is apparently barred from more northward occupancy by the conditions attendant on lower winter temperatures and summer droughts. The physiology appears to have been and still to be inadequate for the occupancy of more than the narrow environmental range encompassed by the shores of the central and southern part of the Gulf of California. However, the physiologic factors cannot show, except through experimental methods, the causes for the confined and disjunct present distributions of the members of the genus. For the purposes of this discussion, therefore, the physiologic potentialities can contribute little, although their possible significance should be kept in mind.

When considering the problem deliberately from the environmental angle, there are developmental factors of special significance. Historically, the environment can be revealingly defined by the physiography. In the area under consideration an eventful, sequential, datable land evolution occurred. It offers strong evidence for interpreting *Vaseyanthus* distributions.

The distribution of *Vaseyanthus* appears to be that of a Tertiary relic. It is closely peripheral to the borders of the early Miocene gulf, when northern limits of that body of water reached only to about the middle of the present gulf. Discounting the more remote possibility of dispersion via sea water, the spotted occurrences on islands, peninsula, and mainland appear to represent remnants of a general distribution in the early or middle Tertiary anterior to the gulf invasion. This is particularly true of the *Vaseyanthus insularis* complex, since *V. Brandegei* occupies the older insular area represented by the Cape District, as will be discussed later.

Reasoning from this basis, the distinct populations of *Vaseyanthus insularis* more or less started their divergent tendencies in the Miocene period. If so, the rate of speciation has been surprisingly slow. Not a single clear-cut species appears to have evolved in the 15 to 20 million years estimated to have elapsed (year estimate based on that as in Schuchert & Dunbar, 1947, pp. 64–71). Evolution of the disjuncts has at present reached the varietal or subspecies stage. Judging from the unstable tendencies of the stamens and ovarian cells, one would suppose it to be a complex in genetic flux, for which only the random segregation in a varying environment was needed for the genesis of new species (cf. Turesson, 1922). However, in this connection, it is also well to remember that morphological instability in floral parts is common in genera known to be very old, e.g., *Nymphaea, Distylium, Magnolia,* etc., so that floral lapses in *Vaseyanthus* may be indicative of an old genus. In the disjunctive situation of *Vaseyanthus,* there was obviously lacking the necessary genetic coherency for any variant to diverge apprecibly along independent lines. Genetic studies might determine the mechanics of this failure. So far as we know the complex today, the net result has been the development of a variety on the mainland, and two varieties coinhabiting the islands and the peninsular gulf shore.

Physiographically, the case of *Vaseyanthus Brandegei* is just as clear. Except for recent minor extensions, it is confined to the Cape District of the peninsula and adjacent gulf islands, which are part of the same basic granitic monolith. Until most recently, the cape was a well isolated island, apparently dating from the early Tertiary (Gentry, 1949, pp. 81–98). The separate specific status of *Vaseyanthus Brandegei* is therefore neatly correlated with its long isolation from other members of the genus. Morphologically and genetically, it appears to be a stable species. Under a relatively constant insular and oceanic type of climate, it has long been environmentally secure. Just as *V. insularis* appears to express, through morphological vagaries, the dynamics of changing land forms, so *V. Brandegei* indicates an insular constancy through its morphological unity.

Thus we have two lines of evidence for the evolution of *Vaseyanthus:* from morphology and physiography. Morphologically, its species have had a common ancestor with those of *Echinopepon. Vaseyanthus* has diverged more in developing the hardened, vescicular 1-seeded fruits and in the tendency to drop stamens, while *Echinopepon* has evolved further by the development of more species and by the greater variation of its perianth and trichomes. *Vaseyanthus insularis* is more modified than *V. Brandegei* in its smooth-fruited variety and the tendency to drop stamens.

Geologically, the evidence indicates that the evolution of land forms had a great deal to do with specific divergence in *Vaseyanthus.* It is surmised that early in the Tertiary, a common ancestor of the *Vaseyanthus* species occupied the California Gulf Region. The invading Tertiary gulf isolated segments of the population: first that of *V. Brandegei* on the Cape District island in early Tertiary times; second, the population of *V. insularis,* was cut into many small populations on either side of the gulf and on the islands within the gulf, in mid-Tertiary. These segregations may have been interrupted by subsequent land resurgence with attendant remixing of plant populations, but in the long run, the segregations allowed opportunity for expression of genetic differences. The differences, as of today, are perceptible in taxonomic varieties. Because segregation of *V. Brandegei* and *V. insularis* dates from the early Tertiary to Recent, it appears to have required most of the Tertiary to develop specific status, and because the *V. insularis* population became disjunct in the Miocene, it appears to have required about one third of the Tertiary to engender varieties in this genus.

Tentatively, the taxonomy is supported by the physiography and vice versa. However, I do not wish to leave the reader with the impression that either line of evidence is erected to support the other, but both together form a hypothesis fit to be tested with studies of other genera. Concommitantly, more exhaustive geologic field studies are badly needed. The hypothesis is that evolution of life forms is correlative with the evolution of land forms in the California Gulf Region and that plant speciation in some cases can be synchronized somewhat with geologic time.

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ON THE SUBSPECIES OF LEPIDIUM MONTANUM

C. LEO HITCHCOCK

In the fall of 1945, Mr. R. C. Barneby sent me a series of specimens of a shrubby *Lepidium* which he and Mr. Ripley had collected twelve miles south of Mountain Home, Elmore County, Idaho. I ventured the opinion that the collection comprised another variant of the plastic *L. montanum* Nutt. ex T. & G. and with this opinion Mr. Barneby agreed. However, in the fall of 1947, he sent me a second series of plants collected near Duchesne, Duchesne County, Utah, which were more similar to the specimens from Idaho than to any other of the various subspecific entities of *L. montanum.* After studying the two collections I believe them to be sufficiently distinctive to warrant description.

Accordingly, these two shrubby-based, dwarf plants were described as new subspecific entities of *L. montanum* and a key was prepared to differentiate them from var. *integrifolium* and the other varieties of *L. montanum.* Therefore, Dr. Rollins' (1948) paper "On Two Perennial Caespitose Lepidiums of Western North America" was of particular interest to me since *L. Davisii* Rollins, therein described (type: from ca. fourteen miles south of Mountain Home, Elmore County, Idaho, June 27, 1946, *R. J. Davis 4670*), is the same entity as that collected by Ripley and Barneby in nearly the same locality in 1945.

Dr. Rollins is of the opinion that his species is comparatively closely related to *L. nanum* and that it partially bridges the gap between that species and *L. montanum.* To substantiate this opinion he states that "the siliques of *L. Davisii* are similar in shape to those of *L. nanum.* The seeds are of similar size and shape, and the cotyledons are accumbent in both species." With Dr. Rollins' conclusions I am unable to agree, since, in my opinion *L. Davisii,* with its entire leaves, is even less similar to *L. nanum* than are several of the forms of *L. montanum. Lepidium nanum* is unique, insofar as North American species are concerned, in having apically trilobed leaves and in being scapose. For this reason, I suggested (1936, p. 314) not that *plants,* but rather that the *habit* of plants of *L. nanum* was "more suggestive of *Draba* than of *Lepidium.*" *Lepidium Davisii,* on the other hand, is so similar to occasional stunted plants of *L. montanum* (*sensu latiore*) from New Mexico or Utah (e.g. *Hitchcock et al 4316*) as to be distinguishable from them with some little difficulty. Furthermore, the cotyledons of *L. montanum, L. nanum,* and *L. Davisii* are all incumbent [according to the definition of "incumbent" as applied to cotyledons by Gray (1887, p. 128, figs. 427, 428) and Jackson (1928)]. This is the normal condition in *Lepidium.*

In my opinion, *L. Davisii* is not specifically distinct from *L. montanum.* In the following revised key to the subspecies of *L. montanum* having entire or non-lobed leaves, *L. Davisii* is included as a subspecies.

- Leaves entire to crenate-dentate.
  - Basal leaves crenate or crenate-serrate .... *L. montanum* subsp. *spathulatum*
  - Basal and cauline leaves entire.
    - Plants with branched, woody crowns; stems many, 5–10 cm. tall, erect; basal leaves linear to oblanceolate, 10–40 mm. long, 1–4 mm. broad.
      - Basal leaves linear to linear-spatulate, 20–40 mm. long, 1–2 mm. broad, glabrous or nearly so, cauline leaves similar but smaller; petals cream-colored .. *L. montanum* subsp. *demissum*
      - Basal leaves spatulate to oblanceolate, 10–20 mm. long, 2–4 mm. broad, sparsely puberulent, cauline leaves somewhat larger; petals white .... *L. montanum* subsp. *Davisii*
    - Plants with thick, unbranched caudex; stems decumbent at the base, 10–30 cm. tall; basal leaves thick and fleshy, 30–100 mm. long, 4–15 mm. broad .... *L. montanum* subsp. *integrifolium*
- Leaves, some of them, lobed to parted or divided . . . , etc.

Since the publication of the numerous varieties of *L. montanum* in 1936, I have come to believe that they might more truly be defined as subspecies, as most present day workers interpret that entity, and I therefore propose the following new names.

Lepidium montanum Nutt. ex T. & G. subsp. **demissum** subsp. nov. Plantae glabrae vel sparse pubescentes, demissae; caulibus 4–10 cm. altis, erectis, ex caudicibus ramosissimis; foliis integris, linearibus vel spathulatis, 20–40 mm. longis, 1–2 mm. latis; racemis elongatis; petalis albo-flavis.

Plants glabrous or very sparsely pubescent, from thick, woody, freely branching crowns; stems many, stiffly erect, 4–10 cm. tall; leaves entire, linear to very narrowly linear-spatulate, the basal mostly 20–40 mm. long, 1–2 mm. broad; racemes about half total length of stems; petals cream-colored.

Type. White shale benches and hilltops at 5900 feet elevation, 4 miles southwest of Duchesne, Duchesne County, Utah, June 15, 1947, *Ripley & Barneby 8699* (Univ. of Washington Herbarium 113909).

The short stature of these plants apparently is not due to particularly poor growing conditions during the season of 1947. They presumably are derived from subsp. *integrifolium* which is to be found in the same locality in moister places, especially where the salinity is high. Since numerous plants were collected, it is certain that the type is representative of a distinctive population.

Lepidium montanum Nutt. ex T. & G. subsp. **Davisii** (Rollins) comb. nov. *L. Davisii* Rollins, Madroño 9: 164. 1946.

Plants similar in habit to those of subsp. *demissum*, the stems many, 3–10 cm. tall, from woody, freely branched crowns, the entire plant finely puberulent; leaves linear-oblanceolate to oblanceolate, entire, the basal smaller than the cauline, the latter 10–25 mm. long, 2–5 mm. broad; stamens 6; petals apparently white.

Material seen. 12 miles south of Mountain Home, Elmore County, Idaho, May 31, 1945, elevation 2750 feet, "plants forming a pure association in dry bed of a small playa on a sagebrush mesa", *Ripley and Barneby 6499;* dried up pond, west of highway ½ mile north of rim of Snake River Canyon, south of Mountain Home (Range 6 E., Township 5 S.), June 27, 1946, *R. J. Davis 4670* (type of *L. Davisii,* Dudley Herbarium no. 314343); from nearly same station, May 9, 1947, *R. J. Davis 4745* (Dudley Herbarium).

In my opinion this phase of the species is also similar to, but apparently more than, a badly stunted form of subsp. *integrifolium.* It is very unlike either subsp. *typicum* or subsp. *papilliferum,* the only subspecies of *L. montanum* previously reported from Idaho, and occurs considerably farther to the north than subsp. *integrifolium* has been reported.

Lepidium montanum subsp. **typicum** nom. nov. *L. montanum* var. *typicum* C. L. Hitchc. Madroño 3: 302. 1936.

LEPIDIUM MONTANUM subsp. *typicum* var. **wyomingense** (C. L. Hitchc.) comb. nov. *L. montanum* var. *typicum* forma *wyomingense* C. L. Hitchc. *op. cit.,* p. 304.

LEPIDIUM MONTANUM subsp. **canescens** (Thell.) comb. nov. *L. montanum* var. *canescens* (Thell.) C. L. Hitchc. *op. cit.,* p. 304.

LEPIDIUM MONTANUM subsp. **cinereum** (C. L. Hitchc.) comb nov. *L. montanum* var. *canescens* forma *cinereum* C. L. Hitchc. *op. cit.,* p. 306.

LEPIDIUM MONTANUM subsp. **papilliferum** (Henderson) comb. nov. *L. montanum* var. *papilliferum* Henderson, Bull. Torrey Bot. Club 27: 342. 1900.

LEPIDIUM MONTANUM subsp. **heterophyllum** (Wats.) comb. nov. *L. montanum* var. *heterophyllum* (Wats.) C. L. Hitchc. *op. cit.,* p. 307.

LEPIDIUM MONTANUM subsp. **glabrum** (C. L. Hitchc.) comb. nov. *L. montanum* var. *glabrum* C. L. Hitchc. *op. cit.,* p. 307.

LEPIDIUM MONTANUM subsp. **alpinum** (Wats.) comb. nov. *L. montanum* var. *alpinum* Wats. Bot. King Exp. 29. 1871.

LEPIDIUM MONTANUM subsp. **tenellum** (Williams) comb. nov. *L. montanum* var. *tenellum* (Williams) C. L. Hitchc. *op. cit.,* p. 308.

LEPIDIUM MONTANUM subsp. **Jonesii** (Rydb.) comb. nov. *L. montanum* var. *Jonesii* (Rydb.) C. L. Hitchc. *op. cit.,* p. 309.

LEPIDIUM MONTANUM subsp. **alyssoides** (Gray) comb. nov. *L. montanum* var. *alyssoides* (Gray) Jones, Zoe 4: 266. 1893.

LEPIDIUM MONTANUM subsp. **alyssoides** var. **Eastwoodiae** (Wooton) comb. nov. *L. montanum* var. *Eastwoodiae* (Wooton) C. L. Hitchc. *op. cit.,* p. 311.

LEPIDIUM MONTANUM subsp. **spathulatum** (Robinson) comb. nov. *L. montanum* var. *spathulatum* (Robinson) C. L. Hitchc. *op. cit.,* p. 312.

LEPIDIUM MONTANUM subsp. **angustifolium** (C. L. Hitchc.) comb. nov. *L. montanum* var. *angustifolium* C. L. Hitchc. *op. cit.,* p. 312.

LEPIDIUM MONTANUM subsp. **integrifolium** (Nutt.) comb. nov. *L. montanum* var. *integrifolium* (Nutt.) C. L. Hitchc. *op. cit.,* p. 313.

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NEW COMBINATIONS IN HYMENOXYS

K. F. Parker

Inasmuch as the species upon which the genus *Actinea* was based (*A. heterophylla*) has proven to belong to the genus *Helenium,* it is necessary to utilize *Hymenoxys* Cass., the next available name, for those other entities formerly placed under *Actinea.* The following new combinations, proposed in a monograph of the genus, are presented at this time in order to make the names immediately available to other workers who may wish to use them. Complete synomymy is included in the forthcoming monograph.

1. **Hymenoxys Torreyana** (Nutt.) comb. nov. *Actinella Torreyana* Nutt. Trans. Am. Philos. Soc. II, 7: 379. 1841.

2. **Hymenoxys acaulis** (Pursh) comb. nov. *Gaillardia acaulis* Pursh, Flora Am. Sept. 2: 743. 1816, as *Galardia.*

3. HYMENOXYS ACAULIS (Pursh) Parker var. **glabra** (A. Gray) comb. nov. *Actinea scaposa* Nutt. var. *glabra* A. Gray, Man. Bot. N. U. S. ed. 5: 263. 1867.

4. HYMENOXYS ACAULIS (Pursh) Parker var. **arizonica** (Greene) comb. nov. *Tetraneuris arizonica* Greene, Pittonia 3: 266. 1898.

5. HYMENOXYS ACAULIS (Pursh) Parker var. **caespitosa** (A. Nels.) comb. nov. *Tetraneuris acaulis* (Pursh) Greene var. *caespitosa* A. Nels. Bot. Gaz. 28: 127. 1899.

6. HYMENOXYS ACAULIS (Pursh) Parker var. **Ivesiana** (Greene) comb. nov. *Tetraneuris Ivesiana* Greene, Pittonia 3: 269. 1898.

7. **Hymenoxys scaposa** (DC.) comb. nov. *Cephalophora scaposa* DC. Prodromus 5: 663. 1836.

8. HYMENOXYS SCAPOSA (DC.) Parker var. **linearis** (Nutt.) comb. nov. *Actinella scaposa* Nutt. var. *linearis* Nutt. Trans. Am. Philos. Soc. II. 7: 379. 1841.

9. **Hymenoxys argentea** (A. Gray) comb. nov. *Actinella argentea,* A. Gray, Plant. Fendl. 100. 1849.

10. **Hymenoxys Brandegei** (Porter) comb. nov. *Actinella Brandegei* Porter ex A. Gray, Proc. Am. Acad. 13: 373. 1878.

11. **Hymenoxys grandiflora** (Torr. & Gray) comb. nov. *Actinella grandiflora* Torr. & Gray, Bost. Jour. Nat. Hist. 5: 109. 1845.

12. **Hymenoxys Bigelovii** (A. Gray) comb. nov. *Actinella Bigelovii* A. Gray, Plant. Wright. 2: 96. 1852.

13. HYMENOXYS RICHARDSONII (Hook.) Ckll. var. **floribunda** (A. Gray) comb. nov. *Actinella Richardsonii* Hook var. *floribunda* A. Gray. Plant. Fendl. 101. 1849.

14. HYMENOXYS COOPERI (A. Gray) Ckll. var. **canescens** (D. C. Eaton) comb. nov. *Actinella Richardsonii* Hook. var. *canescens* D. C. Eaton in Watson, King Geol. Expl. 40th Par. 5: 175. 1871.

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REVIEW

Woody Plants of the Western National Parks. By VIRGINIA LONG BAILEY and HAROLD EDWARDS BAILEY. American Midland Naturalist Monograph No. 4, February 1949. University of Notre Dame, Notre Dame, Indiana. 274 pp., 146 figs., cloth. $4.00.

Visitors to these sixteen national parks who would like to have one book which will enable them to identify the woody plants will welcome this botanically accurate handbook written in nontechnical language. Keys to both trees and shrubs are given, but only shrubs are described in the text as the section on trees has been previously published (Bailey & Bailey, Forests and Trees of the Western National Parks. U.S.D.I., Conservation Bulletin No. 6, 1941). Although the emphasis is on common names, scientific names by species, genera, and families are included. The underlying taxonomy, based on the authors' own research and their interpretation of recent monographs, is conservative and sound. Frequent reference is made in the discussion to varieties and forms and to their distinguishing characters. While in the employ of the National Park Service, the authors carried on extensive field work in these parks and became familiar with the interests of the public. Following the usage of the National Park Service, the authors have, where practicable, adopted the nomenclature of "Standardized Plant Names" prepared for the American Joint Committee on Horticultural Nomenclature (1942).

Following the concise introduction, each of the sixteen parks is briefly characterized and the dominant trees and shrubs of each altitudinal zone are given for each. The inclusion of Isle Royale in a book on western parks may be criticized by some, even though it does have some plants in common with the more northern of the western parks. Its inclusion, however, results in the addition of many eastern species which will make the book more generally useful than its title indicates.

The abundance of each shrub in each park is given, together with the altitude and particular localities at which it may be sought. For many species, interesting facts are given, such as the origin of the name, the conditions under which the plant grows, uses made of it by Indians, the value of the flowers for honey, of the fruit for food, of the foliage for browse, and of the wood for fuel. Of the 560 shrubs (in 48 families), 145 are illustrated by excellent original line drawings by Mrs. Bailey.

Although many, including the reviewer, will regret the apparent small size of the type, the publishers are to be congratulated upon the format and attractive appearance of the book. The dark blue cover is in conformity with other monographs of the series.—MARY L. BOWERMAN, Department of Botany, University of California, Berkeley.

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MESEMBRYANTHEMUM IN CALIFORNIA

Reid Moran

Three species of Mesembryanthemum are well enough established in western North America to have been regarded by some authors as native. As segregated in recent studies, these are *Carpobrotus chilensis* (Molina) N. E. Br., *Cryophytum crystallinum* (L.) N. E. Br., and *Cryophytum nodiflorum* (L.) L. Bolus.

Of the thousand-odd species of Mesembryanthemum, a very great majority are African. Most species of *Cryophytum* are African, and the two occurring in California are found also in Africa. Likewise, most species of *Carpobrotus* are African, though the one occurring in California is found also in Chile but not in Africa. These facts seem to indicate that the California species of Mesembryanthemum are of African ancestry. The question is how and when they reached our shores. Was it before or after the arrival of the white man? And how long ago must they have arrived in order to be "indigenous"?

Brewer and Watson (1876, p. 251) and Wilson (1932, pp. 276–277) considered the California species of Mesembryanthemum as introduced. On the other hand, Parish (1890) argued that the three well-established species were indigenous; and Jepson (1914, p. 462) and Abrams (1944, p. 118) accepted this point of view. Von Poellnitz (1933, pp. 29, 36) and Munz (1935, p. 154) considered only *Carpobrotus chilensis* to be indigenous.

Parish argued that the more or less concentric distribution of these three species was "a natural arrangement for the species of an indigenous genus" but was difficult to understand on the basis of chance introduction. This argument assumes that the three species had a common ancestor in California, which is scarcely credible. The three California plants seem conspecific with plants of other lands. But even if they are not, their closest respective relationships surely are with three foreign species belonging to two very distinct groups here regarded as genera. Therefore, there must have been three—or, at the very least, two—separate introductions from other parts of the world. Any resemblance of the present distribution of Mesembryanthemum in western North America to the distribution of an indigenous genus must, therefore, be regarded as coincidental.

Parish noted the widespread occurrence of the Mesembryanthemum species in wild and isolated areas of California and Baja California, Mexico; he dicussed the difficulties of explaining their early introduction, and he remarked on their apparent lack of rapid means of dissemination. He concluded that it would be difficult to account for their present wide distribution if they had been introduced since the Spanish settlement.

Madroño, Vol. 10, No. 5, pp. 129–160. January 23, 1950.

Although the means of dissemination may be difficult to understand, they seem none the less effective: there is some evidence that both *Cryophytum crystallinum* and *C. nodiflorum* have spread considerably since Parish's time.

Parish knew *Cryophytum nodiflorum* only from Santa Catalina and San Clemente islands and from the mainland in the immediate vicinity of San Diego, though it had also been collected on San Nicolas Island and at Santa Monica. From the early lists for the other islands of southern California and Baja California, *C. nodiflorum* was absent. It was first reported for Santa Rosa and San Miguel islands in 1932 and for Santa Barbara Island in 1941; and it has been found this year on Santa Cruz Island (*Moran 3331*). It was first collected on Guadalupe Island in 1932 and San Benito Island in 1937, and my collection in 1948 (*Moran 3030*) seems to be the first from Cedros Island. On the mainland it is now known from Santa Barbara County, California, to Socorro and San Bartolomé Bay, Baja California. It has also been collected at the mouth of the Pistol River, Oregon, and on ballast at Linnton, Oregon; but Professor M. E. Peck writes that he has no good evidence of its recent occurrence in Oregon.

Cryophytum crystallinum was widely distributed in California and Baja California at the time of Parish's writing. There is a suggestion, however, that it also has since spread both to the north and to the south. Then known only as far north as Santa Barbara County, it now occurs in the vicinity of Carmel. On his trip north from Magdalena Bay, Baja California, in 1889, T. S. Brandegee first encountered this species at San Benito, about 130 miles to the north. It has now been collected as far south as Rancho Salada, near Magdalena Bay; and reports not authenticated by specimens indicate that it may occur considerably farther south. More convincing evidence for the southward extension of *C. crystallinum* would be its discovery at some southern locality where Brandegee collected extensively but failed to find this conspicuous and weedy plant.

The apparent expansion of range of these two species of *Cryophytum* in the last sixty years might be explained partly as an increase in our knowledge of the range. On this basis, however, it is difficult to understand the apparent extension in both directions from an original center; for botanical exploration did not progress in a similar pattern. Thus it appears that *Cryophytum nodiflorum* has spread markedly in recent years, and it seems possible that this plant could have achieved its present distribution from one introduction since the Spanish settlement. With *C. crystallinum*, the evidence, though less convincing, points in the same direction.

Carpobrotus chilensis occurs along the coast from Oregon to Baja California and on the coast of Chile. This distribution pattern is similar to those of several plants whose nativity in western North America is not questioned. There is no evidence at hand of recent extension of range. At present, therefore, there seems no reason to doubt that this species is native in western North America.

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THE GENUS BURRAGEA OF LOWER CALIFORNIA, MEXICO

John H. Thomas

The first collection of a member of the genus *Burragea,* in the family Onagraceae, made in 1844 by R. B. Hinds, surgeon on H. M. S. "Sulphur," at Magdalena Bay, Lower California, Mexico, was described by George Bentham (1844, p. 15) as *Gaura? fruticulosa.* Bentham considered the development of the seeds within the branch to be due to fungi or to an unknown disease. The question mark between the genus and species name indicates that Bentham was doubtful as to the correct generic status. Mary Curran (1888, p. 231) described a new species, *Gongylocarpus frutescens,* from a collection made by W. E. Bryant, apparently without knowledge of *Gaura fruticulosa.* The following year, T. S. Brandegee (1889, p. 158) collected *Gaura fruticulosa,* which he transfered to *Gongylocarpus* Cham. & Schl., a related genus of the Mexican mainland, and gave *Gaura fruticulosa* and *Gongylocarpus frutescens* as synonyms. In the spring of 1911, while a member of the "Albatross Expedition," J. N. Rose collected specimens of what he and J. D. Smith determined as *Gongylocarpus frutescens* and *Gongylocarpus fruticulosus.* However, they considered these two species to be sufficiently distinct from the mainland species of *Gongylocarpus* to merit segregation as a new genus, *Burragea* (1913), named in honor of Commander G. H. Burrage who was in command of the "U. S. S. Albatross" on the expedition to Lower California in 1911. The two species of *Burragea* that Rose and Smith recognized were *B. fruticulosa* and *B. frutescens.* However, as Brandegee (1889) had pointed out, *B. fruticulosa* and *B. frutescens* are synonyms. The specimens that Rose and Smith called *B. frutescens* are distinct from those of *B. fruticulosa.* Since the name *B. frutescens* belongs in the synonymy under *B. fruticulosa,* a new name must be given to the entity that Rose and Smith called *B. frutescens* (1913, p. 298). The following treatment represents the writer's concept of the limits of and entities constituting the genus *Burragea.*

BURRAGEA Donn. Smith & Rose, Contr. U. S. Nat. Herb. 16: 297. 1913.

Plants low, freely branching shrubs, 3–6 dm. tall. Leaves alternate, subsessile, entire, somewhat thickened. Flowers in dense leafy terminal spikes, solitary in the leaf-axils. Calyx-tube filiform, attached to the stem. Calyx-lobes 4, lanceolate, tapering into an acute tip, reflexed in anthesis. Petals 4, orbicular to obovate. Stamens 8, all functional; anthers versatile. Stigma capitate to shallowly bilobed. Ovary 2-celled, enclosed in woody stem, at length dehiscent. Seeds one in each cell.

Type species: *Gaura ? fruticulosa* Benth.

Burragea occurs in a restricted region about Magdalena Bay, Lower California, Mexico.

KEY TO THE SPECIES

Plants glabrous, leaves oblanceolate	1. *B. glabra.*
Plants glandular-pubescent, leaves linear to narrowly oblanceolate	2. *B. fruticulosa.*

1. **Burragea glabra** sp. nov. Planta fruticosa glabra, 3–6 dm. alta, ramis numerosis, brevibus, foliis oblanceolatis, alternis, glabris, subsessilibus, 2–3.5 cm. longis, 5–8 mm. latis, tubo calycis 2–2.5 cm. longo, ca. 1 mm. lato, lobis calycis (sepalis) 4, lanceolatis, basi obtusis, ca. 1 cm. longis, petalis 4, orbicularibus vel obovatis, ca. 1 cm. longis, staminibus 8, ad summam calycis tubi insertis, stylo filiformi, stigmate capitato, ovario biloculari in ramum florigerum immerso.

Plants low spreading shrubs, 3–6 dm. tall, freely branched, branches often appearing short and stunted, young ones purplish, aging reddish-brown, bark shredding, glabrous; leaves numerous at ends of twigs, oblanceolate, 2–3.5 cm. long, 5–8 mm. wide, subsessile, glabrous, sometimes adhering to fruiting branch for some time; flowers 4-merous, showy, single in leaf axils; calyx-tube narrow, 2–2.5 cm. long, about 1 mm. wide, glabrous, partly closed at summit and prolonged into a collar beyond the point of attachment of petals, calyx-lobes, and stamens; calyx-lobes lanceolate, somewhat obtuse at base, about 1 cm. long, glabrous, reflexed in anthesis, rose colored, tips acute, free in the bud; petals orbicular to obovate, about 1 cm. long, slightly clawed, rose-colored, drying pink; stamens 8, all functional; filaments 5–9 mm. long; anthers versatile, about 2 mm. long, yellow; style equalling or exceeding stamens, filiform, stigma capitate, about

1 mm. broad, often shallowly bilobed; ovary enclosed in woody stem, forming a rough clavate structure, 2–8 cm. long, 4–7 mm. in diameter, glabrous, with shallow indentations along which splitting at length occurs; seeds two, one in each cell, 3–4 mm. long, angled, dark brown.

Type. Santa Maria Bay, Magdalena Island, Lower California, Mexico, March 18, 1911, *J. N. Rose 16263* (US, no. 638328; isotype, UC, no. 180094). Abbreviations of names of herbaria are according to Lanjouw (1939).

This collection (*J. N. Rose 16263*) was referred to *Burragea frutescens* by Smith and Rose. The type specimen of *Gongylocarpus frutescens* has been compared with specimens of *Burragea fruticulosa* and with a photograph of the type of *Gaura fruticulosa,* and it is identical with the latter species. *Burragea glabra* differs from *B. fruticulosa* in being completely glabrous and in having broader and more oblanceolate leaves. The leaves of *B. fruticulosa* are quite constant as to shape; the glandular-pubescence varies in length on the same plant, up to about 0.5 mm., the longer trichomes usually being found on the more terminal branchlets. Even though the material, on which the description of *B. glabra* is based, consists of only one collection, it appears to be sufficiently distinct from *B. fruticulosa* to be given specific rank.

2. Burragea fruticulosa (Benth.) Donn. Smith & Rose, Contr. U. S. Nat. Herb. 16: 298. 1913. *Gaura ? fruticulosa* Benth. Bot. Voy. Sulph. 15. 1844. *Gongylocarpus fruticulosus* T. S. Brandegee, Proc. Calif. Acad. Sci. Ser. 2, 2: 158. 1889. *G. frutescens* Curran, Proc. Calif. Acad. Sci. Ser. 2, 1: 231. 1888. *Burragea frutescens* Donn. Smith & Rose, loc. cit. 298.

Plants low shrubs, 3–6 dm. tall, branching freely, glandular pubsecent, branches often short and stunted, purple in youth, reddish-brown in age; bark shredding; leaves closely set at the ends of twigs, linear-lanceolate to somewhat oblanceolate, 2–4 cm. long, 2–6 mm. wide, subsessile, gland tipped, glandular-pubescent, reduced upwards, often adhering to fruiting branch even after seed is mature; flowers 4-merous, single in the leaf axils, showy; calyx-tube narrow, 1.5–3 cm. long, about 1 mm. in diameter, glandular-pubescent, partly closed at top by an annular disk and produced into a collar beyond the point of attachment of petals, calyx-lobes, and stamens; calyx-lobes narrowly lanceolate, about 1 cm. long, externally glandular-pubescent, attenuated into a tapering acute tip, refracted in anthesis, rose-colored; petals orbicular to suborbicular to obovate, about 1 cm. long, slightly clawed, rose-colored, drying pink; stamens 8, all functional, equal or subequal, 5–9 mm. long; anthers versatile, about 2 mm. long, yellow; style equalling or exceeding stamens, filiform, stigma capitate, about 1 mm. broad, often shallowly bilobed; ovary 2-celled, enclosed in woody stem, forming a rough, clavate structure, 2–10 cm. long, 4–6 mm. in diameter, with shallow indentations between ovaries, along which splitting occurs tardily, long persistent on the plant, glandular-pubescent; seeds 2, one in each cell, 3–4 mm. long, angled, pubescent, dark brown.

Type. Magdalena Bay, Lower California, Mexico. *R. B. Hinds,* in 1841 (K, no. 1845).

Collections are known only from Magdalena Bay and Santa Margarita and Santa Magdalena islands, and have been made only along the coastal region. The fact that specimens with mature flowers have been collected from January through November, may indicate that flowering occurs whenever there is sufficient moisture.

Specimens examined. Lower California, Mexico. Magdalena Bay: May 29, 1925, *Mason 1885* (DS, CAS, NY, US); October 10, 1939, *Berry 51* (DS, CAS); January, 1889, *Brandegee* (DS), November, 1902 (US); 1888, *Bryant* (CAS, type of *G. frutescens* Curran). Magdalena Island: January 13, 1889, *Brandegee* (UC, US), March, 1892 (NY, UC); 1888, *Bryant* (UC); April 11, 1930, *Johansen 620* (DS); March 1917, *Orcutt 45* (US), March, 1917, *88* (NY, US); November 24, 1905, *Nelson & Goldman 7295* (US). Santa Margarita Island: April 9, 1930, *Johansen 617* (CAS, DS); March 19, 1911, *Rose 16284* (UC, US), March 20, 1911, *16284b* (NY).

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STUDIES ON THE FLORA OF CHIAPAS, MEXICO—VI

Eizi Matuda

The present paper, like the preceding ones of this series listed at the end of this paper, is devoted principally to reporting new or otherwise noteworthy species of plants from Chiapas, southernmost of the Mexican states. All of the following material has been based upon the writer's own collections.

Grateful acknowledgments are due Dr. H. N. Moldenke of the New York Botanical Garden and to Dr. Herbert L. Mason of the

University of California for their friendly suggestions and valuable aid.

Musaceae

Musa mexicana sp. nov. Planta valida stolonifera caespitos diam. ca. 2–2.5 m. ferens tronco diam. 10–15 cm. cauli subcylindrico. Folia longipetiolata, petioli 8–10 dm. longi subteretes diam. 3–4 cm. insuper canaliculati usque ad laminas longo-vaginati ore membranaceo fibroso ochraceo, laminae oblongo- vel elliptico-lanceolatae apice obtusae vel rotundatae basi rotundatae vel inaequilaterales, usque ad 10–15 dm. longae 26–35 cm. latae supra atro-virides subtus flavo-virides glabrae integrae nitidae (laminae juvenculatae subtus bruneo-virentes). Inflorescentia valde erecta pedunculata, pedunculus 3–4 dm. longus diam. ca. 2.5–3 cm. glaber, bracteae numerosae deciduae extus roseae vel lilaceae intus pallidae subcymbiformes ovatae vel oblongo-ellipticae apice obtuso-acuminatae basi truncatae subamplexicaules 15–25 cm. longae 6–9 cm. latae chartaceae longitudinaliter nervatae, eae 6–8 vel 10 infimae flores feminas, reliquae 15–20 superiores flores masculinas subtendentes; flores utrorumque sexuum 6 vel raro 4–5 sessiles semper uniseriatim in bracteae unicae axilla dispositi, eorum perigonium simplex cylindraceum aurantium latere fissum apice 5-dentatum ore reflexum basi truncatum amplexicaule striatum; petalum unicum (perigonium interius) decolor semipellucidum ovatum apice acuminatum vel acutum perigonio aequilongum basi truncatum paullo vel valde striatum. Perigonium florium masculinorum basi truncato-amplexicaule, 3.5–4.2 cm. longum; stamina 5 primo sepalis breviora sub anthesi eis paullo longiora exserta, filamentis complanatis 2.7 cm. longis, antheris connatis linearibus bilocularibus purpureis 1.8 cm. longis; ovarii rudimentum nudum trigono-obconicum stylo columnari-filiformi albo usque ad medium trifido. Staminodia florium feminorum 5 teretes albida apice aristata 2 cm. longa; eorum stylus teres albidus 3–3.5 cm. longus primo pilosiusculus sub anthesi glabratus stigmate capitato ovario 3-loculare glabro tetragono-subcylindrico 4–4.5 cm. longo 0.7–1 cm. lato. Fructus tetragono-cylindraceus diam. 1.5 cm. 6–8 cm. longus; semina numerosa (35–55), semiturbinata depressa nigra (figs. 1–10).

Type. Brookside at about 100 m. altitude, in a wet sunny field, near Colonia Hidalgo, Acacoyagua, Chiapas, June 5, 1948, *Matuda 18320* (Matuda Herbarium; isotypes at the Instituto de Biología de la Universidad Nacional de México and at the Chicago Natural History Museum).

Additional specimens. Chiapas. Moist sunny thickets along brookside near Cruz de Piedra, 4 km. north of Acacoyagua, July 15, 1948, *Matuda 18321;* beside brook in wet field, altitude about 150 m., Colonia Cintalapa, 7 km. east of Escuintla, August 15, 1948, *Matuda 18319;* moist thickets along brookside, Pataste, 12

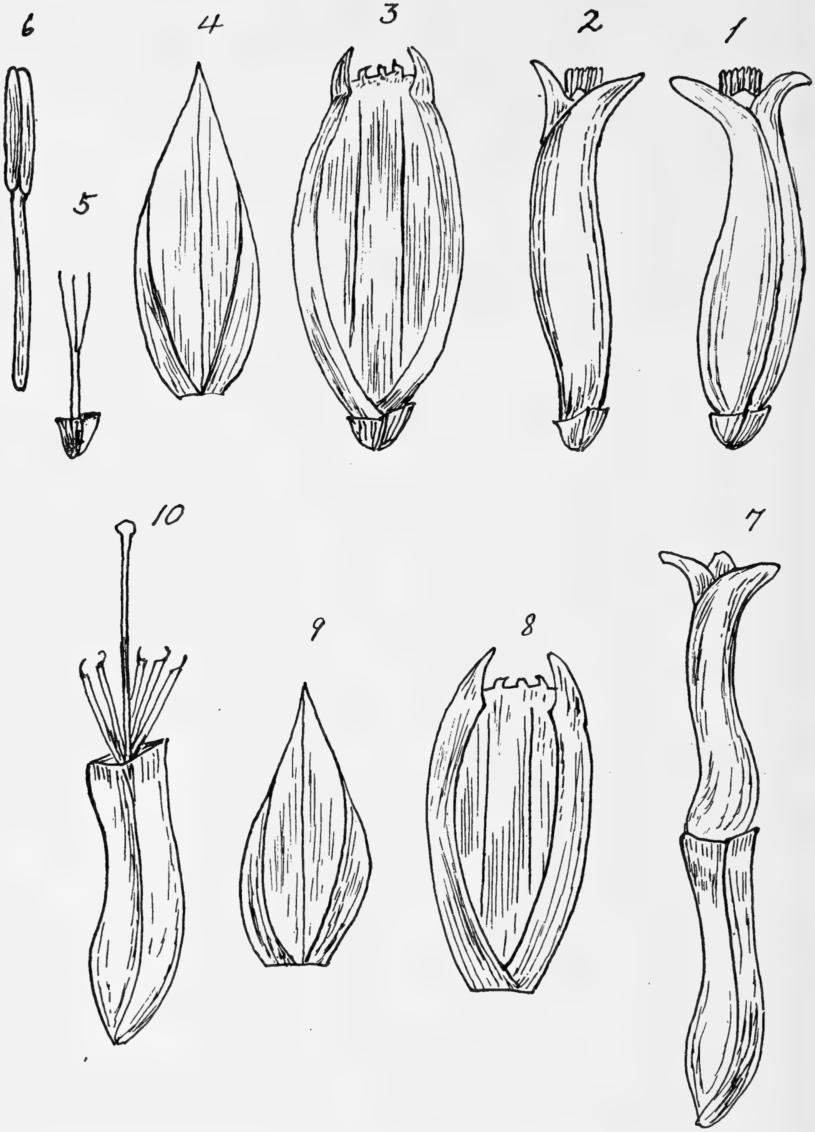

FIG. 1. Flowers of *Musa mexicana* Matuda. *1–6,* staminate flower: *1,* general view; *2,* side view, *3,* perigonium, opened; *4,* petal, opened; *5,* rudimentary pistil; *6,* stamen. *7–10,* pistillate flower: *7,* side view; *8,* perigonium, opened; *9,* petal, opened; *10,* pistil showing staminodia. All approximately natural size.

km. north of Acapetahua (a Pan-American railway station), June 20, 1949, *Matuda 18669.*

Local name: "Plátano silvestre." Occasional, being neither common nor yet rare, and mostly in the wild state. It is never found at elevations below 100 meters, being evidently restricted to a belt between 100 and 300 meters above sea level, and always close to the banks of brooks. It is quite generally distributed between these elevations in the District of Soconusco, and it is sometimes cultivated by the natives along plantation-borders for its attractive rosy bracts.

This new species seems very close to *Musa rosacea* Jacq., but it differs from this in its longer perigonia, and in having six flowers uniseriate in the axils of single bracts, very wide acuminate petals and long stout petioles.

Musa mexicana is not only noteworthy as a novelty but is, in addition, the first record of the occurrence of the genus *Musa* in the native wild flora of the American continent. All the other species so far known have originated in southeastern Asia.

ARACEAE

Anthurium giganteum sp. nov. Planta acaulis caudice radicibusque aeriis carnosis numerosis cataphyllis latis ca. 4 cm. longis mox emarcidis fibrosis, foliis magnis petiolatis coreaceis oblanceolato-oblongis 11–12 dm. longis medio 3–5 dm. latis ad apicem versus gradatim attenuatis vix acuminatis basi acutis vel cuneatis costa crassa venis lateralibus 18–20 patentissimis arcuatim in marginem excurrentibus petiolis crassis 7–15 cm. longis, vivis semitrigonis geniculis ca. 1.5 cm. longis vaginis basalibus parvis circiter 3 cm. longis, pedunculis teretibus crassis glabris 45–50 cm. longis, spatha persistente glauca vel lilacina nitida lineari-lanceolata basi rotundata apice acuta spadice fructifero lilacino cylindraceo 50–65 cm. longo, diam. 2–2.5 cm. floribus ignotis.

Type. On large tree in damp woods by river bank, altitude about 250 m., Salto de Agua, 15 km. northeast of Escuintla, Chiapas, July 15, 1948, *Matuda 18043* (Matuda Herbarium, isotypes at the Instituto de Biología de la Universidad Nacional de México and at the Chicago Natural History Museum).

The affinities of this species are with *Anthurium salviniae* Hemsl. and *A. crassinervium* Schott, but our species is readily distinguished by its large leaves and very large and long spadix.

Anthurium cuspidatum sp. nov. Planta majuscula terrestris caudiculo brevi crasso internodiis brevissimis cataphyllis latis ca. 3 cm. longis fibrosis mox decompositis, petiolis gracilibus subteretibus 20–28 cm. longis fere 1 cm. infra apicem nodoso-incrassatis, laminis coreaceis elongato-hastiformibus 20–25 cm. longis infra medium 6 cm. latis ad apicem versus gradatim attenuatis vix acuminatis vel cuspidatis lobis posticis apice subrotundatis sinibus 15–25 cm. latis ex basi 9-nervosa costa elevata utroque latere nervis ca. 6 angulo angusto adscendentibus tenerrimis subarcuatis prope marginem in nervum collectivum conjunctis, pedunculis gracilibus 30 cm. longis, spatha reflexa rufescente lanceolata apice acuminata basi truncata dilatata amplectente 5 cm. longa diam. 1 cm., spadice sessili in sicco fuscopurpureo 5.5 cm. longo gracili.

Type. In a shaded forest, altitude 700 m., near Colonia Jalapa, 32 km. east of Escuintla, Chiapas, July 3, 1948, *Matuda 18316* (Matuda Herbarium; isotypes at the Instituto de Biología de la Universidad Nacional de México and at the Chicago Natural History Museum).

Additional specimen. In mature forest, altitude 1800 m., near Colonia San Juan Panamá, about 45 km. east of Escuintla, on the Pacific slope of the Sierra Madre de Chiapas, Chiapas, July 23, 1948, *Matuda 18159.*

Anthurium chiapasense Standl. Field Mus. Pub. Bot. 22: 67. 1940.

This plant, previously known only from the type collection, was recently collected by the writer in a mature mixed rain forest on the Pacific slope of the Sierra Madre de Chiapas at an elevation of 1800 m. near Colonia San Juan Panamá, about 50 km. east of Escuintla, Chiapas, July 23, 1948 (*Matuda 18315*).

Philodendron monticola sp. nov. Planta epiphytica scandens caudiculo crasso internodiis superioribus radicibus aeriis haud exceptis 7 cm. longis, petiolis teretibus crassis ca. 4 dm. longis vaginis 6 cm. longis laminis coreaceis oblongis cordiformibus ca. 35 cm. longis basi 26 cm. latis apice sensim acuminatis basi late profundeque cordatis lobis posticis obtuse rotundatis auricularum venis 5 arcuatim excurrentibus reliquis utrinque 6 vel 7 prominentibus, pedunculo crasso terete 7 cm. longo, spatha 10–12 cm. longa infra medium valde constricta basi subglobosa clausa extus viridi intus ochroleuca infra basim purpurea, spadice vix exserto albido-flavescente cylindrico-subsessili 8 cm. longo longitudinis quartam partem pistillato reliquam partem sine staminodiis staminato.

Type. On a large tree in mature forest on the Pacific midslope of the Sierra Madre, altitude 1600 m., near Colonia San Juan Panamá, 50 km. east of Escuintla, July 22, 1948, *Matuda 18169* (Matuda Herbarium; isotypes at the Instituto de Biología de la Universidad Nacional de México and at the Chicago Natural History Museum).

Philodendron monticola may be distinguished from *P. oxycardium,* its closest relative, because of its thick leaf and rather small spathe. Also, it occurs at a much higher altitude, *P. oxycardium* occurring in southern Mexico between the altitudinal limits of 100 and 500 meters.

Philodendron apocarpum sp. nov. Planta epiphytica scandens ramulorum internodiis superioribus diam. 1.5–2 cm. ca. 12 cm. longis petiolis ca. 20 cm. longis gracilibus usque ad 2/3 longitudinis vaginatis laminis coreaceis oblongo-cordatis integris apice acutis vel acuminatis basi lata breviter lateque cordatis 12–15 cm. longis 12 cm. latis nervis primariis ca. 8 subtus prominentibus, pedunculo crasso tereti spatham subaequilongo, spatha semipersistente decidua ca. 15 cm. longa infra medium valde constricta basi sanguinea subglobosa clausa extus caeruleo-viridi intus ad apicem versus flavo-virente, spadice sessili vix exserto lacteo cylindrico 12 cm. longo eius quintam partem basalem flores pistillatos quintam partem intermediam staminodia et tres quintas partes reliquas ad apicem versus flores staminatos ferente, fructo rubente.

Type. In woods along Río Cintalapa, at Gilguero, 15 km. east of Escuintla, Chiapas, altitude about 200 m., August 10, 1948, *Matuda 18313* (Matuda Herbarium, isotypes at the Instituto de Biología de la Universidad Nacional de México and at the Chicago Natural History Museum).

Additional specimens. CHIAPAS. In extensive open woods along Río Cintalapa, near Aguas Calientes, 3 km. northwest of Escuintla, altitude 70 m., *Matuda 18312;* in open woods along brooks, Salto de Agua, Escuintla, altitude 250 m., September 8, 1947, *Matuda 17789;* in open woods, epiphytic on a large tree, Esperanza, 15 km. northeast of Escuintla, altitude 200 m., August 12, 1948, *Matuda 18314.*

Philodendron apocarpum has much the general aspect of *P. oxycardium* which occurs in the same region and with which it has been confused. Our species is readily distinguished by its thinner leaves and longer petiole-sheaths, but a more essential difference is to be noted in the form of the female flowers, conspicuous for their masses of elongated ovaries. The spathe is semi-persistent, not deciduous until after the fruit has ripened.

ANNONACEAE

ANNONA SPRAGUEI Safford, Contr. U. S. Nat. Herb. 16: 270. 1913.

This species has been treated as a restricted endemic of Panama in Standley's Flora of the Panama Canal Zone (Contr. U. S. Nat. Herb. 27: 180. 1928), and as far as I am aware, there have been no reports of its occurrence elsewhere. Yet *Annona Spraguei* occurs on the Pacific slope of the Mexican State of Chiapas (in sandy sunny woods drained by Río Cacaluta, Colonia Hidalgo, 16 km. north of Acacoyagua, altitude about 100 m., September 3, 1947, *Matuda 16888*). Its local name is "Chincuya de llano." This specimen was once identified by J. Steyermark as *A. purpurea* Moc. & Sesse and so distributed.

Annona scleroderma Safford, Jour. Wash. Acad. Sci. 3: 105, fig. 1. 1913. Contr. U. S. Nat. Herb. 18: 18, figs. 22–23. 1914; Standley & Steyermark, Flora of Guatemala, Fieldiana, Bot. 24 (4): 279–280. 1946.

This plant was described from Guatemala and is known as well from British Honduras and the Atlantic coast of Honduras, but apparently, there has been no previous indisputable record of its occurrence in Mexico. In his description of *A. scleroderma,* Safford (op. cit., p. 106) stated, "seeds sent . . . to the U. S. Department of Agriculture from the state of Oaxaca belong very probably to this species." It has been found to grow in the Pacific coastal lowland forest in Chiapas and is known only in the wild state (Finca Esperanza, in a mixed wet forest, 8 km. northeast of Escuintla, altitude 160 m., September 15, 1948 *Matuda 18405*). Its local name is "chirimoya de monte." The edible fruits ripen in January and February. In this region, this tree grows 15 to 20 meters tall with a trunk diameter of 2.5–3 decimeters and with a rather well developed crown.

MELIACEAE

Cedrela salvadorensis Standl., Field Mus. Publ. Bot. 4: 215. 1929.

This plant had been reported earlier from Salvador and more recently from Guatemala (Standley & Steyermark, Flora of Guatemala, Fieldiana, Bot. 24 (5): 450. 1946). Now it is known to occur in Chiapas, southern Mexico (wet mixed forest, altitude about 700 m., Finca la Brisa, 25 km. east of Escuintla, August 10, 1948, *Matuda 18368*). This species is therefore new to the Mexican flora and its occurrence in Chiapas probably represents the northern limit of its range.

APOCYNACEAE

Aspidosperma chiapense sp. nov. Arbor magna recta 25–30 m. alta tronco diam. 8–12 dm. ligno roseo ramulis juvenibus viridibus glabris tandem rugosis vel verrucosis griseis internodiis ca. 1 cm. longis, foliis alternatis proximis rigide coreaceis oblongo-lanceolatis ad apicem versus gradatim attenuatis utrinque vix acuminatis glabris supra lucidis subtus opacis in sicco fusco-olivaceis 15–18 cm. longis medio 4–5 cm. latis costis utrinque elevatis nervis lateralibus utrinque paulo elevatis numerosissimis approximatis parallelis in marginem revolutem desinentibus petiolis 2–3 cm. longis. Inflorescentia apice praecipue densa cymoso-paniculata vel umbelliformis paniculis terminalibus 5–7 cm. longis latisque pedunculis ramisque subglabris vel leviter hirsutis; calyx coreaceus extus minute stellatus intus glaber 3 mm. longus lobis 5 elongato-triangularibus semi-imbricatis 2 mm. longis; corolla pallide testacea salviformis vel tubiformis 7 mm. longa 5-lobata lobis filiformibus 2 mm. longis; stamina 5 prope medium corollae oriunda filamentis liberis 1 mm. longis glabris antheris bilocularibus 1 mm. longis semi-clavatis apice acuminatis; stylus columniformis (stigmate incluso) 7 mm. longus; ovarium semi-globosum apocarpum 1 mm. longum 0.8 mm. latum folliculis obovoideo-oblongis apice rotundatis mucronulatisque basi sensim attenuatis vel cuspidatis 16 cm. longis 10 cm. latis extus rugoso-nervosis minute sericeo-velutinis seminibus numerosis (30–40) semi-orbicularibus diam. ca. 8 cm. embryone submedio cotyledonibus oblongo-orbicularibus basi plus minusve cordatis 2 cm. longis. Latex in petiolis ramulisque juvenilibus albus, in folliculo pallide roseus.

Type. In wet forest, Esperanza, Escuintla, altitude about 160 m., Chiapas, Mexico, February 15, 1946, *Matuda 16361* (flowers) (Matuda Herbarium, isotypes at the Instituto de Biología de la Universidad Nacional de México and at the Chicago Natural History Museum).

Additional specimens. CHIAPAS. In the region about Esperanza, Escuintla, altitude about 160 m., August 15, 1948 (perfect leaves and immature fruit), *Matuda 18412;* in wet mixed forest, Cacaluta, Acacoyagua, altitude 170 m., February 1, 1946 *Matuda 18406* (flower and fruit).

Local names: "Chichi colorado"; "Chichi prieto."

This plant has long been confused with *A. cruentum* Woodson, who himself identified my specimen (*16361*), sent to him by the United States National Herbarium, as that species. *Aspidosperma chiapense,* however, is very different, and may be distinguished by its longer leaves, long petioles, larger follicles and rather large flowers.

This tree-species is well known and esteemed by native lumbermen for its timber, the sapwood being white or yellowish-white and the heartwood dull rose and so hard when cured that it is impossible to drive a nail into it. The bark is grayish-brown, about 4 cm. thick, scaly or with coarse deep fissures, and secretes no latex.

The original description of *A. cruentum* was based on a flowerless specimen. We therefore have had no opportunity thus far of comparing its diagnostic floral structures with those of our species.

ASPIDOSPERMA CHIAPENSE f. **tenax** f. nov. Folia semper pendula; lignum semper luteum vel luridum valde tenax.

Local name: "Chichi amarillo."

The wood of f. *tenax* is not a favorite of the native lumbermen because of its toughness. It occurs mixed with *A. chiapense* in the same forest.

Type. In wet forest, Esperanza, Escuintla, Chiapas, January 25, 1948, *Matuda 17386* (Matuda Herbarium; isotypes at the Instituto de Biología de la Universidad Nacional de México and at the Chicago Natural History Museum).

Additional specimen. In the region of Esperanza, Escuintla, Chiapas, August 15, 1948, *Matuda 18413* (perfect leaf and immature fruit).

From herbarium material alone, it is not easy to separate *A. chiapense* from its forma *tenax,* though it is easily distinguished in the forest by its generally somewhat smaller and pendent leaves of which the natives have been heard to say, "Se ve hojas tristes." A more essential character, however, is the tough yellowish heartwood. Its bark is the same color as that of *A. chiapense,* but it is rather thin and not deeply fissured. The latex which, as in the case of typical *A. chiapense,* is secreted only from young branches and petioles is always white and never pinkish.

Cufodontia escuintlensis sp. nov. Arbor magna erecta 25 m. alta diam. 5–7 dm. ramulis teretibus griseis glabratis lenticellis multis parvis internodiis 1–2 cm. longis foliis alternatis coreaceis vel pergameniis oblongo-lanceolatis 15–20 cm. longis 4–5 cm. latis ad apicem versus gradatim attenuatis utrinque vix obtusis margine integris in sicco flavo-olivaceis glabris supra paulo nitidis subtus opacis costis supra impressis subtus elevatis venis primariis lateralibus utroque costae latere parallelibus approximatis 27–30 gracillimis supra haud subtus tenuiter elevatis petiolo glabro supra caniculata 1–1.5 cm. longo. Inflorescentia cymae extra-axillariae alternatae floribus 25–30 constantes pedunculo minute puberulo pedicellis 3–5 mm. longis minute puberulis calycibus exterioribus coriaceis campanulatis extus puberulis intus glabris 4 mm. longis basi 1.7 mm. latis 2-lobatis apice obtuso-rotundatis concavis interioribus paulo minoribus ad 3 mm. longis 1.4 mm. latis corollis flavo-albis eorum tubis cylindricis ca. 6 mm. longis extus prope os puberulis intus tomentosis 5-lobatis diam. basi 1.3 lobis sinistrorsum contortis inter se obtectentibus oblique lineari-lanceolatis 6 mm. longis prope basem minute tomentosis demum patulis staminibus 5 prope tubi corollae medium affixis filamentis ca. 0.5 mm. longis glabris antheris 1.2 mm. longis brevissime apiculatis basi obtusis ovariis ovoideis ca. 1 mm. longis glabris stylis ca. 2 mm. longis stigmatibus coniformibus folliculis subreniformibus verrucosis glabris apice rotundatis latere valde mucronulatis basi acuminatis 10–12 cm. longis 9–11 cm. latis seminibus suborbicularibus diam. ca. 6–8 cm. embryone submedio cotyledonibus fere oblongo-orbicularibus diam. ca. 2 cm.; pedunculo diam. 1 cm. verrucoso 1.4 cm. longo.

Type. In wet forest, Cacaluta, Acacoyagua, Chiapas, altitude 150 m., August 17, 1947, *Matuda 16978* (fruit) (Matuda Herbarium; isotypes at the Instituto de Biología de la Universidad Nacional de México and at the Chicago Natural History Museum).

Additional specimens. In wet forest, Finca Esperanza, 8 km. east of Escuintla, Chiapas, altitude 200 m., February 23, 1948, *Matuda 17538* (flower); *17634* (fruit).

Local name: "Chichi blanco."

In the region of the type locality, *Cufodontia escuintlensis* flowers in February and March; and the follicle is not fully mature until March of the following year. It has an altitudinal range of from 100 to 700 meters above sea level in the Pacific coast rain forest and is always found growing with *Aspidosperma chiapense* and its form. It has no use as timber but can be used for firewood. The natives, however, find a use for its bark, from which they make a very bitter decoction to cure malaria. The general aspect of the seed, with its papery concentric wing, is very similar to that of those of the species of *Aspidosperma,* and for this reason, our plant may be taken for a species of that genus, especially if only the follicles and not the flowers themselves are examined.

By inadvertence, two specimens (*Matuda 16978,* type of *Cufodontia escuintlensis; 17538*) were determined by Steyermark as *Aspidosperma cruentum* and so distributed.

Cufodontia escuintlensis seems rather close to *C. stegomeris* of Costa Rica, but it differs in its somewhat narrower, longer and larger leaves and in its larger floral organs. It is noteworthy that one of these specimens (*16978*) is the first collection ever made of a fruiting *Cufodontia.*

Cufodontia Lundelliana Woodson, Archivio Bot. Sist. Fitogeog. & Genet. 10: 40. 1934. *Aspidosperma Lundellianum* Woodson, Bull. Torrey Club 4: 684. 1935.

Aspidosperma Lundellianum was described from fruiting material which had no flowers while the description of *Cufodontia Lundelliana* was based on flowering material devoid of fruits. I have examined a photograph of an isotype (*Lundell 1284*) of *Aspidosperma Lundellianum,* kindly forwarded through the courtesy of Dr. Rogers McVaugh, Curator of the Herbarium of the University of Michigan. Without any doubt, this is a fruiting specimen of *Cufodontia* and not of *Aspidosperma.*

When Dr. Woodson proposed the genus *Cufodontia* (Archivio Bot. Sist. Fitogeog. & Genet. 10: 39. 1934), he wrote, "It is hoped that additional, particularly fruiting, specimens of this genus will shortly be forthcoming." In point of fact, he actually *had* received, about a year previous, a representative fruiting specimen of *Cufodontia* (*Lundell 1284*), referred to above, to which he had applied the herbarium name of *Aspidosperma Lundellianum* with the date "Nov., 1933," though this binomial was not published until July, 1935. Woodson had thus described the same plant twice, each time in a different genus, basing his characters in one case on the flowers and in the other, on the fruits. The present writer has had the opportunity of collecting the flowers and fruits of *Cufodontia escuintlensis,* at different seasons to be sure, from the same tree. At the time of flowering, its fresh newly developed leaves are relatively thin while at the time the follicles are collected, six months or more later (it takes one whole year after flowering for the fruit to ripen), the fully developed leaves are thick and leathery so that it seems as though they were not from the same plant species.

There are now four species of *Cufodontia,* all confined to southern Mexico and Central America. These may be distinguished as follows:

Outer calyx-tube 3.5–4 mm. or more long; pedicels 3–5 mm. long.
  Leaves oblong-lanceolate (plant of Chiapas) .... 1. *C. escuintlensis*
  Leaves elliptic (plant of Costa Rica) .... 2. *C. stegomeris*
  Leaves oblong-elliptic, 12 × 4.5 cm., lateral nerves 15–18 (*fide* Woodson) .... 3. *C. arborea*
Outer calyx-tube never as long as 3.5 mm.; pedicels only 1 mm. long (plant of Yucatan region) ...... 4. *C. Lundelliana*

From the same area, three species and one *forma* of *Aspidosperma* are known, which may be separated as follows:

Leaves 3–5 × 10–15 cm.; follicles 10–12 cm. long, essentially glabrous .... 1. *A. megalocarpon*
Leaves 2.3–3 × 6–8 cm.; follicles 8–10 × 14 × 16 cm., floccose-velutinous; latex red (*fide* Woodson) .... 2. *A. cruentum*
Leaves 4–5 × 15–18 cm.; follicles 10 × 16 cm. sericeous-velutinous.
  Heartwood moderately tough, vivid or dull rose; latex of fresh follicle pale rose .... 3. *A. chiapense*
  Heartwood yellow and very tough; cortex not thick nor scaly; latex white .... 4. *A. chiapense* f. *tenax*

Specimens examined. Cufodontia Lundelliana. Petén, Guatemala, *Lundell 3408* (photo, Chicago Nat. Hist. Museum); Tuxpena, Campeche, *Lundell 1284,* misidentified as *Aspidosperma Lundellianum* (photo, Herb. Univ. Michigan).

Cufodontia stegomeris. Costa Rica, *Cufodontis 220* (photo, Chicago Nat. Hist. Museum).

Aspidosperma chiapense. Chiapas, *Matuda 18412, 18406, 16361* (flower) (Matuda Herb.).

Aspidosperma chiapense f. tenax. Chiapas, *Matuda 17386, 18413* (Matuda Herb.).

Cufodontia escuintlensis. Chiapas, *Matuda 16978* (fruit), *17538* (flower), *17634* (fruit) (Matuda Herb.).

Matuda Herbarium
Tacubaya, México, D.F.

Earlier Papers by the Author Treating the Flora of Chiapas.

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A NEW VARIETY OF ENGELMANN SPRUCE

George J. Goodman

Picea Engelmanni Parry ex Engelm. var. **glabra** var. nov. Ramulis glabris.

Type. Near Nash's Fork, Medicine Bow Mountains, altitude 10,000 feet, Albany County, Wyoming, July 10, 1948, *Goodman 4904* (Bebb Herbarium, Univ. Oklahoma).

The location given is in the climax Engelmann spruce-alpine fir forest near the University of Wyoming Science Camp. Other specimens in the Bebb Herbarium collected in this locality are as follows: near the Camp, June 20, 1931, *Howard King*, June 27, 1935, *C. T. Eskew;* Mill Pond (about 2 miles west of the Camp) July 22, 1949, *Goodman 5114*.

This glabrous phase was first observed at the type locality, which is at a point along the very eastern limit of the range of *Picea Engelmanni*—the mountains soon dropping off to the eastward to the Great Plains. Near the Camp several score of trees were observed and it was noted that, regardless of habitat or size and age of tree, about one out of three trees had glabrous twigs.

Judging from the few observations made thus far, this high concentration of glabrous individuals is decidedly localized. On the Hayden Division of the Medicine Bow National Forest, about forty-five miles southwest across the Continental Divide, and in a range separated from the Medicine Bows by the sagebrush covered valley of the North Platte River, three brief samplings were made. At the first locality, there were twenty pubescent trees and two glabrous ones. At the second, fifteen pubescent and no glabrous ones, and at the third, twenty-seven pubescent and one glabrous—a sharp difference from the count of two pubescent to one glabrous on Nash's Fork.

The uniformity of the literature in referring to the pubescent twigs of Engelmann spruce attests to the wide prevalance of the character. Occasional reference may be found, however, to variations in, or lack of pubescence. Kearney and Peebles (1942, p. 64) state in their key, ". . . comonly pubescent or puberulent," and the description of Engelmann spruce in Jepson (1925, p. 51) reads, ". . . branchlets (in ours) glabrous." Whether the Shasta County, California, specimens are of the same variety as those from eastern Wyoming is unknown.

The trees with pubescent twigs are herewith designated as follows:

Picea Engelmanni Parry ex Engelm. var. **typica** nom. nov. *P. Engelmanni* Parry ex Engelm. Trans. Acad. Sci. St. Louis 2: 212. 1863.

The few cones measured are on the average shorter in the glabrous variety, but no other differences have been detected between the two varieties. The distribution of the resin ducts in the needles is primarily in the proximal half, as recorded by Marco (1931) and Freytag and Reed (1948) for Engelmann spruce.

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Marco, H. F. 1931. Needle structure as an aid in distinguishing Colorado blue spruce from Engelmann spruce. Bot. Gaz. 92: 446–449.

FRED WILLIAM FOXWORTHY

Fred William Foxworthy was born in Goodland, Indiana, July 3, 1877, the son of a Methodist clergyman. Largely by his own efforts, he was able to attend DePauw University, where he was graduated in 1899. After a season at Woods Hole, he entered Cornell University where he received his master's degree in entomology in 1902, and his doctorate in botany in 1904.

He was in the Philippine service from 1905 through 1916, the last three years as head of the School of Forestry and Chief of the Division of Forest Investigation in the Bureau of Forestry, and Professor of Dendrology in the University of the Philippines. In a group of men of distinction, he was particularly distinguished by devotion to the search for the truth (research), and as a teacher of students.

In 1917, he went to the Federated Malay States as Forest Research Officer, being the only non-British subject in the British Colonial Service. He remained there until retired for age in 1932.

He was always particularly interested in timbers, in their sources, characteristics and uses, and published many important works on these subjects. A book on the timber resources of the Orient, finished two years ago, is understood to be in press.

He was a zealous traveler. His journeys, which took him from Scotland to New Zealand, and which included Africa from the Cape to Cairo, enabled him to see in person what the World could contribute to his understanding. After his retirement, he visited Latin America.

In 1934, he married Laura Mae Williamson and settled in Berkeley where the status of a Research Associate in the Department of Botany gave him the facilities of the University of California. He was President of the California Botanical Society in 1942. His death came suddenly in Berkeley on February 4, 1950.

Because the operation of botanical nomenclatural rules tends to commemorate those who contribute to this field of botany, Dr. Foxworthy will be remembered longer for his work in systematic botany, chiefly in the Dipterocarpaceae, than for his more really and immediately important work on the sources, structure and uses of wood.

His friends, throughout the World, will cherish his memory as that of a perfect gentleman.—E. B. Copeland, Department of Botany, University of California, Berkeley.

GENERIC NAMES OF ALGAE PROPOSED FOR CONSERVATION. II.

George F. Papenfuss[1]

In a previous article in this journal, the writer (Papenfuss, 1947) drew attention to several well-established generic names of algae which appeared to be illegitimate and hence in need of conservation. Further work on the marine algae has brought to light a few additional names which might profitably be conserved. They are hereby proposed for conservation.

Chlorophycophyta

Percursaria Bory (Ulvaceae), Dict. class. hist. nat. 4: 393. 1823; and 13: 206. 1828.

versus

Percursaria Bonnemaison, Jour. Phys., Chimie, Hist. Nat. et Arts 94: 178. 1822.

Tetranema Areschoug. Phyc. scand., sect. posterior 418, pl. 2, fig. A. 1850. (Not *Tetranema* Bentham, 1843.)

Diplonema Kjellman, Alg. Arctic Sea 302. 1883. (Not *Diplonema* G. Don, 1838, nor *Diplonema* De Notaris, 1846.)

Type species: *Percursaria percursa* (Ag.) Bory (1828, p. 206).

Although *Percursaria* Bory is a monotypic genus, it has a wide distribution and has for a long time been known by this name. A few authors have regarded the genus as synonymous with *Enteromorpha* Link (1820) but the non-tubular thallus, with its two longitudinal rows of cells, clearly distinguishes *Percursaria* from *Enteromorpha*. The illegitimatizing homonym *Percursaria* Bonnemaison, which is based on *Scytonema compactum*, is synonymous with the schizophycean genus *Dichothrix* Zanardini (1858).

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[1] The greater part of the work connected with the preparation of this article was done while the writer held a Guggenheim Fellowship.

RHODOPHYCOPHYTA

PRIONITIS J. Agardh (Grateloupiaceae), Sp. alg. 2(1): 185. 1851.

versus

Prionitis Adanson, Fam. pl. 2: 499. 1763.

Zarnardinula De Toni fil., Not. nomencl. alg. VII, p. [6]. 1936.

Type species: *Prionitis lanceolata* (Harvey) Harvey (1853; see also Schmitz 1889, p. 452 = *Prionitis ligulata* J. Agardh, 1851).

As has been pointed out by J. De Toni (1936), the generic name *Prionitis* J. Agardh (1851) is a later homonym of *Prionitis* Adanson (1763), a genus of flowering plants. J. De Toni accordingly gave the name *Zanardinula* to the genus of algae and this epithet was subsequently adopted by Papenfuss (1944), Dawson (1945, 1946) and Doty (1947). Inasmuch as the name *Falcaria* Host (1827) has been conserved against *Prionitis* Adanson and since *Prionitis* J. Agardh has been the accepted name of a genus of algae for almost a century, it is suggested that this name be considered for conservation.

BINDERA Harvey (Rhodymeniaceae), Phyc. austr. 2, pl. 111 and accompanying text. 1859.

versus

Bindera Rafinesque, New fl. Amer. 4: 71. 1836 [1838].

Bindera J. Agardh, Linnaea 15: 36. 1841.

Webervanbossea De Toni fil., Not. nomencl. alg. VII, p. [5]. 1936.

Type species: *Bindera splachnoides* Harvey, *op. cit.*, pl. 111, figs. 1–2 (cf. Kylin, 1931, p. 5).

In 1936 J. De Toni proposed the name *Webervanbossea* as a substitute for *Bindera* Harvey (1859) because the latter epithet was illegitimatized by both *Bindera* Rafinesque (1838), a genus of flowering plants, and *Bindera* J. Agardh (1841), a genus of red algae. Since *Bindera* Rafinesque is a synonym of *Aster* Linnaeus (1753) and *Bindera* J. Agardh a synonym of *Spyridia* Harvey (in Hooker, 1833), there is no obstacle to the retention of *Bindera* Harvey if the name were legitimatized through conservation.

Although *Bindera* at present includes only three species (*B. splachnoides* Harvey, *B. kaliformis* J. Agardh and *B. Levringii* Lindauer ined.), the genus is of considerable morphological interest. Moreover, it commemorates the name of a man who did much for the furtherance of our knowledge of algae, and of whom Harvey (*loc. cit.*) wrote: ". . . I gladly take this opportunity of paying an old debt, by inscribing it with the name of Dr. [Nicholas] Binder, of Hamburg, an enthusiastic admirer of Algae, the possessor of a noble collection [elsewhere referred to by Harvey as 'one of the finest collections of Algae in Europe'], which he freely opens for the use of all interested in this branch of botany, and to whom I am personally under obligation for repeated contributions of valuable specimens."

CHAUVINIA Harvey (Delesseriaceae), Phyc. austr. 4, pl. 240 and accompanying text. 1862.

versus

Chauvinia Bory, Cryptogamia, in L. I. Duperrey, Voyage autour du monde, . . . , la Coquille, . . . , 2 (1): p. 204. 1829.

Vinassaella De Toni fil., Not. nomencl. alg. VII, p. [5], 1936.

Type species: *Chauvinia coriifolia* (Harv.) Harv. (cf. Kylin, 1924, pp. 12–13).

When Harvey described his genus *Chauvinia* in 1862, he credited it with three species, viz., *C. imbricata* (Aresch.) Harv. (= *Delesseria imbricata* Areschoug), *C. Hookeri* (Lyall) Harv. (= *Delesseria Hookeri* Lyall) and *C. coriifolia* (Harv.) Harv. (= *Delesseria coriifolia* Harvey). In the course of time, *Chauvinia imbricata* was removed by J. Agardh (1898, p. 174) to his newly established genus *Phitymophora,* where it serves as the lectotype of the genus (cf. Kylin, 1924, p. 13) and *C. Hookeri* was made by Kylin (1929) the type of a new (and at that time monotypic) genus, *Laingia.* Through the principle of residue, *Chauvinia coriifolia* thus came to serve as the type of *Chauvinia,* despite the fact that Schmitz in 1889 had designated *C. imbricata* as the lectotype of the genus.

Although J. Agardh (1898, p. 148) and Kylin (1924) seem to have overlooked the fact that Schmitz had designated *Chauvinia imbricata* as the lectotype of *Chauvinia,* there is considerable justification for their selection of *C. coriifolia* as the type of this genus. *Chauvinia* was, to be sure, established by Harvey in connection with his account of *C. imbricata* in 1862, but he had already, in 1860, in connection with his account of *Delesseria coriifolia,* come to realize the desirability of creating a separate genus for this species and *D. Hookeri.* To avoid the substitution of a new name for *Phitymophora,* it thus seems best to follow J. Agardh and Kylin in their choice of *Chauvinia coriifolia* as the type of *Chauvinia.* When J. De Toni (1936) substituted the name *Vinassaella* for *Chauvinia,* he also accepted *C. coriifolia* as the type of the genus.

Inasmuch as *Chauvinia* Bory (1829) is synonymous with *Caulerpa* Lamouroux (1809), there appears to be no obstacle to the continued use of *Chauvinia* Harvey and it is proposed that this name be considered for conservation. In addition to *C. coriifolia, Chauvinia* at present includes a species recently described by Børgesen (1945) under the name *C. Jadinii.*

POLYNEURA Kylin (Delesseriaceae), Delesseriaceen 33. 1924.

versus

Polyneura J. Agardh, Anal. alg., contin. 5: 58–60. 1899.

Type species: *Polyneura Hilliae* (Grev.) Kylin (*loc. cit.*).

The genus *Polyneura* Kylin (1924) has received general recognition, and it would be advantageous to conserve this name against the earlier homonym of *Polyneura* J. Agardh (1899).

This monotypic genus of J. Agardh was established on a species, *P. californica* J. Agardh, which Setchell and Gardner (1903, p. 304) have found to be representative of *Erythrophyllum* J. Agardh (1872), viz., *E. delesserioides* J. Agardh. The existence of the name *Polyneura* J. Agardh was brought to my attention by Mr. David Erskine of the University of California and I thank him for kindly agreeing to the inclusion of *Polyneura* Kylin in the present list of names proposed for conservation.

Martensia Hering (Delesseriaceae), Ann. and Mag. Nat. Hist. 8(49): 92. 1841.

versus

Martensia Giseke, Prael. 207, 227, 249. 1792.

Hemitrema R. Brown, in S. L. Endlicher, Mant. bot. sistens gen. pl., suppl. 3: 50. 1843.

Mesotrema J. Agardh, Öfvers. K. Sv. Vetensk.-Akad. Förhandl. 11: 110. 1854.

Capraella De Toni fil., Not. nomencl. alg. VII, p. [3]. 1936.

Type species: *Martensia elegans* Hering.

J. De Toni in 1936 drew attention to the fact that the algal genus *Martensia* Hering (1841) was illegitimatized by *Martensia* Giseke (1792), a genus of flowering plants, and he accordingly proposed the name *Capraella* for the genus of algae. Papenfuss (1942) pointed out, however, that the name *Mesotrema* J. Agardh (1854) was available for the genus of algae. *Hemitrema* R. Brown (1843) is illegitimate since it is based on isotype material of the type species of *Martensia* Hering, *M. elegans,* and was nomenclaturally superfluous when published [Int. Rules Bot. Nomencl., Sec. 12, Art. 60(1)].

In view of the fact that *Martensia* Giseke is a synonym of *Alpinia* Linnaeus (1753) and since *Martensia* Hering, named in honor of Dr. Georg Matthias von Martens, the author of "Die Tange der preussische Expedition nach Ost-Asien", has for more than a century been the accepted name for a very remarkable genus of reticulate algae (of some eight species), which has become well known through the monographic account of Svedelius (1908), it is proposed that *Martensia* Hering be considered for conservation.

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A CHANGE IN STATUS OF A MALVASTRUM FROM BAJA CALIFORNIA, MEXICO

Ira L. Wiggins

In September, 1929, the late John W. Gillespie and I collected an attractive species of *Malvastrum* a few miles north of Ensenada, Baja California, Mexico. It was strikingly different from any representative of the genus growing in San Diego County, California, less than one hundred miles to the north. When we returned to Stanford University a description was written, a plate made to illustrate the "new species" and then, fortunately, the description and drawing were laid aside until a thorough check of types in eastern herbaria could be made. The scope of the research problem begun in 1929 had to be changed, and the *Malvastrum,* growing outside the confines of the Sonoran Desert, was not compared with types until recently. Dr. Reed C. Rollins has kindly permitted me to borrow the type of Asa Gray's *Malvastrum marrubioides* var. *paniculatum*. The plant collected in 1929 belongs to the same entity, but for reasons that will be discussed below it seems advisable to elevate the "variety" to specific rank. Accordingly the following new combination is proposed.

Malvastrum paniculatum (Gray) comb. nov. *Malvastrum marrubioides* var. *paniculatum* Gray, Proc. Am. Acad. 22: 290. 1887.

An erect or ascending openly branched shrub 1–2.5 m. tall, with stoutish, densely stellate-tomentose branches, the tomentum pale tawny to brownish; petioles 4–10 (or rarely to –15) mm. long, densely tomentose and somewhat scurfy; leaf-blades ovate to pentagonal-ovate, obscurely to distinctly 3-lobed, 1.5–4 cm. broad, 2–5 cm. long, or those on vigorous young shoots 8–10 cm.

long, irregularly and rather coarsely dentate, prominently veined beneath, slightly rugose with impressed veins on the upper surface, densely stellate-tomentose with grayish to tawny hairs on both surfaces, the lateral lobes usually rounded, the terminal one acute to rounded, the teeth broadly deltoid and rounded or coarser and acute; inflorescence paniculate, rather open, often 3–5 dm. long; peduncles and pedicels slender, about 0.3–0.5 mm. in diameter, to 6 cm. long, at first densely stellate-tomentose, but eventually scurfy and subglabrate; bracts 1–3, filiform-subulate, 3–4 mm. long; calyx-cup broadly turbinate-campanulate, 3–4 mm. deep and about as wide at anthesis, densely tomentose; calyx-lobes broadly cordate-ovate, abruptly attenuate, 6–8 mm. wide, 6–15 mm. long, distinctly veined, stellate-tomentose without, silky-villous within; corollas pale pink to deep rose, the petals 10–15 mm. long, narrowly obovate and more or less emarginate or rounded at the apex, cuneately narrowed to the base, the claws hispidulous at the base; stamineal column about two-thirds as long as the petals, nearly glabrous; fruit depressed-globose, 3–4 mm. high, 5–6 mm. broad, the carpels obovoid-reniform, rounded and densely stellate-tomentulose dorsally, dehiscing the full length; seeds 1.5–1.8 mm. long, dark brown, minutely and irregularly puberulent in broken patches, sparsely and minutely papillate between the puberulent patches.

Specimens examined. Baja California, Mexico: Ensenada de Todos Santos, July 14, 1885, *C. R. Orcutt* (type, Gray Herb.); on banks of small ravine, 6 miles north of Ensenada, *Wiggins* and *Gillespie 4013;* slopes of a small canyon 5 miles west of Ojos Negros, *Wiggins* and *Gillespie 4079;* arid ridge 20 miles east of Ensenada on road to Ojos Negros, *Wiggins 11,869.*

The type of *Malvastrum marrubioides* var. *paniculatum* is an ample specimen consisting of flowering and fruiting branches about 5 dm. long, twice folded to fit on the herbarium sheet. It had originally been labeled "*Malvastrum foliosum,* Watson" but in Gray's characteristic handwriting is the annotation, "*Malvastrum marrubioides* var. *paniculatum* n. var."

When Gray published var. *paniculatum* he did so in a footnote to a paper dealing with a number of genera being worked on in connection with the preparation of his "Synoptical Flora of North America." He furnished a very brief characterization that read "having copious and loosely paniculate flowers, some of them rather slender-pedicelled."

Gray's examination of Orcutt's specimen may have been hurried, or he may have remembered incompletely the characters of *M. marrubioides* Durand & Hilgard, for the plant from Ensenada bears only a superficial resemblance to *M. marrubioides.* The latter, the type of which I have examined critically, has ovate to suborbicular leaves with serrate-dentate margins, the teeth being sharply acute and often twice as long as broad; bractlets beneath

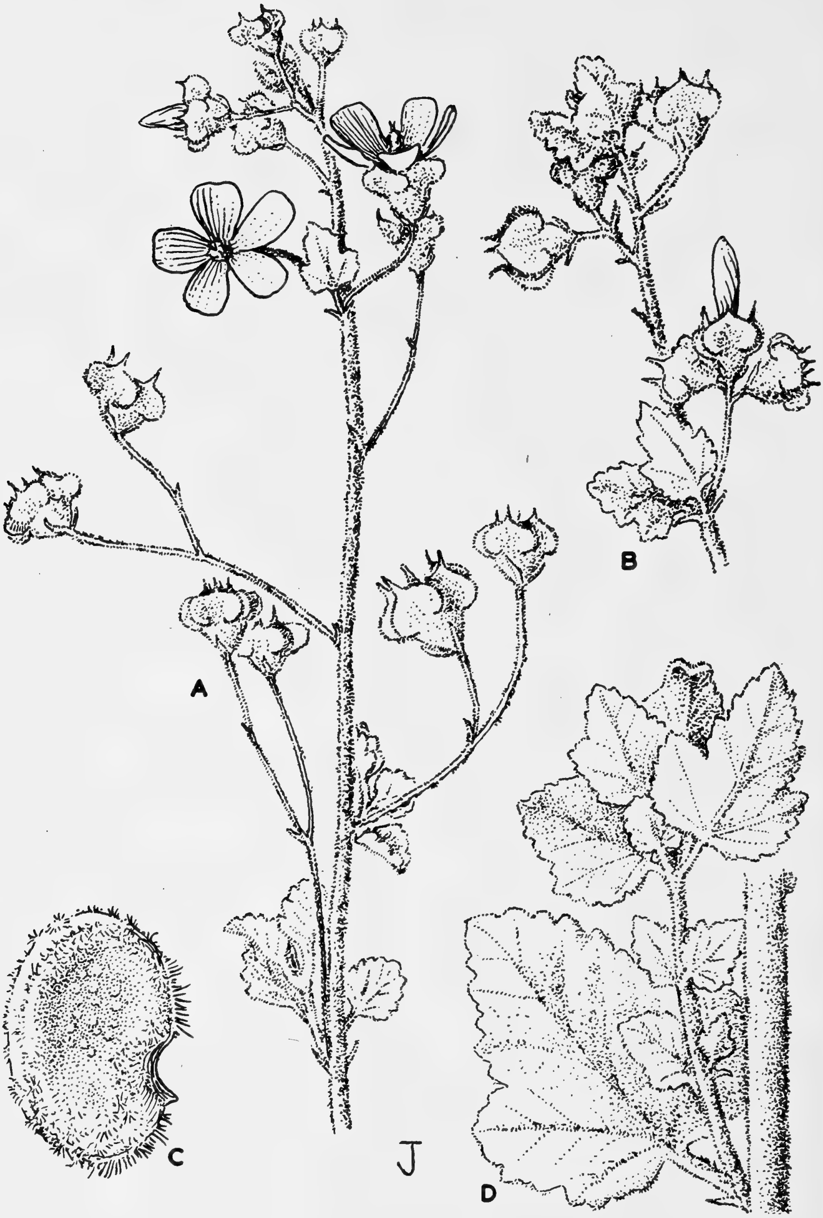

Plate 12. Malvastrum paniculatum. Figs. A–B, habit of flowering branches, ×1. Fig. C, seed, ×19. Fig. D, leaves, ×1. (Drawing by Mrs. Carl Janish.)

the calyces 8–18 mm. long and often equalling the calyx-lobes; calyx-lobes merely lance-ovate and not cordate. The carpels of *M. marrubioides* are closely invested with erect hairs on the upper surface, while those on the carpels of *M. paniculatum* are appressed and nearly parallel to the surface. In view of these differences between the two plants it seems that specific rank should be accorded the population to which Gray gave only varietal recognition. None of the material from the United States has pedicels as slender as those possessed by *M. paniculatum* and none of the material of *M. marrubioides* from the interior foothills of southern California and from the eastern side of the San Joaquin Valley exhibits the abruptly flaring, cordate calyx-lobes developed in *M. paniculatum* and shown in the accompanying figure.

In the same paragraph in which Gray proposed var. *paniculatum* he relegated *M. foliosum* S. Wats. (Proc. Am. Acad. 20: 356. 1885) to the synonymy of *M. marrubioides* Dur. & Hilg. An examination of the type of *M. foliosum* S. Wats., shows that it has the leaf-pattern of *M. densiflorum* S. Wats., rather than that of *M. marrubioides*. *Malvastrum foliosum* may be a race of *M. densiflorum*, but certainly it is not conspecific with *M. marrubioides*. On the basis of the material examined to date, I prefer to recognize both *M. paniculatum* and *M. foliosum* as distinct species.

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A NEW SPECIES AND SUBGENUS OF ATRIPLEX FROM SOUTHWESTERN COLORADO

William A. Weber

The genus *Atriplex* in the Chenopodiaceae is characterized, in part, by the presence of a pair of bract-like organs which enclose more or less permanently a single carpellate flower. The carpellate flower, moreover, lacks a perianth except in a very few species. These species fall into two groups, (1) the Eurasian section *Hortenses* in which some of the carpellate flowers are ebracteolate and are provided with a regular 3–5-lobed herbaceous calyx, and (2) the North American section *Endolepis* in which the carpellate flowers are provided with a calyx of hyaline scales.

Hall and Clements (The phylogenetic method in taxonomy. The North American species of Artemisia, Chrysothamnus, and Atriplex. Carnegie Inst. of Wash. Publ. No. 326. 1923) divided the North American species of *Atriplex* into the two subgenera *Euatriplex* and *Obione,* and postulated the characters which might be combined in a primitive stock from which the subgenera were derived. This primitive stock, according to Hall, would have an inferior radicle, and would have a perianth present both in staminate and pistillate flowers. The present paper records the discovery of a species of *Atriplex* which embodies these and other primitive characters.

The proposed new species was collected in the spring of 1949 on a botanical survey of the "Four Corners" area of southwestern Colorado which was sponsored by the University of Colorado Council on Research and Creative Work. This area is one that is noteworthy for the extreme localization of the species inhabiting it. The season was an especially good one for the collection of ephemeral desert annuals. One small colony of a few hundred individuals of the new species was found on an extremely barren gray clay mesa slope uninhabited by any other species except *Phacelia demissa* A. Gray. The two species grew in adjacent stands and were superficially very similar in habit, stature, and foliage characters.

In addition to the two characteristics stated above, the proposed species possesses the following attributes which Hall asserted to be primitive or generalized in *Atriplex;* bracts soft, herbaceous, widest below the middle, free to the base or nearly so; plants monoecious, with flowers of each sex mixed together in small axillary clusters; herbaceous habit. The new species also possesses a primitive feature of considerable phylogenetic importance which Hall did not anticipate, namely, the inclusion of several carpellate flowers (i.e., an entire branch of an inflorescence) within a pair of bracts. Occasional pairs of bracts were found to surround from one to two pairs of similar but smaller bracts, each in turn enclosing from two to four carpellate flowers. This evidence supports the viewpoint that the bracteal structure of the carpellate flowers of *Atriplex* represents a greatly modified and reduced inflorescence in which the bract-pairs are homologous to the floral bracts of a complex dichasium. The shape and the absence of fusion of the bracts, the inferior position of the radicle, and the annual habit suggest a close relationship with the section *Hortenses*. The nature of the carpellate perianth suggests some relationship to the section *Endolepis*, the members of which, however, differ from the new species in certain fundamental respects, such as the superior radicle and united bracts. In the author's opinion, the combination of characters exhibited by the new species is unique and necessitates (1) an expansion of the definition of the genus *Atriplex* to include the several-flowered carpellate bract-pairs, and (2) the recognition of a third subgenus for Hall's primitive stock, exemplified by the present species. This subgenus is here proposed.

Subgenus **Proatriplex** W. A. Weber, subgen. nov. Radicula inferior. Perianthium et in floribus staminatis et in carpellatis adest. Bracteae usque ad basin liberae plerosque flores carpellatos includentes.

Radicle inferior. Perianth present in both staminate and carpellate flowers. Bracts free to the base, enclosing several carpellate flowers.

FIG. 1. *Atriplex pleiantha* Weber, type specimen.

Atriplex pleiantha sp. nov. Herba annua monoica erecta glabra vel rare farinosa paene ex basi ramosissima 0.5–1.5 dm. alta caule foliisque subsucculentis; rami ascendentes albi vel plerumque subrufi; folia plura alterna integra succulenta petiolis 0.5–1.0 cm. longis laminis ovatis vel suborbicularibus 5–15 mm. longis apice obtusissimis et per gradus in contraria acutis basi eodem modo cuneatis vel truncatis; flores staminati et carpellati in inflorescentia immixti aut flores staminati in spicas breves terminales moniliformes collecti; stamina florum staminatorum 5, segmentis perianthii opposita affixa; bracteae florum carpellatorum trianguli-ovatae brevi-petiolatae integrae 3–7 mm. latae et longae apice obtusae vel mucronatae ad basin ipsam tantum conjunctae, margine superiore cilia inflexa aliquot ferente, binis bracteis quibusque 2–6 flores carpellatos includentibus demum cupulam fingentibus; perianthium florum carpellatorum manifestum squamis 5 hyalinis lanceolatis vel oblanceolatis rare ciliato-marginatis in cupula permanentibus 1.0–1.2 mm. longis consistens; utriculus suborbicularis compressus ater glaber et fulgens 1.5 mm. longus, maturatus discedens, non in perpetuum in bracteis inclusus; semen verticale; radicula inferior.

Erect annual herb, much branched from near the base, glabrous or sparsely farinose, 0.5–1.5 dm. tall with rather fleshy stem and foliage; branches ascending, white or commonly reddish; leaves numerous, alternate, entire, fleshy, the petioles 0.5–1.0 cm. long, the blades ovate or suborbicular, 5–15 mm. long, very obtuse to acute at the apex, cuneate to truncate at the base; flowers monoecious, the staminate and carpellate mixed in the inflorescence or the staminate grouped into short terminal moniliform

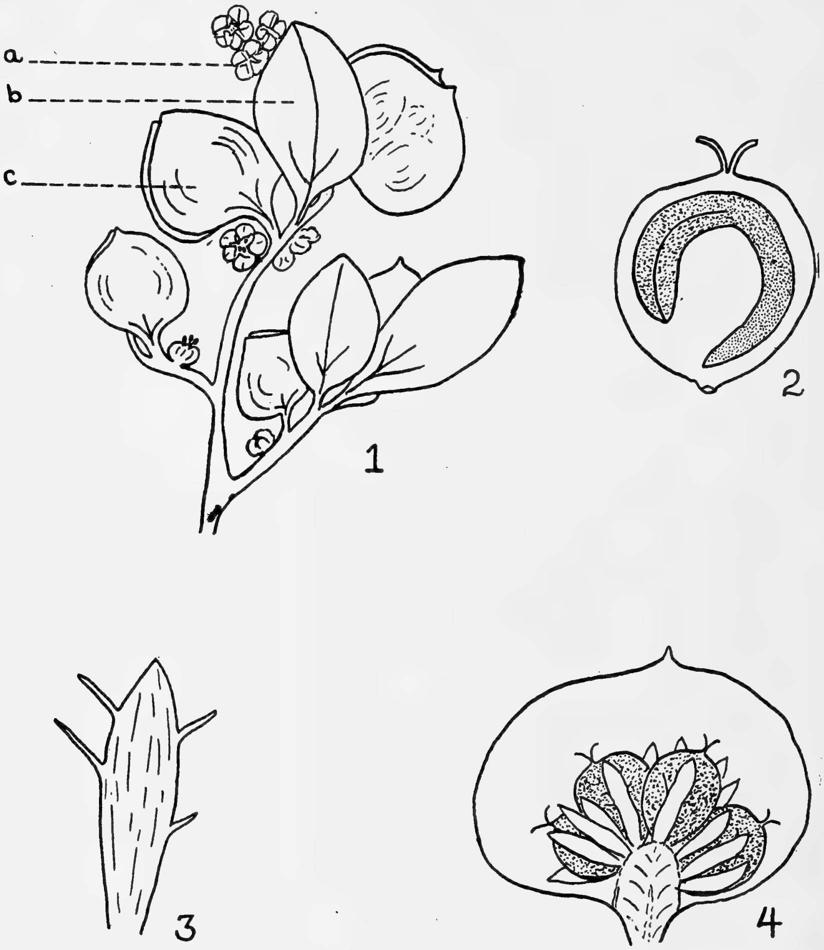

Fig. 2. *Atriplex pleiantha* Weber, *1,* portion of plant (×5), showing *a.* staminate flower, *b.* leaf, *c.* bract of carpellate flower cluster; *2,* gynoecium showing position of embryo (×15); *3,* perianth segment of carpellate flower (×30); *4,* diagrammatic representation of ventral view of bract showing enclosed cluster of carpellate flowers (×6).

spikes; stamens of staminate flowers 5, opposite the perianth segments; bracts of carpellate flowers triangular-ovate, short-petiolate, entire, 3–7 mm. broad and long, obtuse or mucronate at apex, united only at the very base, usually bearing a few inflexed cilia on the upper margin, each pair of bracts enclosing from 2 to 6 carpellate flowers; perianth of carpellate flowers well-developed, consisting of 5 hyaline, lanceolate or oblanceolate, sparsely ciliate-margined scales, 1.0–1.2 mm. long, persistent in the cupule formed by the bracts; utricle suborbicular, compressed, black, smooth and shining, 1.5 mm. long, falling free at maturity, not permanently enclosed within the bracts; seed vertical; radicle inferior.

COLORADO. Montezuma County: barren clay slope of mesa, northeast of trading post on Mancos River a few miles above its junction with the San Juan River, ca. 27 mi. southwest of Towaoc, Ute Indian Reservation (Township 32 N., Range 19 W., Section 17), June 12, 1949, *W. A. Weber 4788* (type, Univ. of Colorado Herb.; isotypes, Gray Herb., Pomona College Herb., U. S. Nat. Herb., Univ. of California Herb.).

The writer wishes to express his appreciation to Dr. John Hough for preparation of the Latin diagnoses.

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REVIEW

Marin Flora, Manual of the Flowering Plants and Ferns of Marin County, California. By JOHN THOMAS HOWELL. University of California Press, Berkeley and Los Angeles, California. vii + 1–323 pp., frontispiece, plates 1–24, maps 2. 1949. $4.50.

Among the symptoms of approaching maturity of the science of Botany in California are the number of semi-popular and popular local floras that are beginning to appear for various regions of the state. The latest is "Marin Flora" by John Thomas Howell of the California Academy of Sciences. Such works serve a very useful purpose for the professional botanist as well as for the layman and naturalist. They become a detailed historical record of the composition and condition of a flora which through the activities of man is destined to become irrevocably altered with time.

The first twenty-eight pages deal with a discussion of descriptive ecology and plant geography as these appear to relate themselves to the physical features of the area. The lists of plants comprising the various plant associations should prove very useful to ecologists in both the plant and animal fields. It is not to be expected that all ecologists and plant geographers will agree with Mr. Howell's conclusions. It must be borne in mind that in so far as we are able to deal with such problems today, we must rely largely upon interpretation of the innumerable and varied interrelated facts for our conclusions in ecology and plant geography. This being the case, it is important that as many points of view be presented as possible. Mr. Howell presents the point of view of one intimately acquainted with the detailed occurrence of the known species of plants over the area, and of one who has contemplated the details of their local variation. There follow four pages containing a brief resume of the botanical history of the area and including a fitting tribute to the place of Miss Alice Eastwood and the California Academy of Sciences in this history.

The taxonomic section, which represents the bulk of the work, is a scholarly treatment replete with critical notes on variation, ecology, and nomenclature. It is obvious that Mr. Howell's taxonomic conclusions are his own conclusions and not compiled from the taxonomic treatments of others. However, where his conclusions deviate considerably from those of others, they are accompanied by a compelling argument or an explanatory statement. Of the 1,313 species included in the flora, 309 are non-native introduced plants which have become established in this area. In Jepson's "Manual of the Flowering Plants of California" published in 1925, there are included 4,019 species for the entire state, of which 292 are considered to be "alien immigrants." The large proportionate number of introduced plants reported for Marin County reflects Mr. Howell's keen interest in this aspect of botany as well as the changes which have taken place in the flora during the past twenty-five years. The two works, "Marin Flora" and "Ferns and Flowering Plants of Mount Diablo," by Dr. Mary Bowerman, taken together, cover much of the flora of coastal central California. We who habituate this area are indeed fortunate in having two such excellent treatments of its flora.

The twenty-five black and white photographs from the camera of Charles H. Townsend portray the beauty and variety of plant associations and specimen trees that are to be found in Marin County. Two outline maps prepared by Malcolm G. Smith give general localities in Marin County and the trails and localities on Mount Tamalpais. Both maps are indexed; so the newcomer to Marin County will have no difficulty in orienting himself. Much of the glossary of some 380 terms is expressed in refreshingly original language.

As the flora of Marin County is presented by Mr. Howell, it must be construed as a semi-popular work in what I would say is a most successful style. He injects just enough personality to make it very readable. Obviously, when dealing with technical material, it is impossible to reduce all of it to popular language. Mr. Howell, however, draws a very dignified balance between the technical material and popular presentation.—Herbert L. Mason, Department of Botany, University of California, Berkeley.

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Contents

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TAXONOMY, SYSTEMATIC BOTANY AND BIOSYSTEMATICS

Herbert L. Mason

Before me are copies of several works in which are used the terms "Taxonomy," "Systematic Botany," "Biosystematics," and "Experimental Taxonomy." They include works by such authors, among the botanists, as Linnaeus (1753), De Candolle (1813), Lindley (1830, 1853), Le Maout and Descaisne (1876), Radlkofer (1883) and his student Solereder (1899), Engler and Gilg (1924), Wettstein (1924), Hall and Clements (1923), Bremekamp (1939), Turrill (1942), Gilmour and Turrill (1941), Benson (1943), Clausen, Keck and Hiesey (1939, 1940), Camp and Gilly (1943), and among the zoologists such writers as Dobzhansky (1941) and Ernst Mayr (1942). I seek an understanding of the scope of Plant Taxonomy in terms of its organization, the sources of its materials, its research methods and its objectives. More particularly, I seek to understand whether Taxonomy, Systematic Botany and Biosystematics have any separate and independent standing or whether they are to be regarded as wholly or partially synonymous with each other. For the most part, I am not searching for definitions: I am interpreting usage, oftentimes over and above, or in spite of definition, for it is usage and the history of usage that ultimately molds the meanings of our words and terms. I am familiar with the current concepts of plant taxonomy and how its scope and its methodology have grown with the advancement of the science of Botany. I know the confusion in the literature, and in the minds of botanists, between the terms "Taxonomy" and "Systematic Botany." And I have grown up along-side of Biosystematics and have shared the enthusiasm of its workers, am aware of its values, and know something of its limitations. Let me make it clear that I write not as an authority who would seek to impose what may seem to be his somewhat arbitrary views upon the uninformed but rather as one who has given the subject long and serious thought and who now wishes to present his tentative conclusions to open forum for discussion.

The word "taxonomy" was given us by the elder De Candolle. He used it as a heading for a part of "Theorie Elementaire" with the subheading "Theorie de Classification," a phrase which he presented in the text as a definition of taxonomy. However, he oriented the principles of taxonomy toward seeking a basis of resemblance (symmetry) among plants in order to explain their "relationship." Relationship was thought of solely in terms of the community of characteristics that accounted for resemblance. His principles, although not entirely acceptable today, were largely those of a systematic approach to comparative morphol-

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ogy, chiefly organography. In later chapters, he discussed natural arrangement, the concept of the taxonomic categories, and phytography, which has been termed the art of description, and included in it what we today term nomenclature and synonymy. Thus the classical taxonomy was concerned with classification and the establishment of relationship and used as its major tools comparative (systematic) morphology as the source of fact, a system of taxonomic categories, a system of nomenclature, and precise description.

There is no doubt but that the tangible product of the labors of such men as De Candolle was a system of classification, but in view of the principles outlined by him and the logic of their arrangement, it is also perfectly clear that the system of classification did not stand as the end and objective of taxonomy but rather through its arrangement into a system of inclusive categories, and its nomenclature it served as the vehicle of expression of the relationship that the taxonomist sought to depict. Thus the system of classification, rather than solely an end, is also a tool of the taxonomist. It is his working hypothesis. It seems clear then that from the beginning of taxonomy, the stage was set for a clear differentiation between the overall objectives of taxonomy and the tools it fashioned and established to achieve its ends. These tools included a source of, and a method of arriving at facts, and a method of presentation or arrangement of these facts to express the relationships among plants. Thus from the beginning Taxonomy was a synthesis of facts into an expression of botanical interrelationships.

I have not as yet established just where and with whom the term "Systematic Botany" originated. From its early use, it must have followed very closely upon the term "taxonomy" and might possibly have even preceded it. Lindley used it in 1830 but seems not to have mentioned it in the 1853 edition of "The Vegetable Kingdom" in which he gave an elaborate survey of the history of taxonomy. Certainly the term "systematic" pertained to the "System" and presumably the "Natural System." Its early use seems to have been as a casual self-evident term, but later definitions associated it with seeking the evidence of relationship and this must mean the relationship that is associated with community of characters rather than the phylogenetic relationship which followed the theory of evolution. It was not until the effective application of the methods of the plant anatomists to taxonomy under the impetus of Radlkofer that we find the term used with enthusiasm. Here, quite definitely, it was used in the sense of a "new Taxonomy" with Systematic Anatomy as its major tool. Taxonomy, however, is ageless; there is no old and no new Taxonomy. There are, however, new methods of arriving at facts and new integrations possible from time to time and it is these new methods that constitute the new Taxonomy of succeeding generations of botanists. Radlkofer and his students defined "Systematic Botany" much in the sense we have outlined Taxonomy as established though usage by De Candolle and his contemporaries. These plant anatomists, however, emphasized arriving at relationships and left for Taxonomy only classification and nomenclature. They glorified the anatomical method as the true method of determining relationship yet, in effect, many but not all of them accepted the system of the early taxonomist and in an orderly manner built up an enormous volume of fact about each systematic group of plants without at the same time utilizing these facts to establish relationship. The type example is the magnificent work of Solereder, "The Systematic Anatomy of the Dicotyledons." Here the anatomical method is not used to build a system of classification, as one would suppose from Solereder's introduction, but rather the working hypothesis of Bentham and Hooker was accepted as a method of approach to the subject of Systematic Anatomy. Solereder's work stands in its own right as a solid and valuable contribution to Plant Anatomy and to Taxonomy. If we accept the usage of Solereder, this is his Systematic Botany in spite of his definition, and it can be put to any use to which the facts of Comparative Anatomy may be utilized. Such a Systematic Botany is enormously valuable to Taxonomy by virtue of the accumulation of facts along a systematic pattern. It is "systematic" primarily by virtue of canvassing, however thoroughly, the anatomical features of the system. It is a method of arriving at comparable facts and is indispensable to the taxonomist in testing his hypotheses. Whereas it can and must be utilized to the fullest by the taxonomist, it certainly is not synonymous with Taxonomy.

Because of the confusion in the literature relative to the terms Systematic Botany and Taxonomy, it may seem now to be a matter of arbitrary choice as to which we shall accept for the classical Taxonomy. I would choose the older term "Taxonomy" for this role for, if we accept the term Taxonomy in the sense of the usage of those who use "Systematic Botany" in the broader sense, then what is here considered under the heading of Systematic Botany will either have to be considered under Taxonomy, in a restricted sense, or a new term created for it. It is desirable to keep it separate because its conclusions are wholly objective and fully documented in contrast to those aspects here considered under the Taxonomic System, which are almost wholly subjective and involve interpretation in terms of concepts of taxonomic categories and of phylogenetic series of morphological characters. Systematic Botany, as I see it, involves research techniques and a research point of view that uncovers facts which may also be utilized independently of any taxonomic usage. I have found no evidence that Taxonomy ever has been used in this particular restricted sense while certainly Systematic Botany was so used even though the authors who so used it defined it in a broader sense, a sense they did not adhere to in their own work.

With the development of the various branches of Botany to the point that a systematic approach to their problems will yield fruitful results, there will be an increasing need for the term "Systematic Botany," used in the precise sense in which Solereder em-

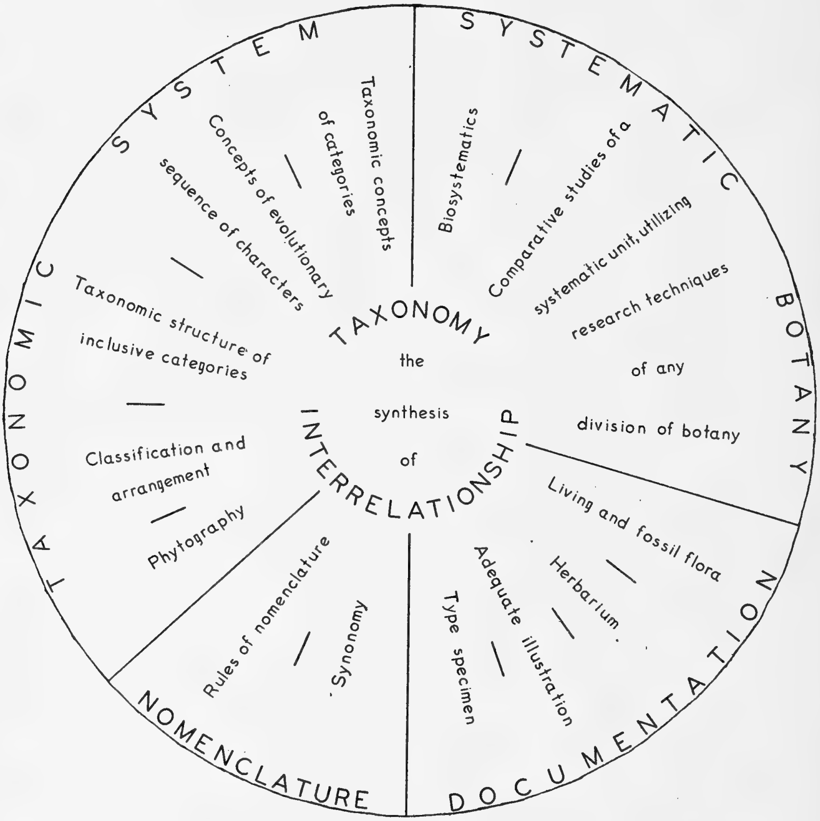

FIG. 1. The organization of the science of Taxonomy. Four fields are represented. The field of research and investigation (the fact-finding processes) are centered in Systematic Botany. The facts so determined are assembled and classified according to concepts of the evolutionary sequence of characters and organized into the series of inclusive categories. These categories are then arranged in the taxonomic structure in such a way as to give expression to the pattern of relationship. A system of nomenclature is employed according to rules, and superfluous names are relegated to synonymy. The botanical facts and the nomenclature are documented by 1) the flora of living and fossil plants, 2) the herbarium, 3) the type specimen or, 3a) by adequate illustration. Each segment of the diagram constitutes a significant tool of Taxonomy and plays a part in this synthesis of interrelationship.

ployed it. Already we see evidence of a rapidly formulating Systematic Cytology and a Systematic Genetics. Some significant beginnings have been made in a Systematic Biochemistry. "Comparative Botany" (Comparative Anatomy and Comparative Morphology, etc.) is not adequate to the needs of Taxonomy unless it presents a systematic comparison. The comparison, to be significant, must be throughout a systematic group. The connotation of a "systematic group" is significant to the concept of Systematic Botany and of Taxonomy because of the implication of relationship. It is an implication that the systematic approach to a basic discipline is designed to test. The systematic approach to each of the divisions of Systematic Botany will yield documented facts that may be of use to the taxonomist in his synthesis of interrelationships. They constitute the materials for a method of pitting the facts of one discipline against those of another to test hypotheses of relationship. We may define Systematic Botany as the comparative study of any related (systematic) group of plants utilizing the research techniques of any of the divisions of botany. In contrast, Taxonomy is the synthesis of all of the facts about plants into a concept and expression of the interrelationships of plants. Systematic Botany is its major source of botanical fact.

At the time of De Candolle, only Comparative Organography had accumulated a sufficient body of fact and methodology about it to enable systematic studies to be fruitful. Later, Comparative Anatomy reached a point where certain additional but limited systematic approaches were available. It was not until near the end of the first quarter of the current century that Cytology and Genetics jointly found themselves in a position to approach their field from the point of view of systematics, and Taxonomy finds the results of this work of very great significance. Further advances in the investigations of the vascular anatomy of flowers and of the anatomy of stems and leaves have provided new facts and methods of value to Taxonomy. It is significant that the theory of evolution completely revolutionized the point of view in Taxonomy and gave direction and clear meaning to the concept of relationship but it did not immediately provide additional facts. It resulted only in the reconsideration of those facts already established. Since community of characteristics serves as the evidence of relationship under the evolutionary concept as it did under the natural systems, certain putatively phylogenetic systems differ little from the older natural systems, and all are strikingly alike in many of their details. The chief differences between modern systems result from differences in point of view in interpreting developmental trends in the evolution of morphological characters.

It should be pointed out that Taxonomy can advance only to the extent that the basic fields of research in botany upon which it rests have accumulated documented, comparable facts of utility to the taxonomist. Should these fields go to sleep or fail to awaken, Taxonomy must also sleep. During such times, Taxonomy may be brought up to date but it cannot advance.

There has recently come into prominence a new term, namely, Biosystematics, and it has been hailed as the "New Taxonomy," as appears to have been the case with the term "Systematic Botany" that preceded it. This over-emphasis arises out of the enthusiasm of its workers for the impetus that it has provided to Taxonomy. And like the early anatomists, some of the biosystematists are convinced that this is Taxonomy and that there is no other adequate approach to Taxonomy. Thus, some would take unto Biosystematics the classical objectives of Taxonomy and again leave only classification and nomenclature to Taxonomy and to Systematic Botany. I think that it is now clear that Biosystematics is a valid and very important aspect of Systematic Botany as here outlined and, as such, a significant tool of Taxonomy. It, however, is on the plane of integration as well as of comparison. It utilizes Comparative Cytology and Comparative Genetics. It seeks to determine relative crossability and relative intersterility and seeks an analysis of the genetic constitution of natural and potential interbreeding populations. It attempts to classify the genetic units of such populations in terms of the cytogenetic phenomena that initiate them, the isolating mechanisms under whose sanction they develop and the nature of the environmental forces that permit their survival. To this end, it uses such terms as ecospecies, ecotypes, ecoclines and cytotypes, though this terminology is as yet a long way from being settled as to its precise role in Biosystematics. Since these same genetic and cytological phenomena are responsible for the morphological and physiological character of the individuals that make up natural populations, Biosystematics is sometimes fittingly spoken of as "studies in the nature of species" and its dynamics are often spoken of as "speciation." It approaches the ideal Taxonomy when it seeks to establish phylogenetic relationship among the members of a genus. It is our only means of establishing true genetic relationship.

This brings up the point as to the difference between phylogenetic relationship of the taxonomist, and genetic relationship as construed by the geneticist. Phylogenetic relationship is the system of genetic lineages that have brought us our species populations as they exist today. Its interpretations are drawn from the irretrievable past. It is the field of relationship that is of major concern to the taxonomist and he would like nothing more than to be able to reconstruct the pattern of genetic lineage that has been traversed. The phrase "genetic relationship" etymologically means precisely the same thing as phylogenetic relationship. As this phrase is used by geneticists, however, it means more than that. It includes also, in effect, the entire genetic potential of related species populations, the known facts of which are arrived at through manipulation to determine relative crossability and the relative intersterility of progeny. It is concerned with the sum total of genic materials capable of being exchanged and the methods by which this may be accomplished.

The difference is entirely comparable to the difference between genetic relationship and genealogy in any randomly selected group of people or between the races of man. It would require only a relatively few generations of carefully supervised mating to mix thoroughly the gene pattern available. It would require an enormous number of generations back through time to reach a point of common genealogical origin for the individuals or the groups. Obviously such groups are more closely related genetically than they are genealogically. Similarly is it possible for certain species, subspecies or populations to be more closely related through genetic potential than they are related phylogenetically. The taxonomist cannot operate in the field of potential situations. He must therefore draw a careful line between the dynamics of the past and those of the future. He can use genetic facts of the present where they shed light upon the dynamics of the past but he must leave the future to the elements of chance that may build natural populations under the sanction of a selective natural environment. When these are accomplished, he will have additional material for his synthesis. A case in point is evidence indicating the close genetic but distant phylogenetic relationship of *Platanus orientalis* L. and *P. occidentalis* L. through their fertile hybrid, *P. acerifolia* Willd. Here the old and new world world parents have presumably been separated at least since Miocene time if not since Cretaceous time and have diverged significantly through genetic processes both morphologically and physiologically so that the taxonomist has recognized in them two species. When brought together artificially, they cross with the production of a fertile hybrid. Some geneticists and biosystematists argue that this is evidence that they should be classed as subspecies of a single species, however remote the phylogenetic ancestry. It is important here to realize that both the morphological and the physiological divergence of these two species are each the result of genetic change, resulting, presumably, from the accumulation of enormous numbers of successive gene mutations or other chromosomal changes. Somehow these did not also involve a sterility barrier, or if they did, a reverse mutation or a compensating mutation that wiped it out may have occurred later. In any event, no one has demonstrated that the progeny can or will establish themselves in a natural stand and serve as a bridge for the persistent exchange of genes between the two parents. This is an interesting case but let it be emphasized that the taxonomist cannot deal in futures. It is obvious that not all of the total genic complement involved in potential genetic situations goes into every lineage. There is no way of predicting how much or what part of the genic complement will be involved in any particular case and whether or not the resulting combination will survive environmental selection. The taxonomist can operate effectively in such cases primarily on morphological, physiological and palaeontological evidence. On this evidence these divergent populations have reached a level of differentiation which permits them to be regarded as taxonomically different and yet there is sufficient evidence of relationship such as permits them to be included in the same genus. Whether they be classed as species or subspecies will depend upon the judgment of the classifier in assessing the role of the two entities in the taxonomic system of the genus. We do not as yet know enough about the nature of sterility barriers or of retained fertility to assess them phylogenetically. We can assess them only in terms of present day genetic potential and genetic opportunity.

It is likewise possible that two entities may be more closely related phylogenetically than the degree of possible gene exchange between them would indicate. Through any of several cytogenetic mechanisms a sterility barrier may be erected isolating one population from another so that no further gene exchange between them is possible. Such a population in its inception may be only one generation removed from the other phylogenetically, yet the genetic barrier between them may be complete. When polyploidy is involved as the cytogenetic mechanism, morphological and physiological differences in the progeny sometimes are achieved that are of such magnitude as to warrant taxonomic recognition. Here, again, the taxonomist is interested not only in the taxonomic rank of the entity but also in the phylogenetic lineage involved over and above the genetic evidence derived from manipulation.

On the other hand, where natural introgression can be demonstrated, it is obvious that we are dealing with the accomplished junction of two lineages in a reticulate pattern of phylogeny. The taxonomist must consider such cases. It seems therefore important for the taxonomist, in adjudging the findings of the biosystematists, carefully to consider in each case whether it is evidence of an accomplished natural fact or of a potential situation whose unfulfilled actuality lies in the nebulous future.

It is possible to work biosystematically only with plants between which genetic manipulation is both possible and practical. This of course limits the sphere of its usefulness enormously. Its usefulness is chiefly on the subspecific level. Often, however, it yields facts that prove eminently useful to the taxonomist in formulating his species concepts. Biosystematics then furnishes another source of facts organized systematically to stand independently in their own right, or some of which may also effectively serve the taxonomist in his synthesis.

Some biosystematists prefer to speak of their field of research as experimental taxonomy. If we can assume that experimentation and manipulation are synonymous, such a term as Experimental Taxonomy might be regarded as validly applied. However, I think most workers regard the results of experiments as strictly objective since experimentation presumably establishes proof or disproof. We may establish proof of genetic relationship in the limited sphere where this is possible. If we can then demonstrate that the genetic relationship is precisely what the phylogenetic relationship has been the term Experimental Taxonomy is a valid one. In the overwhelming majority of cases, however, it is necessary to adjudge the situation in terms of our concepts of phylogeny before assigning taxonomic rank and position. In the postulation of such phylogenetic relationship, we strive toward an ideal through the exercise of judgment. It is doubtful whether judgment, apart from the facts upon which it rests, is subject to experiment. Because of this, most genetic manipulation in Taxonomy falls short of being an experiment.

Another aspect of Taxonomy is what has been termed the taxonomic system. There are many botanists who would regard the system as the ultimate goal of Taxonomy since it provides the basis of classification. There is, however, confusion of concepts evident in this point of view since classification is the basis of building the taxonomic system, rather than the taxonomic system the basis of classification. The taxonomic system may serve as a tool in identification or may serve as a tool of expression of relationship.

It is important to point out that today orders and families are placed in the system not to indicate a lineal sequence of phylogenetic relationship from order to order or from family to family. Rather, these names stand in lieu of combinations of characters, and their arrangement expresses successive modifications of characters thought to have been followed in the evolutionary history of the orders and families. The plant groups as we know them today are obviously the end points in many such phylogenetic sequences built upon a divaricate pattern. What lies before us now is a cross section of the phylogenetic lineages that have resulted in the orders and families as we know them today. How far back in the lineage a given genus or a family or an order may have diverged is now wholly conjectural. It would indeed be hazardous to assume that of two orders arranged in sequence the higher originated in the lower. The utility of the phylogenetic system rests in the fact that by knowing the characters of the orders and families, the botanist can interpret the system and can find an expression of the interrelationship that is construed to exist.

The taxonomic system involves the arrangement of plant groups in a series of hierarchical categories, which I shall refer to as the taxonomic structure. This at once introduces a dual concept as to the meaning and use of taxonomic categories. They may be spoken of in relation to the taxonomic structure, wherein they constitute an arrangement of empty abstract categories, or they may be spoken of in relation to the taxonomic system, wherein we deal with actual plants and animals organized in terms of the categories of the taxonomic structure. When we use the term "species" without reference to any group of organisms under consideration, we are speaking of the abstract category in the taxonomic structure. When we speak of the species of the genus *Pinus,* we are referring to organized entities of the taxonomic system. Because of difficulties involved in attempts at definition of taxonomic categories, it is important that this distinction be kept in mind. The categories of the taxonomic structure involve a series of inclusive groups of different value as one descends from the kingdom through phylum, class, order, family, genus, and species. The wisdom of past experience has dictated that the taxonomist purposely refrain from defining these categories in any way that will impose restrictions on the freedom with which he may express the interrelationships that he construes to exist. However, the inclusive sequence or relative position of the categories with respect to one another is important and is fixed by international agreement (Briquet, 1935). This constitutes a basis for the relative evaluation of the categories. A relationship among plants that one taxonomist may wish to express in terms of three families in one order may be regarded by another taxonomist as better expressed in terms of three separate orders. This constitutes a legitimate difference of opinion wholly consistent with the nature of the facts and with the objectives of taxonomy. The facts necessary for an objective Taxonomy are not at present available except possibly on an exceedingly limited scale. However, in order to organize our materials into a workable system, it has been necessary to bridge the gaps in our knowledge with hypotheses. For this reason, the systems of classification are largely if not wholly subjective. They constitute the working hypotheses of the taxonomist. The hypotheses, however, are not nebulous; they have been based usually upon comparative morphology interpreted in terms of current concepts of what constitutes evidence of relationship and are subject to modification as new evidence from any source may develop. The expressed relationships are mostly incapable of proof, but are subject to personal acceptance or personal rejection by taxonomists. The "empty" categories in the taxonomic structure are incapable of inclusive and exclusive definition in any way that is phylogenetically or taxonomically significant. It therefore seems evident that there can be no absolute system of classification arranged on a structure of clearly defined and precisely evaluated categories. Under these circumstances, the taxonomic structure will better serve the needs of the taxonomist if its categories remain elastic and relative. An illustrative case is presented by *Phlox gracilis* Greene of the Polemoniaceae. During its taxonomic history, it has found a place in *Phlox, Gilia, Collomia, Microsteris,* and *Navarretia.* Professor Wherry, a student of the Polemoniaceae and especially of the genus *Phlox,* sees in this species characters which he deems sufficient to exclude it from *Phlox.* Being informed also on the other genera in the family, he knows that it is not at home in any of these, so he follows the latter decision of Greene and elevates it to the category of a separate genus, *Microsteris.* So long as Professor Wherry construes evidence of relationship as he does, he is absolutely correct in his disposition of this species. I, who also am a student of the Polemoniaceae, see in this species evidence of such close relationship to *Phlox* that I believe that the objectives of taxonomy are better served by including it in *Phlox,* even though it demands subgeneric status in that genus. So long as I construe relationship as I do I am equally correct in placing it in *Phlox.* I think Professor Wherry and I understand each other in this matter. There are no definitions of the genus or of the species, as such, that compel us to unify our treatment. The important point about this example is not what happens to nomenclature and not that two experts disagree. It is rather that each of us is free to express relationships as we see and interpret them in terms of a system of classification and a nomenclature that may be judged by those botanists who may wish to use them. The resultant differences in nomenclature and synonymy serve as tools in the taxonomic system and reflect two concepts of relationship, or five concepts of relationship if we consider the entire synonymy. Taxonomy is obligated to a stable nomenclature only to the point of consistency with its objectives. When synonymies are once worked out and properly cited, nomenclature is stable to anyone who understands the objectives of taxonomy, the use of indices, and the methods of citation. This is little enough to expect of all informed botanists. To many other branches of learning, synonymy is a welcome symptom of the richness of the language. To the taxonomist, it is a tool of expression for his concepts which he hopes will not become unwieldy. The non-taxonomist, it seems, looks upon synonymy as a symptom of the *rigor mortis* of taxonomy.

There have been many attempts by taxonomists and others to define the categories of the taxonomic structure. Many of these attempts rest on an assumption that the category possesses objective reality. And most of these have attempted to define the species category. Their authors, unfortunately, have largely confused concepts involved in definition with concepts involved in characterization as well as concepts of phylogenetic relationship as construed by the taxonomist with those of genetic relationship as construed by the geneticist. The concept of definition involves the circumscription of limits; a definition must be both inclusive and exclusive. I have seen no putative definition of a taxonomic category so worded as to be incapable of application either to the next higher or the next lower category of the taxonomic structure. That which is a species to one taxonomist may be a subspecies to another, and that which is a family to one may be an order to another. This difference of opinion is wholly consistent with the nature of the known facts and does no harm to the objectives of Taxonomy. The empty category of the taxonomic structure has no foundation in reality and obviously cannot be objectively defined. If the category in the taxonomic system has reality, it may be defined only in terms of the particular plants comprising it. It is my personal belief that there is no significant definition possible that can be applied categorically in the taxonomic structure or in the taxonomic system to the total exclusion of the next higher or the next lower category. Taxonomic categories possess only relative values insofar as we are now in a position to understand them. Until they can be made objective, it is best that they remain relative and elastic in their application. The sphere of relativity is solely with respect to the next higher and the next lower category within the immediate sphere of taxonomic relationship. An interpretation as to what constitutes a species of pine has little meaning relative to an interpretation as to what constitutes a species of *Rosa* even though the specific category is used for both. However, within the genus *Pinus* one is more nearly able to develop concepts of comparative evaluation without at the same time being able to fix these values at their precise level in the taxonomic structure to the satisfaction of all. In such a sphere of relationship, it is strictly within the province of sound logic and observable fact for a taxonomist to hold concepts of species which may cause him to be regarded as a "splitter" with one segment of a group and a "lumper" with another. At its worst, lumping is the tool of the superficial and splitting the tool of the uncritical. There are, however, depending upon the nature of the problem, intelligent uses for each procedure that are both necessary and desirable. In most cases, relationship can be expressed only in terms of relative nearness of relationship, and within the plant kingdom all degrees of relationship exist. This situation can be reduced to a system of rigidly defined categories only by arbitrary decisions which result in artificial categories. *Pinus radiata* is a species of a relatively large genus. Because of certain common characteristics which are construed to indicate relationship, this and other pines are aggregated into the genus *Pinus*. *Pinus* differs in several characters from *Abies* and *Tsuga*, but because of certain other common characters, these three genera, along with several others, are aggregated into the family Pinaceae. In a like manner, Pinaceae, Taxodiaceae, and Cupressaceae differ from one another but are grouped with other families under the order Coniferales. Thus the species *Pinus radiata* is only a small part of the genus *Pinus,* the family Pinaceae, and the order Coniferales. *Ginkgo biloba,* on the other hand, is not only the only living species, but is also the living genus, the family, and the order. Whereas, in *Pinus radiata,* we can enumerate characters that indicate in turn the species, the genus, the family, and the order, in *Ginkgo biloba* there are no characters of structure or function significant to any conceivable definition of these taxonomic categories that can be utilized to designate each in turn in the living member. The position of *Ginkgo biloba* in the taxonomic system is significant only as an order in the class Gymnospermae and coordinate with the orders Coniferales, Taxales, and Cycadales. In this case, there is no foundation for evaluation in definitive terms in any of the categories below the order. Obviously, the living *Ginkgo biloba,* the species, is precisely the same genetically as the living *Ginkgo,* the genus, Ginkgoaceae, the family, and Ginkgoales, the order. There is no way of defining the species on a genetic basis in this case that will exclude the genus, the family, or the order, without setting up some arbitrary criteria. A concept of species is significant only in a genus of more than one entity. I cite these cases to point out that taxonomic categories are relative and that the sphere of relativity rests among the species of a genus, the genera of a family, and the families of an order. It rests in closeness of relationship and not across the entire taxonomic structure.

Taxonomy is one of the few sciences that documents its results by preservation of actual plant materials that have served as a basis for its concepts. Through the citation of specimen vouchers and their permanent preservation in herbaria, the literature of Taxonomy is forever current and always in demand. The Species Plantarum (1753) of Linnaeaus is in continued demand through its documentation in the specimens preserved in the Linnaean herbarium, however archaic the system of classificaiton may be that was utilized in it. Were it not for the Linnaean herbarium, the Species Plantarum and its nomenclature would long since have passed to the limbo of literary novelties, much as the ancient herbals, and serve only to tantalize the student as to what the author might possibly have had in mind when he described, imperfectly or incompletely, this or that species of plant. It could not possibly have been utilized as the boundary of priority of nomenclature. Similar documentation of the results of research should be urged upon the other divisions of botany.

Taxonomy can only bring itself up to date. It cannot advance independently of the basic disciplines upon which it rests. It is important to all of the basic disciplines, however, that Taxonomy keep itself up to date with the state of development of each of them. Knowledge of the interrelationships of plants is the key to many problems that arise in botany, the applied sciences, industry, and agriculture. One discouragement the taxonomist has had to face throughout this past century is that although systematic morphology clearly provided the basis for Taxonomy and the foundation for the natural system and pointed clearly through the theory of evolution to the phylogenetic systems, detailed advances in Morphology and Anatomy beyond this point were for a long time largely inadequate to help him solve his problems. The Morphology upon which classical Taxonomy rests is little more than simple organography involving position and number of parts, adhesion, cohesion, abortion, and modification of floral organs. This method has centered around the concept of Wolff (Samassa, 1896), championed by Goethe (1790) that the flower was a modified shoot and that its organs were homologous with leaves. It has accepted in its phylogenetic approach DeCandolle's idea that in the natural system anything which tended to obscure basic symmetry was a mark of advance in the system. The fact of the matter is that we are not as yet agreed as to what a flower is in terms of its homologies. We are in almost complete ignorance of the phylogenetic sequences in the development of the parts of the flower. There is much disagreement among morphologists and anatomists as to the meaning of vasculation in these organs in terms of arriving at homologies. These and many other unsolved problems of systematic morphology are vital to a sound phylogenetic Taxonomy. Research in Taxonomy has largely skirted these problems, with the result that there has been no sound advance in this aspect of the science. Instead, research in Taxonomy has centered chiefly in organizing the genus and species and ordering the nomenclature.

If Taxonomy is to fulfill its function in the botanical sciences, it must shift its emphasis from purely organizational techniques to include active research in some of the basic disciplines upon which Taxonomy rests. The taxonomist can be of little service to the objectives of his science by the pursuit of organizational monographs executed without contemplation of the basic problems upon which the science rests. The taxonomist must become a morphologist, a cytologist, a geneticist, and we hope, in time also a physiologist, and a biochemist. There is no field of specialization in taxonomy apart from these disciplines that is in any way adequate to the problems that confront the taxonomist. It makes little difference what area of the taxonomic structure or the taxonomic system he is investigating, because, with the exception of the riddles of nomenclature, the problems upon which he passes judgment are all basic botanical problems. In the higher categories, his problems thus far have been concerned chiefly with the evaluation of the structures of the flower as he seeks evidence concerning phylogenetic sequence of its structures. Some new lines of approach are now available from the field of Anatomy. In order that his judgment may be sound, he must master the research techniques of Comparative Morphology and Comparative Anatomy and Histology and apply them to his problem. He must be in a position to judge for himself the controversial matter in these fields as it applies to his problems. If his researches are on the level of species and genera, he must, in addition, master the research techniques of the cytologist and the geneticist, so that he may utilize the tools developed in these sciences for the interpretation and evaluation of variation and intergradation. It is only from these points of view that he will be able to assess his problems in terms of the expression of the interrelationships that are his objectives. The taxonomist must first of all be a botanist with the broadest of training. Only then will he be capable of being a competent taxonomist.

Summary

In the various works dealing with the general field of Taxonomy, we may arrive at many different concepts as to the meaning of the terms "Taxonomy" and "Systematic Botany." Most definitions, however, have regarded the two terms as synonymous even though usage in the same work differed sharply from the definition stated. Since there is need for a term applicable in the sense in which Solereder used Systematic Anatomy, and since little is to be gained by invoking a new term, it now seems necessary to make an arbitrary choice between these definitions and usages.

Through usage, over and above definition, De Candolle supplied the classical Taxonomy with a method and an objective that served to establish the term "Taxonomy" in the inclusive sense we here advocate. His usage involved the methodology and tools concerned with taxonomic research, classification, nomenclature, the taxonomic system and the determination of relationship. Since De Candolle, we have added little to the classical concept of taxonomy except additional and improved method and additional botanical fact. The objective remains the same, namely the classification of plants into a system that expresses their interrelationships. All that the theory of evolution accomplished immediately for taxonomy was to make clear the meaning of the selfsame "relationships" that De Candolle sought, namely the relationship based upon resemblance or community of characters which now becomes the evidence of relationship through common evolutionary descent. Being first associated with the natural systems, the term "Taxonomy" was at its inception inescapably linked with the motive of establishing relationship among plants.

With the adoption of this broad concept of Taxonomy as herein advocated, there is no need today for the term "Systematic Botany" used in a sense that is synonymous with Taxonomy. There is, however, an important use for the term "Systematic Botany." This is its application to the systematic approach to any of the basic divisions of Botany, much as Solereder used the

term "Systematic Anatomy." Its objective will be the establishment of botanical facts upon which concepts of relationship are based rather than simply the establishment of relationship. This is the field of botanical research upon which Taxonomy rests.

With such a concept of Taxonomy and Systematic Botany, Biosystematics fits naturally into Systematic Botany on the plane of integration. It seeks to establish facts about a systematic group in systematic order so that these may be used in the synthesis of taxonomic relationships.

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POLYPLOIDY IN ECHINOCYSTIS

Thomas W. Whitaker

During the course of a survey of wild and cultivated species of the Cucurbitaceae to determine the host range of the cantaloupe mosaic virus, I have had an opportunity to study at first hand living material of a great many species of this interesting and diverse family. In conjunction with the mosaic studies, cytological investigations were initiated, and a technique was developed to study the chromosomes by modern methods. As an incidental part of the latter investigation, I had occasion to examine *Echinocystis macrocarpa* Greene, the chilicothe or mock-cucumber native to coastal California from Monterey Bay southward to Lower California, Mexico.

McKay (1931) studied *Echinocystis macrocarpa* and two other West Coast species (*E. fabacea* Naud. and *E. oregana* Cogn.) and reported that each species has 16 pairs of chromosomes. *Echinocystis lobata* T. & G., a species of the eastern United States, is apparently a diploid, since it was reported by Kirkwood (1907) to have sixteen pairs of chromosomes.

Fig. 1. *Echinocystis macrocarpa:* late anaphase showing 32 chromosomes; note chromatin bridge. Lower grouping shown only in outline. ×2400.

Plants of *Echinocystis macrocarpa* that I have sampled in San Diego County, California, have thirty-two gametic chromosomes (fig. 1). Evidently, they are tetraploid. Meiosis is characterized by an occasional multivalent and chromosome bridge; otherwise, the meiotic divisions are perfectly normal. In lactophenol the stainable pollen averages about 97 per cent. These observations argue against the possibility of this material of *E. macrocarpa* being a recent autopolyploid. Specimens on which these counts are based have been deposited in the Herbarium of the University of California, Berkeley, California.

There is some supporting evidence from morphological characters for the tetraploid nature of *Echinocystis macrocarpa.* The fruits and seeds in particular exhibit "gigas" characters. The fruits are normally three to six inches long and two to three inches in diameter, considerably larger than the fruits of other species of *Echinocystis* in the Pacific Coast area. The contrast in seed size is not so great as that found in the fruit; nevertheless, the average size of seed is apt to be larger in this species.

The discovery of a naturally occurring, numerical polyploid in the Cucurbitaceae is of unusual significance. Numerical polyploids are exceptionally rare in this family and have been found in only one other genus, *Trichosanthes,* although fifteen or more genera have been studied cytologically. Nakajima (1937) reports that the dioecious species *T. cucumeriodes* Maxim. has twenty-two pairs of chromosomes, whereas *T. japonica,* also dioecious, has only eleven pairs.

The above facts suggest that evolution at the species level in the Cucurbitaceae has proceeded for the most part by genic differentiation. For example, in the relatively large and greatly diversified genus *Cucurbita,* evidence from species crosses (Whitaker, unpublished) indicates that the difference between some of the species is dependent upon a comparatively small number of single gene mutations. Thus, it seems safe to conclude that evolution in this large and diverse family has proceeded mostly by genic differentiation (at the species level), supplemented by the infrequent occurrence of polyploidy.

Bhaduri and Bose (1947) have interpreted their observations to mean that increase in chromosome number in this family is primarily due to allopolyploidy, combined with fragmentation of chromosomes at particular loci. Their evidence is largely indirect, and, in any event, does not provide a critical test for their assumptions. However, these suggestions are stimulating and subject to experimental attack. By the use of colchicine and modern cytological methods, it should be possible to obtain some insight into the question of fragmentation. The most favorable genus for this work would undoubtedly be *Cucumis,* where *C. sativa,* the cucumber, has seven pairs of chromosomes, and the remaining species are reported to have eleven and twelve pairs.

To summarize, the discovery of a natural, numerical polyploid in the Cucurbitaceae is of some biological significance for several reasons. First, it indicates that polyploidy may have had an important role in the evolutionary development of certain genera in the family. Second, it tends to harmonize the evolutionary pattern in the Cucurbitaceae with that found in other dicotyledonous families.

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IRA WADDELL CLOKEY

The death of Ira Waddell Clokey at his home in South Pasadena, California, on January 13, 1950, marks the passing of a man whose career was extraordinarily useful to the science of botany even though botany was but an avocation with him. Born at Decatur, Illinois, on December 21, 1878, Ira Clokey was the son of Josiah Mitchell Clokey and Susan Carrie Elson. He attended the University of Illinois and Harvard University, receiving from the latter in 1903 the degree of Bachelor of Science *cum laude* with a major in mining engineering, a profession which he followed until 1920, when he entered Iowa State University to specialize in botany. He received the degree of Master of Science in Plant Pathology from this institution in 1921.

As a boy, Ira Clokey showed an avid interest in botany and this interest remained with him as long as he lived. In Decatur High School, one of his classmates was H. A. Gleason, and together they went on many a trip to collect and study the flora of Illinois. His career as a mining engineer took him in 1904 to Mexico, where he remained for seven years, and in 1915 to Colorado. In both regions he collected extensively, and built up a herbarium containing an excellent representation of the plants of each area. Unfortunately, in 1912, his herbarium, containing all of his Mexican collections and some of his early Illinois material was destroyed by fire. The fact that the duplicates of his Mexican collections had never been distributed, is a great loss to science. His later collecting was pursued with a view to rebuilding his herbarium through exchange. With this end in mind, he collected many duplicates, and as a result, there are few herbaria in the world that do not have representatives of his collections. Despite his having collected in large quantities, his specimens were beautifully prepared.

Mr. Clokey's early interest in botany centered around the genus *Carex* and he carried on extensive correspondence and exchange with several of the caricologists of the early part of the current century. As a result of these early exchanges, much of the classical material of the genus *Carex* is in his herbarium.

In 1935 Mr. Clokey became interested in the flora of the mountains of the southwestern United States and selected the Charleston Mountains of southern Nevada for intensive study. Here he collected large sets and it may be said that through his efforts, the flora of the Charleston Mountains in Nevada is perhaps more completely represented in major herbaria than is the flora of any equal area of the world. Through the cooperation of the Civilian Conservation Corps, many of these specimens were collected in sets of 100 to 150. All of these were distributed, some of them as Gray Herbarium Exsiccatae No. VIII. His intensive field work in the Charleston Mountains covered a period of approximately seven years. To work up this material, Mr. Clokey enlisted the aid of many specialists who treated the families and genera of their special interest, but as may be noted in the appended bibliography, he himself published several papers treating special groups in this area. The manuscript for the "Flora of the Charleston Mountains" was completed and accepted for publication by the University of California Press just prior to Mr. Clokey's death.

As recreation from his studies on the Charleston Mountain flora, Mr. Clokey engaged in researches on the genetics of maize, the work being carried on largely in collaboration with Dr. E. G. Anderson of the California Institute of Technology. This seeming divergence may be accounted for by the fact that while he was at Iowa State University he had developed considerable interest in the field of genetics under the influence of the late E. W. Lindstrom.

No one as whole-heartedly interested in botany as was Ira Clokey could have been satisfied without building up a sizeable botanical library. He expended considerable time and energy in obtaining complete sets of botanical journals and was jubilant when a missing number was finally acquired and the series in question thus made complete. In addition to the journals and many miscellaneous and indispensable references, his library contained the majority of the floras treating various parts of the United States. The California Institute of Technology at Pasadena is indeed fortunate in having this collection presented to it as the Ira W. Clokey Memorial Library.

In 1941, Mr. and Mrs. Clokey deposited the Clokey Herbarium at the Universiy of California with the understanding that it become the property of the University at Mr. Clokey's death. From that time until the present, most of the Clokey Herbarium exchange has been carried on through the Herbarium of the University of California. Containing an estimated 102,600 specimens, the Clokey Herbarium constitutes the largest single collection ever received by the Herbarium of the University of California. It exceeds in size the Brandegee Herbarium which might be said to be the nucleus of the University of California herbarium.

To Mr. Clokey, botany was always a source of happiness which he pursued with vigor. He was a cheerful, intense man with a keen sense of humor. I shall never forget his amusement

PLATE 13. IRA WADDELL CLOKEY.

over having sent fourteen specimens of a very complex species to a specialist and having them returned to him under fifteen different names. I believe he doubtfully accepted three entities as involving the fifteen names. He retold this story many times, always closing it with rollicking laughter.

Mr. Clokey is survived by his widow, Mrs. Cleora Brooks Clokey, who accompanied him on many of his collecting expeditions and who often assisted him with the preparation of specimens, and by two daughters.—**Herbert L. Mason**, Department of Botany, University of California, Berkeley.

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A GRAPHIC REPRESENTATION OF BESSEY'S TAXONOMIC SYSTEM

R. Lucas Rodriguez C.

The present diagram (fig. 1) is an effort to show Bessey's (1915) orders of Angiosperms and their relationships, with reference to the main characteristics which distinguish them and which are held to indicate their degree of primitiveness or advancement.

Studying Bessey's system one comes into acquaintance with his chart (fig. 2) in which he showed the relationship of the orders and, approximately, the number of species in each. When lines are drawn on this familiar "cactus plant" diagram to separate one characteristic from its opposite, they interweave, necessarily, in irregular fashion.

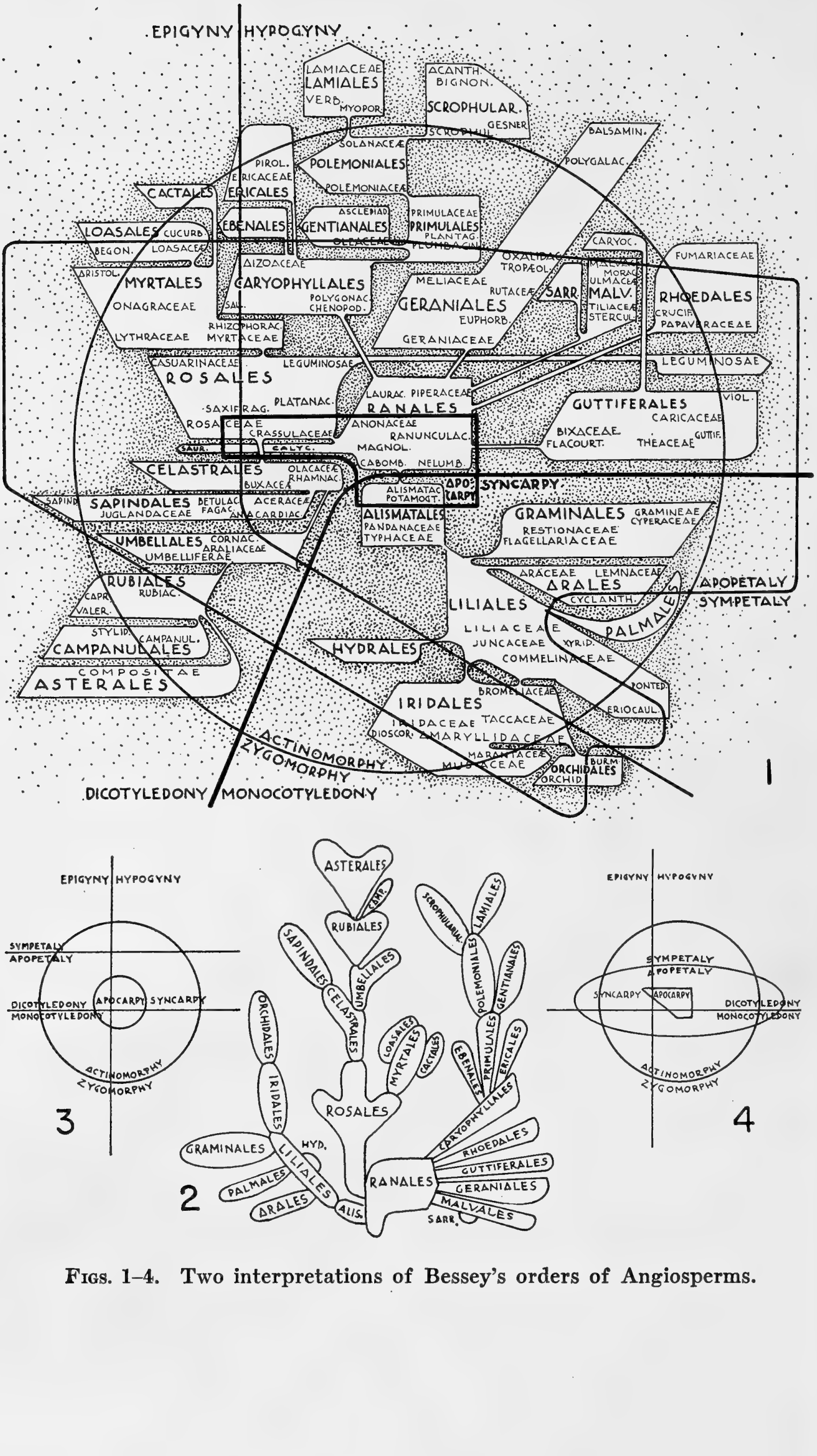
An attempt was made to plot the main divisions of characeristics significant in phylogenetic taxonomy as either straight lines or simple geometric curves (fig. 3), and make the branches of the "cactus plant" adapt to them. In this arrangement, the lines separating monocotyledony from dicotyledony, and sympetaly from apopetaly crossed at right angles that which represented the transition from hypogyny to epigyny; the transitions from apocarpy to syncarpy, and from actinomorphy to zygomorphy, were drawn as concentric circles, as required by successive levels of advancement reached by practically all postulated lines of descent. When Bessey's orders were arranged on this frame, th two most primitive orders, Ranales and Alismatales, occupied the center, and the different groups flowed radially out, the distance from the center becoming an indication of their degree of advancement. It was evident, however, that the transition to sympetaly should also be represented as a closed line, cutting in and out of the circle showing zygomorphy (fig. 4).

This layout proved more satisfactory as a starting point; but to avoid having both branches of the Oppositifoliae-Cotyloideae —the series ending in Loasales and Cactales, and that leading to the Asterales—twining around each other, it was again necessary to modify the general frame, reducing the space given to the monocotyledons and bending the line marking the change to epigyny. Such is the arrangement finally adopted for the diagram in fig. 1.

In this representation, Bessey's idea of showing the relative number of species in each group was abandoned, as the area covered by an order depends on the extremes of variation included within that order. In the diagram as given here, some families have been indicated in each order, to clarify somewhat the extension given to it.

Using this diagram as a working tool, it seemed interesting in the preparation of some seminar reports to plot additional characteristics on it, in order to compare other criteria for primitiveness with the accepted Besseyan concepts. In general, the lines marking off the trilacunar condition of the node (Sinnott, 1914) stipulate leaves (Sinnott and Bailey, 1914) and presence of endosperm, formed also closed curves, of necessity irregular but centering also on the Ranales. In each case there was at least one "avenue" along which the theoretically advanced condition reached the apparently primitive orders. The relative position of the families within each order as shown in fig. 1 already reflects the distinctions established by the additional criteria mentioned.

Bessey's original diagram has one disadvantage, that of appearing to be simultaneously a systematic chart and a genealogical tree. When the present diagram form is used, it becomes easier to keep in mind, or to show students, that neither of them is a "family tree" but a cross section at one time level (the present)



FIGS. 1–4. Two interpretations of Bessey's orders of Angiosperms.

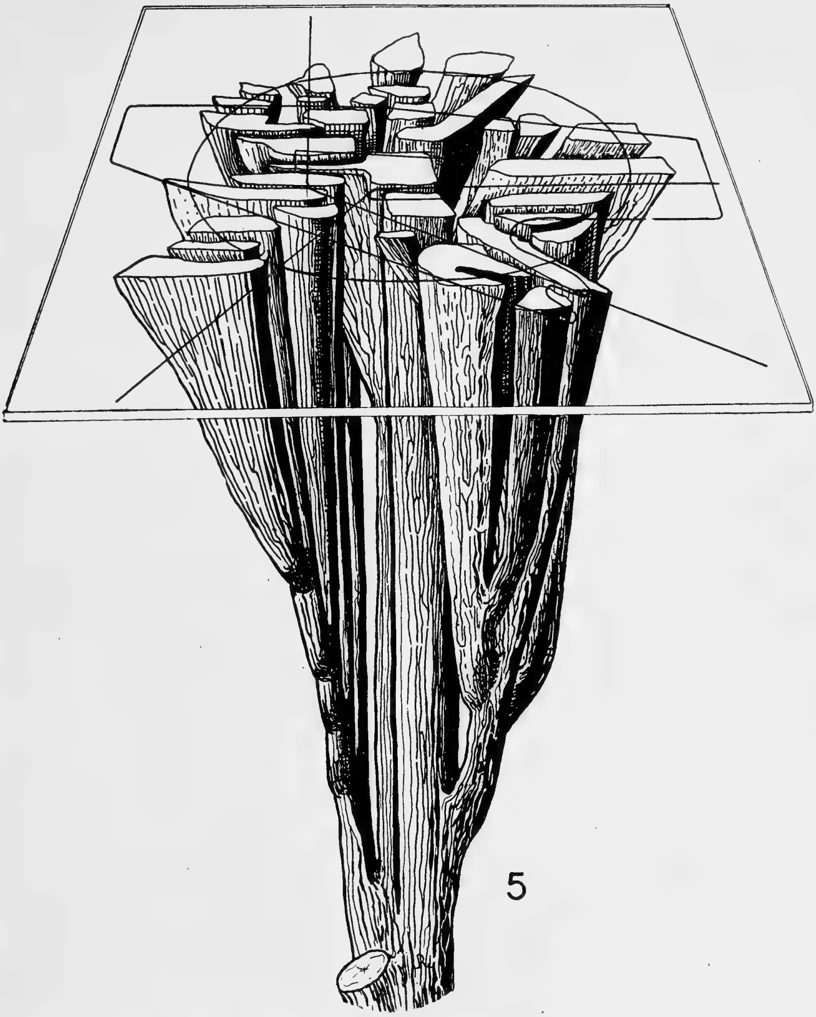


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Fig. 5. The diagramatic interpretation of Bessey's system as a cross-section of the Angiosperm genealogical tree. The vertical dimension represents time. No factual value is attached to the relative levels at which the groups branch out from their putative predecessors.

of the true genealogical tree growing out of the past (fig. 5). The degree of divergence from the primitive condition corresponds to the distance from the axis of the tree, while the connections in both diagrams (figs. 1 and 2) between one order and another are projections of a connection which existed at an earlier time level. The frame of the diagram, drawn on the plane of a particular time level, is only an attempt to define the lines along which the several series are diverging from the central stock, and the order in which the different changes are achieved. Considered in this manner, the diagram comes a little closer to Lam's (1936) ideal phylogenetic model, in which each detail, dimension or direction should have a definite meaning.

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DIOECIOUS MELANDRIUM IN WESTERN NORTH AMERICA

H. G. Baker

A history of the spread of *Melandrium dioicum* (L.) emend. Coss. and Germ. and *M. album* (Mill.) Garcke following their introduction (with impure clover seed from Europe and in rubbish from grain ships) into eastern North America has been given elsewhere (Baker, 1945, 1948a). A gradual spread westward is indicated, both species becoming more and more common in meadows, fields and waste places and along railroads in the ballast. There is no North American record of either species from a natural habitat, a fact of particular importance in the case of *M. dioicum* which seems ill-adapted for life as a weed (Baker, 1948b). In Europe plants with coloured petals occurring in cultivated land are of hybrid ancestry (involving *M. album*).

The means of introduction renders it likely that the material of "*M. dioicum*" arriving in America was already hybridised and, with the thrusting of the two obligatorily outbreeding forms into similar habitats, further hybridisation must have been an unavoidable consequence. Forms least resembling *M. dioicum* as it is known in Europe may be expected to have been selected. For this reason, now that the campions have become distributed throughout the United States, one would not expect recognisable *M. dioicum* to be found among the weeds of western North America.

The only specimens of "*M. dioicum*" from western North America available in wartime Britain were both collected in

British Columbia (woods just above sea level, Garrow Bay, Vancouver, 28 April 1935, *Whiting and Stewart,* K). They represent a shade form with rounded leaves but their calyces are very reminiscent of those of *M. album.* It was tentatively suggested (Baker, 1945, 1948a) that these plants might represent extreme segregants from the hybrid swarm occupying a habitat similar to that of one of the European parents.

I am indebted to Dr. E. P. Killip and Mr. C. V. Morton of the Smithsonian Institution, Washington, D. C., for the information that there is no specimen of *M. dioicum* from any of the Pacific States in the National Herbarium.

It was the fortunate experience of the author to accompany Drs. Jens Clausen, William Hiesey and Paul Grun on a journey from the laboratories of the Division of Plant Biology of the Carnegie Institution of Washington at Stanford, California, through Oregon and Washington to British Columbia in May and June, 1949. During this excursion it was possible to make observations upon the occurrence of *M. dioicum* and *M. album* in this region and to consult herbarium material.

A collection believed to be the first record of *Melandrium dioicum* naturalised in Western United States was made in Oregon (ca. one mile east of Vista Point, Columbia River Gorge, Multnomah County, 2 June 1949, *Baker 433,* Herbarium of Leeds University). The plants were well established beneath a canopy of softwood and hardwood trees (e.g. *Acer macrophyllum, A. circinatum, Alnus rhombifolia, Cornus Nuttallii, Pseudotsuga taxifolia* and *Thuja plicata*) near the roadside amidst a great profusion of herbaceous species and appeared to be reproducing freely by seed. The appearance of the specimens collected indicates little influence of *M. album* in the genotype and one is not given the impression that a woodland type has segregated from a hybrid swarm involving both species but rather of the establishment of *M. dioicum* by separate introduction.

The suspicion was strengthened by the observation of populations of *M. dioicum* in Stanley Park, Vancouver, British Columbia and in West and North Vancouver. In this area, this species appears to be not uncommon in wooded areas, being found both in clearings and wood borders on one hand and in dense shade on the other. Although a number of calyx characters suggests the influence of *M. album,* the general appearance of the populations as a whole suggests that their origin is to be found in a separate introduction from rather impure European stocks of the species rather than by segregation from a campion population which has pushed its way across the continent from eastern North America. In one case, the species was noticed among debris thrown from a house garden in West Vancouver and its original introduction as an ornamental plant seems likely in contrast to the manner in which pink-petalled plants became established in eastern North America.

In this connection, it may be of interest to record that *Geranium Robertianum* found growing in Stanley Park was definitely unlike that which is native to eastern North America and closely resembled European woodland material (Baker, 1949). The considerable connection between maritime British Columbia and the British Isles (until recent decades possibly closer than between western and eastern Canada), may indicate the probable source of *Melandrium dioicum* in the Vancouver area.

At the same time it is significant that Robbins, Bellue and Ball (1941) record that plants with rose-coloured petals occur in populations of *M. album* in California. These rare plants are indicators of past hybridisation with *M. dioicum* which cannot have occurred locally. The colonisation of western North America by *M. album,* although probably reinforced by introduction through the Pacific Coast ports, cannot be separated from the westward march of the white campion across North America for there are records of its occurrence from a complete chain of states from the eastern to the western coasts.

Although it is not claimed that these are necessarily the earliest records, herbarium specimens of *M. album* with the following dates have been seen from western North America. Abbreviations of names of herbaria are according to Lanjouw (1939).

CALIFORNIA. Hoopa Valley, Humboldt County, 1901, *Mrs. M. H. Manning,* as *Silene Hookeri* (UC). OREGON, Sandy shore of North Santiam River, North Santiam Station, Marion County, 1919, *J. C. Nelson,* as *Lychnis alba* (WTC). WASHINGTON. Near Coupeville, Whidby Island, 1897, *N. L. Gardner 43,* as "Silene" (WTC). BRITISH COLUMBIA. Coldstream Ranch near Vancouver, 1917, *Miss E. M. Warren* (K). ALASKA. Sandy beach formation, Cape Nome Roadhouse 14 miles east of Nome, 1937, *C. W. Thornton* (K). MONTANA. Waste places, altitude 3200 feet, near Missoula, Missoula County, 1921, *J. E. Kirkwood 1103* (UC); Lake MacDonald, Glacier National Park, 1921, Mrs. *Susan D. McKelvey* (K). IDAHO. Roadside south of Moscow, Latah County, in *Agropyron* prairie zone, 1937, *R. F. Daubenmire 37490* (WTC).

It was apparent in the study of herbarium specimens that there is considerable confusion between *Melandrium album* and *Silene noctiflora* L. Table 1 shows the more obvious points of distinction for herbarium specimens.

Investigation of the phylogenetic connection between these two very similar species might lead to valuable conclusions regarding the relationship of *Silene, Melandrium* and *Lychnis,* between which genera there is considerable inter-fertility. In fact,

Table 1

Melandrium album	*Silene noctiflora*
Dioecious	Hermaphrodite
Calyx nerves without obvious anastomoses; parts without nerves greenish.	Calyx nerves anastomosing prominently; parts without nerves whitish.
Capsule with 10 teeth which stand upright or spread slightly outwards.	Capsule with 6 slightly recurved teeth.
Seeds tawny; surface bluntly tuberculate.	Seeds grey-brown; surface granulate.
Glandular hairs fairly frequent in region of inflorescence.	Glandular hairs very numerous causing marked viscidity.

a consideration of the many characters by which *Melandrium album* differs from *M. dioicum* leads to the surprising revelation that almost every one may be supplied by *Silene noctiflora!* Over one hundred years ago, Gärtner (1849) crossed *Melandrium dioicum* with *Silene noctiflora* and obtained a hybrid in which rather less than a quarter of the capsules contained up to fourteen seeds. The repetition of this cross is, therefore, of very considerable importance and a determined effort to extract a form similar to *M. album* from the products of recombination might well be successful. The evidence from geographic distribution is in harmony with such a suggestion for *Silene noctiflora* is probably of South European origin and it has been shown (Baker, 1945, 1948a) that the centre of distribution of *M. album* is in the Mediterranean region. Also, such an investigation might, once and for all, settle the arguments whether *M. album* and *M. dioicum* are to be considered specifically or merely sub-specifically distinct.

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REVIEW

Water in the Physiology of Plants. By A. S. Crafts, H. B. Currier, and C. R. Stocking. xxi + 239 pages, 56 figures, 49 tables, 3 plates, and 4 vignettes. (Volume XXI of A New Series of Plant Science Books edited by Frans Verdoorn.) $6.00. Chronica Botanica Company, Waltham, Massachusetts. 1949.

The appearance during 1949 of two books in the field of plant-water relations serves as a potent reminder of the fact that water is a basic, essential requirement of plants and that it is a major concern of agriculture in many parts of the world. The two books, *Water in the Physiology of Plants* by A. S. Crafts, H. B. Currier, and C. R. Stocking, all of the University of California at Davis, and *Plant and Soil Water Relationships*[1] by Paul J. Kramer of Duke University, Durham, North Carolina, cover—between them—the broad field of water relations including the translocation of solutes, though only passing reference is made to problems of drought and cold resistance.

Water in the soil, the plant, and the atmosphere constitutes a continuous system tending toward equilibrium in all of its parts. Thus, it is difficult to discuss any one part of the system to the exclusion of the rest. This leads unavoidably to a certain amount of duplication in the two books even though the authors were cognizant of each others' effort. One is more impressed, however, with how well they complement each other to give an extremely broad coverage of the field. For this reason both are essential to the plant physiologist. The focal point of Kramer's book is the soil water-root interphase and the factors operative on each side of the boundary with respect to water and solutes. Crafts and his colleagues center attention on the water within the plant and the factors affecting its distribution. Both books discuss the closely related subject of the translocation of solutes. Kramer restricts his treatment to mineral transport in the xylem while Crafts, *et. al.,* include, also, transport in the phloem. Each book has an extensive bibliography thus providing a comprehensive survey of the literature.

Although the book for which this review was requested is *Water in the Physiology of Plants* it seems appropriate to first indicate briefly the contents of both books before passing to a detailed consideration of the one under review. The introductory chapter in each book is followed by a development of the physical-chemical groundwork for considering the water relations of the plant. Crafts, *et. al.,* devote four chapters (about fifty-five pages) to the structure of water, the nature of aqueous solutions and osmosis, and the mechanism of osmosis. Kramer, in his first four

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[1] Kramer, P. J. 1949. Plant and Soil Water Relationships. xiii + 347 pp. McGraw-Hill Book Company, Inc., New York.

chapters of some eighty pages, discusses the nature, movement, measurement, and control of soil moisture.

The plant is now introduced into the picture, the background for the approach to plant-water relations having been laid in each book. Kramer then considers, in order, the structure and growth of roots, the factors affecting the development of root systems, root and stem pressures and exudation phenomena, processes concerned in water absorption, factors affecting the absorption of water, the absorption of solutes, and, finally, absorption deficits and their effects on plants. Crafts and his colleagues continue their book with the intracellular distribution of water, osmotic quantities of plant cells, active cell water relations, uptake and movement of water in plants (including translocation of solutes), concluding with water loss and retention.

Turning now to the book under review (Crafts, *et. al.*), in particular, the two page introductory chapter is a terse summary of source materials, being primarily a bibliography of the classical literature as well as of recent reviews and books in the field of water relations.

Chapter 2 on the structure of water will leave no doubt in the reader's mind that water is far more complex than merely a "mass of spherical molecules, randomly arranged, and independently agitated by thermal energy," but rather, "is composed of polar molecules coordinately arranged in some sort of lattice-like network and bound by a number of intermolecular forces such as dipole attractions, London forces, and hydrogen bonds." Similarly, the next chapter stresses the complexity of aqueous solutions, discussing at length the intermolecular forces between solute and solvent and their effect upon colligative properties. The controversial problem of "bound water" is considered here also.

Consideration of osmosis and the mechanism of osmosis appropriately follows the laying down of working concepts of the nature of water and aqueous solutions. Realizing the dissatisfaction of plant physiologists with the inexact and multitudinous terms in use and the lack of a satisfactory explanation of the mechanism, the authors carefully trace the development of our knowledge of osmosis. They arrive at a set of definitions, liberally illustrated, of the important osmotic quantities and propose a mechanism. Even so, it does not become clear until a later chapter that osmotic pressure includes all factors, not just solute alone, which reduce the diffusion pressure of water. Similarly, the broad meaning of turgor pressure is not clear until a later chapter. The terminology adopted is that recommended by the Physical Methods Committee of the American Society of Plant Physiologists. These authors also postulate a mechanism for the kinetic interpretation of osmosis. I doubt that the arguments over mechanism and terms will be resolved by the treatment given here; however, the terminology seems destined to become universal in the United States, since most students are being exposed to it.

The next two chapters, VI and VII, include the distribution of water in cells, i.e., its distribution between cell wall, protoplasm, and vacuole, and methods for measuring osmotic pressure and diffusion pressure deficit. After this treatment of the water movement between cells as a strict osmotic phenomenon, it becomes necessary here—as in other recent articles—to evaluate the evidence indicating that the protoplasm is not passive with respect to the passage of water, but plays some vital role in water distribution. They conclude, after a lengthy discussion in Chapter VIII, that the evidence is inconclusive.

Chapter IX is concerned with the absorption of water by roots and the translocation of water and solutes. A curious duality in the use of terms becomes apparent in this chapter. Here, "active absorption" is considered to be the osmotic entrance of water from the soil solution into the xylem resulting (under appropriate conditions) in a root pressure. "Passive absorption," on the other hand, is a similar movement, but one in which the diffusion pressure deficit in the xylem is due to tension rather than solute. This conflicts with the definitions in the earlier chapter on the active uptake of water by cells, where the metabolic absorption of water is considered to be the "active absorption" while "passive absorption" is the osmotic entrance of water. After the evaluation of the evidence and the discussion of methods for the "movement of water through the plant, there is an extended fine-print section on the translocation of solutes. Concerning the flow of food, viruses, indicators, etc., they state, "The simplest and most compatible mechanism to account for such flow would seem to be mass flow along hydrostatic gradients developed osmotically." It seems to me that, in view of equally valid data which are incompatible with the mass flow concept, it is illogical to support a theory because it is "simple and most compatible," if it does not fit all of the facts.

The concluding chapter of this book discusses the researches on transpiration, stomatal behavior and mechanisms, subaqueous transpiration, and the effects of water deficits.

I trust that this review indicates, as does the book, that the field of plant-water relations is far from a closed subject. Unsolved problems await the investigator even on such issues as terminology and mechanism of osmosis, to say nothing of the complexities of water relations within the plant. This book provides a logical and comprehensive insight into the complex and extensive field of plant-water relations. **Leonard Machlis**, Department of Botany, University of California, Berkeley.

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A WEST AMERICAN JOURNAL OF BOTANY

Contents

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STUDIES IN THE GENUS DALEA

Howard Scott Gentry

Dalea is an American genus of the Papilionaceae, whose center of distribution appears to be in the Sierra Madre Occidental of Mexico. *Dalea* Juss. was conserved over *Parosela* Cav. by the International Botanical Congress of 1935. Herbarium folders of *Dalea* have been greatly enriched by recent collections, and certain sections of the genus have recently been studied by Wiggins (1940) and Clausen (1946a and 1946b). But the latest comprehensive treatment of the group is that of Rydberg (1920), listing 178 species for North America. This is an excellent treatment although, in the interest of binomial nomenclature, he delimited species very narrowly.

During the past ten or twelve years, *Dalea* has been of increasing interest to me in the field. Current studies in plant geography and the preparation of forthcoming floras now make it desirable to publish some new names and some judgments. It is merely an accident that most of the species here treated belong in Rydberg's section *Versicolores*, for I do not propose to revise the section at this time. Its southern representatives, including the type species, *D. versicolor*, are still imperfectly known; and its relationship to other sections of the genus needs reevaluation.

The genus is strikingly rich in characters which may be used for taxonomic evaluation. By way of appraisal I once listed 150 morphological differences as expressed by the variants of the genus. As our collections of these variants increase, the limits of populations and species will become more surely apparent. There is much endemism and as our knowledge of Tertiary land forms grows, their distributions may be areally explained. Almost no cytogenetic work appears to have been done. The annual, *Dalea alopecuroides*, and the perennial, *D. occidentalis*, are known to have a diploid number of 14 chromosomes (Atchison, 1949). Obvious active speciation of this genus so wonderfully expressed in abundant characters recommends it highly for intensive taxonomic, genetic and evolutionary studies.

Loans of specimens from the University of Arizona, the Gray Herbarium, and the Dudley Herbarium have greatly facilitated the current studies. To the respective curators, Kittie Parker, Reed Rollins, Ira Wiggins and Roxana Ferris, the author expresses his keen appreciation for that cooperative spirit which has freely circulated the American materials of science. In citation of specimens, the institutional abbreviations are those proposed by Lanjouw (1939).

The following key introduces and orients a number of new

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entities, referable to *Dalea,* section *Versicolores,* from the Sierra Madre region of northern Mexico and adjacent New Mexico and Arizona.

- Bracts and calyx lobes with tentacular glands on backs and margins; bracts persistent, conspicuously shorter than the calyx; leaflets without a distinctive mid-vein below; plants glabrous below inflorescence or only sparsely pubescent on upper side of leaflets .... *D. tentaculoides*
- Bracts and calyx lobes without protruding glands on backs, but usually with a pair of marginal spur-like glands on calyx lobes; bracts early deciduous (except in *D. pinetorum*), two-thirds as long to longer than calyx; leaflets with a distinct mid-vein below; plants pubescent below the inflorescence (*D. Wislizeni calcarata* excepted).
  - Wing petals and usually keel petals without apical glands; calyx weakly ribbed, without glands or with indistinct glands between the ribs; heads densely flowered, the flowers sessile.
    - Stems with tufts of depauperate leaves near the base; stipules several times longer than the petioles; banner blade orbicular; wing petals nearly equaling keel petals in length .... *D. pinetorum*
    - Stems without tufts of depauperate leaves near the base; stipules shorter than the petioles; banner blade cordate to deltoid, longer than wide; wing petals shorter than keel petals.
      - Heads large, 3–6 cm. long, 15–20 mm. wide (without corollas); leaflets up to 15 to 20 pairs, sparsely pubescent; virgate, mainly monopodial perennials .... *D. surotatensis*
      - Heads small, less than 2.5 cm. long and 15 mm. broad; leaflets up to 5 pairs, densely pubescent; prostrate to decumbent or diffusely branched polypodial perennials.
        - Leaf rachis up to 10–20 mm. long, the petiole not more than twice as long as next segment; heads less than 10 mm. broad (without corollas), not subtended by a calyculus of ovate bracts; upper floral bracts 4–5 mm. long, broadly lanceolate; calyx 5–6 mm. long; keel (with claw) 5–7 mm. long; plants prostrate or decumbent with rooting runners .... *D. Greggii*
        - Leaf rachis less than 10 mm. long, the petiole 3 to 4 times as long as the next segment; heads 12–16 mm. broad, subtended by a calyculus of caducous ovate bracts; upper floral bracts 6–8 mm. long, linear lanceolate; calyx 6–8 mm. long; keel 7–10 mm. long; plants erect, to 6–8 dm. tall, without runners .... *D. pulchra*
  - Wing and keel petals with apical glands; calyx strongly ribbed, clearly glandular between the ribs (with calyx opened); heads not so densely flowered, the flowers short-pedicellate.
    - Heads elongate (5 to 10 cm.); leaf rachis grooved above; lower calyx lobe twice as long as calyx tube; flowers pale lavender to nearly white .... *D. leucantha*
    - Heads not elongate or but little so (2–4 cm.); leaf rachis not distinctly grooved above; lower calyx lobe less than twice as long as calyx tube; flowers lavender to rose or purplish .... *D. Wislizeni*

Dalea pulchra sp. nov. *D. Greggii* of authors, not *D. Greggii* A. Gray. Plate 14.

Suffrutex 5–8 dm. altus, ramis brunne-griseis vel pallide griseis; ramulis adscendentibus, tuberculatis, pubescentibus; foliis remotis, parvis, 6–10 mm. longis, sericeis; petiolo 1–5 mm. longo; foliolis 3–9, obovatis, rotundatis, conduplicatis, 2–5 mm. longis, 1.5–2 mm. latis, subtus glanduloso-punctatis; inflorescentiis pedunculatis, capitatis, confertifloris; calyce sessili pubescente, 6–8 mm. longo, lobis quam calycis tubus longioribus, plumosis, prope basin lateraliter calcaratis; vexillo toto vel partium albo luteove; petalis caeteris roseis.

Erect, diffusely spreading, polypodial, suffrutescent herb 5–8 dm. tall with abundant showy flowers. Stems dull brownish gray; branchlets ascending, yellowish gray to reddish brown, striate, tuberculate, sericeous to glaucous-glabrate, multibracteate at the base; stipules brownish, subulate, pubescent, 1–2 mm. long, geminate, united at base; leaves few, mostly remote, densely silvery pubescent; rachis 4–10 mm. long, grooved above; petiole 2–4 mm. long, more than twice the length of other rachis segments; stipels glandular; leaflets 3–9, obovate, petiolulate, conduplicate, rounded at apex, glandular punctate below, 2–5 mm. long, 1.5–2 mm. wide, thickish; inflorescence pedunculate, mainly terminal, the heads globose, 12–16 mm. broad (without corollas), subtended by an involucre of caducous, ovate, chartaceous, densely pilose bracts; upper floral bracts linear-lanceolate, 5–8 mm. long, densely long white pubescent on backs; calyx narrowly campanulate, long-pubescent, 10-ribbed; tube glandless or nearly so, notched deeply by the banner, ca. 3 mm. long, lobes subulate, unequal, the shorter 2–3 mm. long, the longer 3–5 mm. long, spurred laterally near the base; banner pale lavender to yellow, glandless, 6–8 mm. long, the blade deltoid-cordate, shorter than the claw; other petals rose, well exserted, the keel petals 7–10 mm. long, the blade rhomboid-ovate, longer than the claw; fruit depressed subquadrate, greatly narrowed and hyaline towards the base, crested, herbaceous, pubescent, and glandular dotted distally, ca. 3 mm. long; seed single, flattened, smooth, brownish, beaked above the hilum.

Type. Soldiers Trail Canyon, near Mount Lemmon road, southern slopes of the Santa Catalina Mountains, Pima County, Arizona, about 4500 feet elevation, April 15, 1946, *F. W. Gould* and *G. T. Robbins 3534* (ARIZ., no. 40197).

This attractive Arizona plant has long been identified with *Dalea Greggii* of northern Mexico. Observation and collection of *D. Greggii* in the north Mexican highlands and near the type locality by the author in 1942–43, brought the realization that two distinct populations had long been considered as one. A study of materials brought together, including the type of *Dalea*

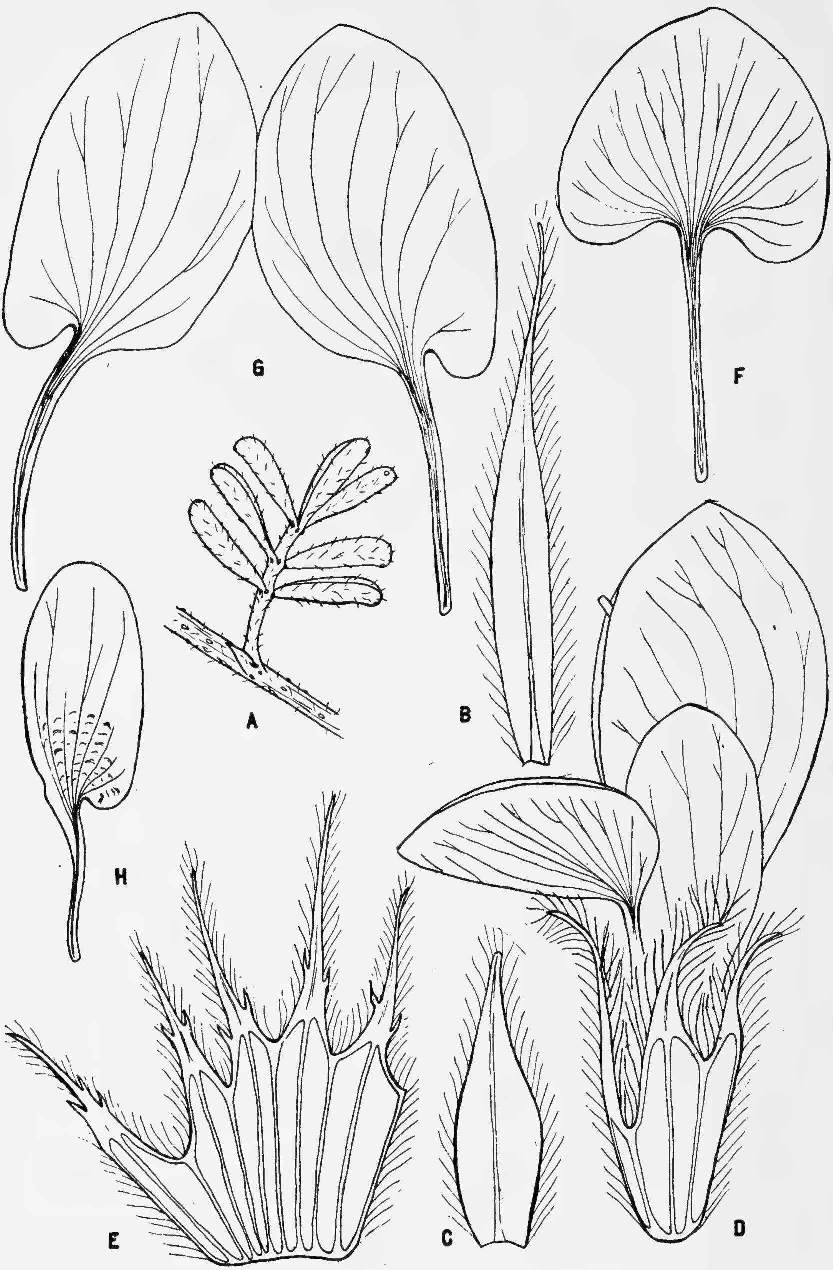
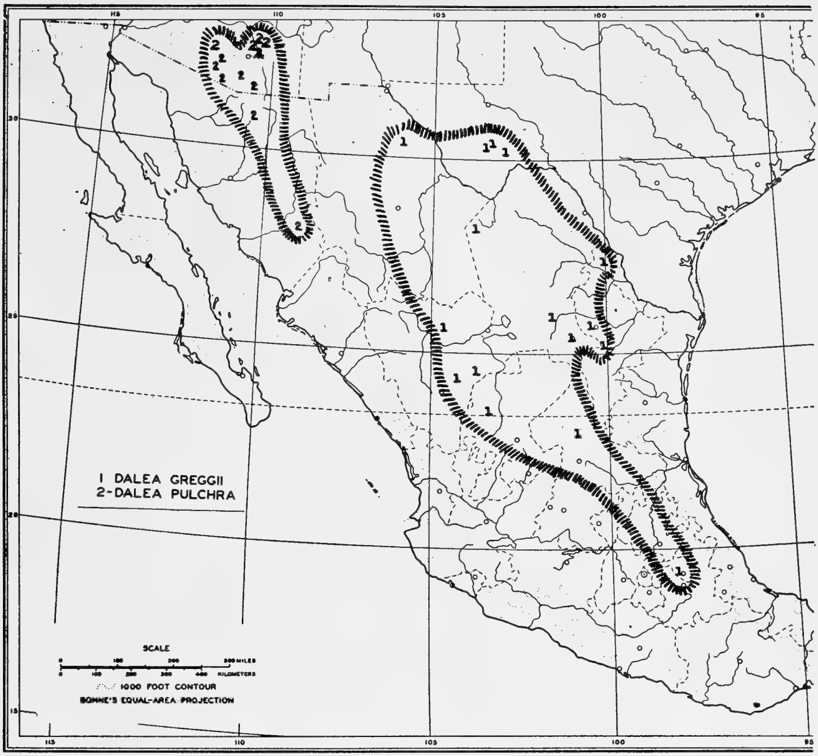


Plate 14. Dalea pulchra. Fig. A, leaf, 10. Figs. B and C, upper and lower floral bracts, ×20. Fig. D, flower, ×20. Fig. E, calyx spread open, ×20. Figs. F, G, H, banner, keel and wing petals, ×20. Drawn from the type.



GOODE'S SERIES OF BASE MAPS

Fig. 1. Distribution of *Dalea Greggii* and *D. pulchra.*

Greggii, leaves no doubt in the author's mind but that we are dealing with two distinct species occupying separate areas (fig. 1 and pls. 14 and 15). They are both grama grassland species. *Dalea Greggii* grows upon the piedmonts of the Sierra Madre around the borders of the Chihuahuan and Hidalgan deserts from Texas to Puebla while *D. pulchra* is more restricted to the oak woodland and grassland bajadas of southeastern Arizona, bordering the Sonoran Desert as far south as southern Sonora through the western foothills of the Sierra Madre Occidental.

Dalea pulchra and *D. Greggii* have similar calyces and both have drought-inhibited, ovate, conduplicate, densely sericeous leaflets. The morphological similarity apparently has led modern taxonomists to follow Gray and later Rydberg in assigning the Arizona plant to Gray's *D. Greggii.* However, those two men were working with very limited collections and neither knew the plants in the field. Although there has been considerable collecting in both areas of the species during the last twenty years, collections of these two species are still not abundant, viz.:

Gray Herbarium, *D. Greggii,* 15 sheets, *D. pulchra,* 8 sheets; University of Arizona Herbarium, *D. Greggii,* 3 sheets, *D. pulchra,* 14 sheets.

The erect, bushy *D. pulchra* with relatively large heads and showy flowers contrasts strongly in appearance with the low decumbent to prostrate *D. Greggii* with small heads and inconspicuous flowers. These two species, with *D. surotatensis,* form a tight complex of the section *Versicolores,* characterized by compact heads, sessile calyces with weak ribbing and nearly glandless tubes.

DALEA GREGGII A. Gray, Mem. Am. Acad. Ser. 2, 5: 314. 1854. Not *D. Gregii* of authors. Plate 15.

This is a small decumbent or prostrate perennial herb of gray aspect with small reddish lavender to purple flowers borne in small erect terminal pedunculate heads. It spreads vegetatively by rooted runners and in time forms rather tight clones one or more meters in diameter. Perhaps correlative to its vegetative reproduction, the lower flowers appear commonly to be sterile. This is in contrast to the fertile lower flowers of *D. pulchra.* Whereas in *D. pulchra* the floral bracts are dimorphic, in *D. Greggii* the upper and lowermost floral bracts have essentially the same form, although the lowermost bracts are usually somewhat smaller, as in other species of this section. The area known to be occupied by *D. Greggii* is shown in Fig. 1. Gregg's original collection in the Gray Herbarium is labelled "Near Buenavista [Coahuila, Mexico], March 27/47". It is mounted on a sheet with two specimens collected by Thurber in northern Mexico in 1852.

Dalea leucantha (Rydb.) comb. nov. *Parosela leucantha* Rydb., N. Am. Fl. 24: 103, 1920.

This low shrubby herb, 5 to 10 dm. tall was originally described from Nayarit and Jalisco, Tepic being the type locality. Although clearly related to *D. Wislizeni,* its elongate and relatively lax inflorescence, short calyx tube with long lobes, quadrate and grooved leaf rachis persisting on the stems, the generally sparser pubescence, and twiggy branching, warrant considering *D. leucantha* as specifically distinct. The type specimen (*Palmer* no. *P* in 1891–1892, G), represents a plant in advanced flowering condition, nearly leafless, but the rachis persists. Other than 1891–1892, the specimen carries no date, but it is obviously a winter collection. A recent collection extends the range well into Sinaloa: *Gentry 5685,* Sierra Tacuichamona summit, February 19, 1940; "Low-bending shrubby herb in grass under oaks. Flowers pale lavender." Rydberg described the flowers as white. The Sinaloa material is in leafy condition, but also exhibits persistent leaf rachi with fallen leaflets, a character carried to some extent by part of the *D. Wislizeni* complex. The calyx lobes are noticeably longer in the Sinaloa specimens.

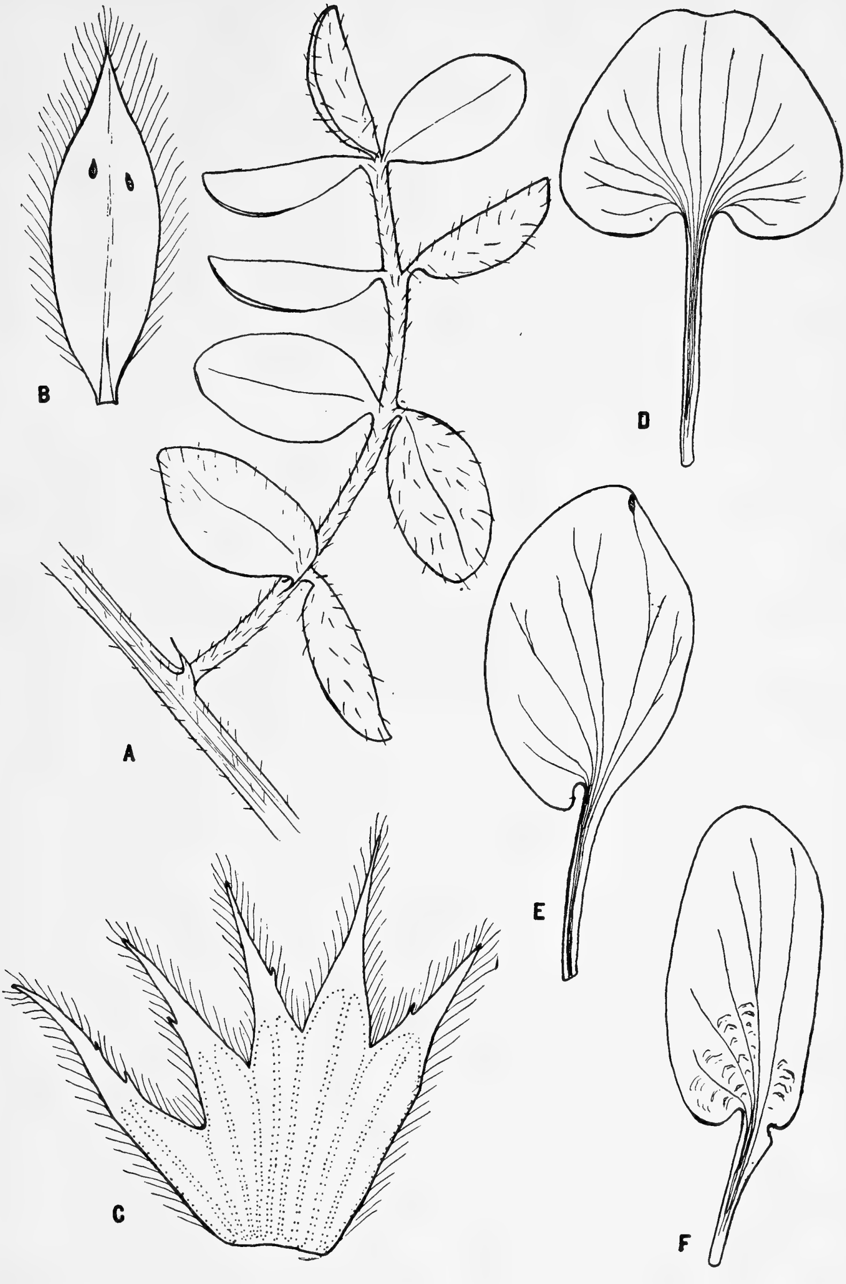


PLATE 15. DALEA GREGGII. Fig. A, stem section with leaf, ×10. Fig. B, floral bract, ×20. Fig. C, calyx spread open, ×20. Figs. D, E, F, banner, keel and wing petals, ×20. Drawn from *Gentry 8554*.

Dalea pinetorum sp. nov. Herba perennis 2–4 dm. alta; caulibus ad basin rosulas densas foliorum parvorum ferentibus; stipulis 6–9 mm. longis, subulatis, pubescentibus, brunneis, persistentibus; petiolo 1–3 mm. longo; foliolis 25–39, 5–8 mm. longis, ellipticis, acutis, pilosis, subtus granduloso-punctatis; bracteis lanceolatis;, 7–9 mm. longis, pilosis, persistentibus; calyce sessili, 7–8 mm. longo, pubescente, lobis quam calycis tubus longioribus, plumosis, subulatis; vexillo rotundo, 4 mm. diametro. Plate 16.

Perennial herb, the 1 or 2 stems 2–4 dm. tall, densely tufted near the base with soft pilose depauperate leaves; stems erect, yellowish to reddish brown, striate, copiously white-pilose; stipules 6–9 mm. long, linear subulate, long pilose, brownish, persistent, commonly reflexed; leaves above the tufts 2.5–4 cm. long, the petioles 1–3 mm. long, white-pilose; rachis rounded, rufus, persisting after the fall of leaflets; stipels obscure conic glands adnate to the petiolules; leaflets 25–39, narrowly elliptic, mostly 5–8 mm. long, acute at each end, sparsely silvery pilose above and below, minutely gland-dotted below, the mid-vein prominent below to the apiculate tip; peduncles terminal, 2–6 cm. long, thickened below the head, pilose; heads densely flowered, 13–15 mm. thick (without corollas), up to 3–5 cm. long; bracts narrowly lanceolate, acuminate, 7–9 mm. long, persistent, pilose, the lowermost reflexed, somewhat longer than the upper; calyx 7–8 mm. long, the lower lobe somewhat longer, strongly 10-ribbed, glandular between the ribs, sessile, subtended by 1 or 2 yellowish, subulate glands ca. 1–2 mm. long; tube 2.8–3.0 mm. long, shallowly notched by the banner, long pilose about the rim and glabrate below; lobes 4.5–6 mm. long, subulate, long-pilose, with pale yellow lateral spurs; blade of the banner orbicular, 4 × 4 mm.; purplish, with an apical gland and a bent arc of glands across the middle; blades of the wings oblong, purple, 4.5–5 mm. long, about equaling the keel petals, the claw attached obliquely, glandless; blades of the keel petals oblong-ovate, ca. 5 mm. long, purple, glandless; stamens 10, long exserted, the column, equaling or exceeding the calyx lobes; ovary densely long-pilose; ovule 1.

Type. La Mesa Colorada in Sierra Madre of western Chihuahua, Mexico, "Pine-oak association, pine mesa," October 12, 1933, *Gentry 529* (DS, no. 257578; isotype ARIZ).

This distinct species has no close relative among the known species of *Dalea* of northern Mexico. The dense elongate heads, the elongate subtending flower glands, the strongly 10-ribbed calyces with plumose subulate lobes and the numerous elliptic

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EXPLANATION OF THE FIGURES. PLATE 16

PLATE 16. DALEA PINETORUM. Fig. A, section of stem with leaf and stipules, ×5. Fig. B, detail of leaflets, ×8. Figs. C and D, dorsal and lateral sides of floral bracts, ×16. Fig. E, calyx spread open, ×16. Figs. F, G, H, I, banner, wing, keel petals, and staminal column, ×16. Drawn from type.

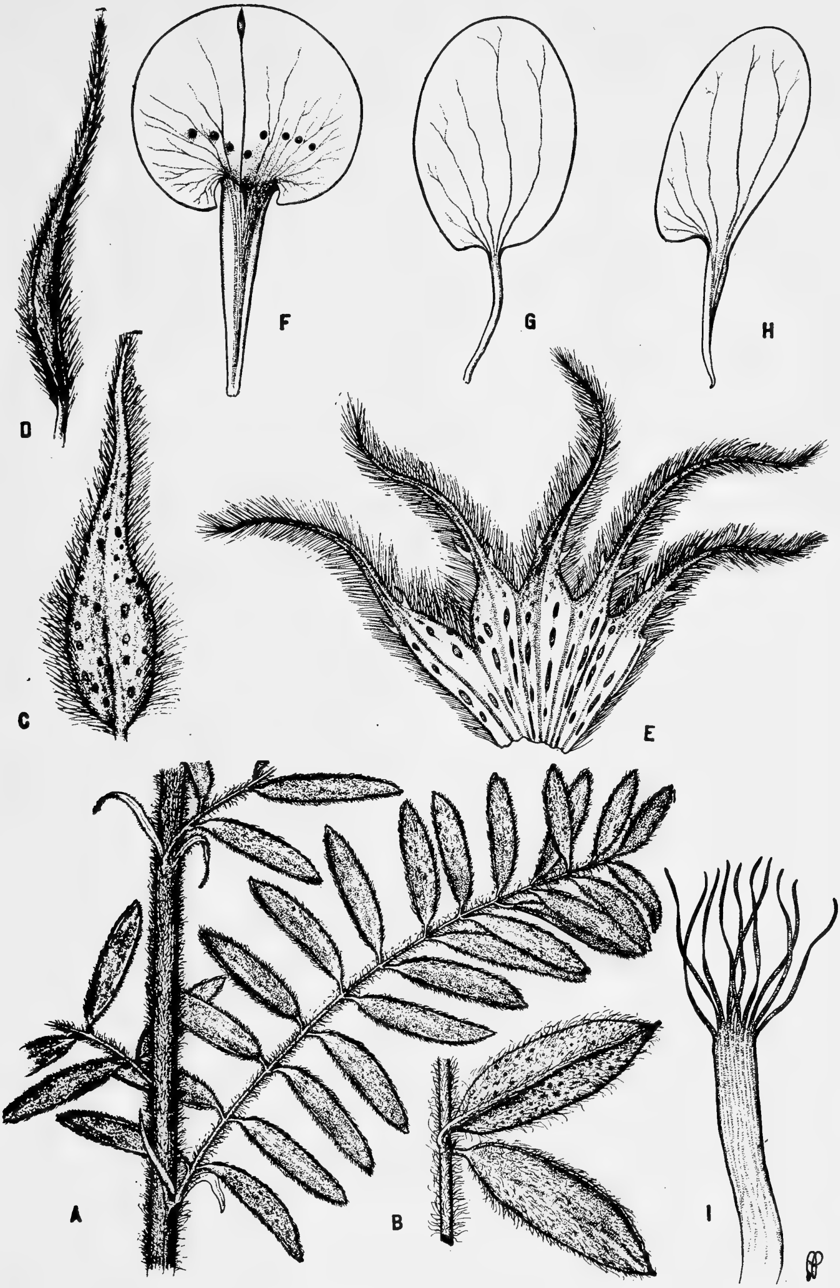

Plate 16. Dalea pinetorum.

leaflets with heavy mid-veins place it in Rydberg's section *Versicolores*. While the dense sessile flowers with glandless wings suggest relationship with the *pulchra-surotatensis* group, the elliptic, strongly veined leaflets separate it towards the *Wislizeni* complex. It is easily distinguished from all congeners by the peculiar tufts of basal leaves, the elongate stipules, and the glabrate calyx tube. The only other collection available is from the same area near the Chihuahua-Sonora boundary (*Gentry 653*, Sierra de las Papas, Chihuahua, October 22, 1933, DS.) These specimens were just beginning to head. Both localities are between 6000 and 7000 feet elevation and are dominated by pine.

Dalea surotatensis sp. nov. Suffrutex virgatus 5–15 dm. altus; ramis gracilibus; villosis, luteo- vel badio-brunneis; foliis 2–5 cm. longis, villosis; petiolis 4–6 mm. longis; foliolis 15–39 ellipticis usque ad obovatis, rotundatis, mucronatis, brevi-petiolulatis, subtus obscure glanduloso-punctatis, 5–7 mm. longis, 2–3 mm. latis; inflorescentiis longe pedunculatis ramos coronantibus; calyce sessile, dense longe villoso, eglanduloso, petalis pallide violaceis, vexillo minus saturato. Plate 17.

Slender virgate subshrub 5–15 dm. tall, mainly monopodial, with large cylindrical, long-pedunculate, showy heads; stems reddish brown, sparsely white-villose, striate, non-tuberculate; branchlets and peduncles paler and more densely pilose or villous; stipules brownish, pubescent, 2.5–3 mm. long, persistent; leaves mostly fascicled on short shoots, 2–5 cm. long, the rachis rounded, pilose; petioles 4–6 mm. long; stipels conic, minute, below the petiolules; leaflets 15–39, oblong, mucronate, 5–7 mm. long, 2–3 mm. wide, sparsely silvery pilose on both sides, weakly and irregularly black punctulate below, mid-vein prominent basally, obscure apically; peduncles lateral and terminal, 3–10 cm. long; heads large, cylindric, up to 5–6 cm. long, 15–18 mm. wide (without corollas), densely flowered; bracts scarcely persistent, 7–8 mm. long, equaling or exceeding calyces, linear-lanceolate, subulate, bent below and conduplicate, densely long silvery pilose, obscurely glandular; calyx narrowly campanulate, ca. 7 mm. long, weakly ribbed, eglandular or minutely glandular between the ribs, slightly notched by the banner; lobes subulate, 3.5–4.5 mm. long, longer than the tube, with minute lateral spur-glands, plumose; petals lavender, drying reddish, the banner paler, deltoid, 4.5 × 3.5 mm., with scattered glands near the middle; blades of the wings linear-oblong, 5.5–6 mm. long, 2 mm. wide

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EXPLANATION OF THE FIGURES. PLATE 17

PLATE 17. DALEA SUROTATENSIS. Fig. A, section of stem, leaves, and stipules, ×5. Fig. B, detail of leaflets, ×8. Fig. C, dorsal view of floral bract, ×16. Fig. D, calyx spread open, ×16. Figs. E, F, G, H, banner, keel, wing petals, and stamens, ×16. Drawn from type and topotype (*Gentry 7180*).

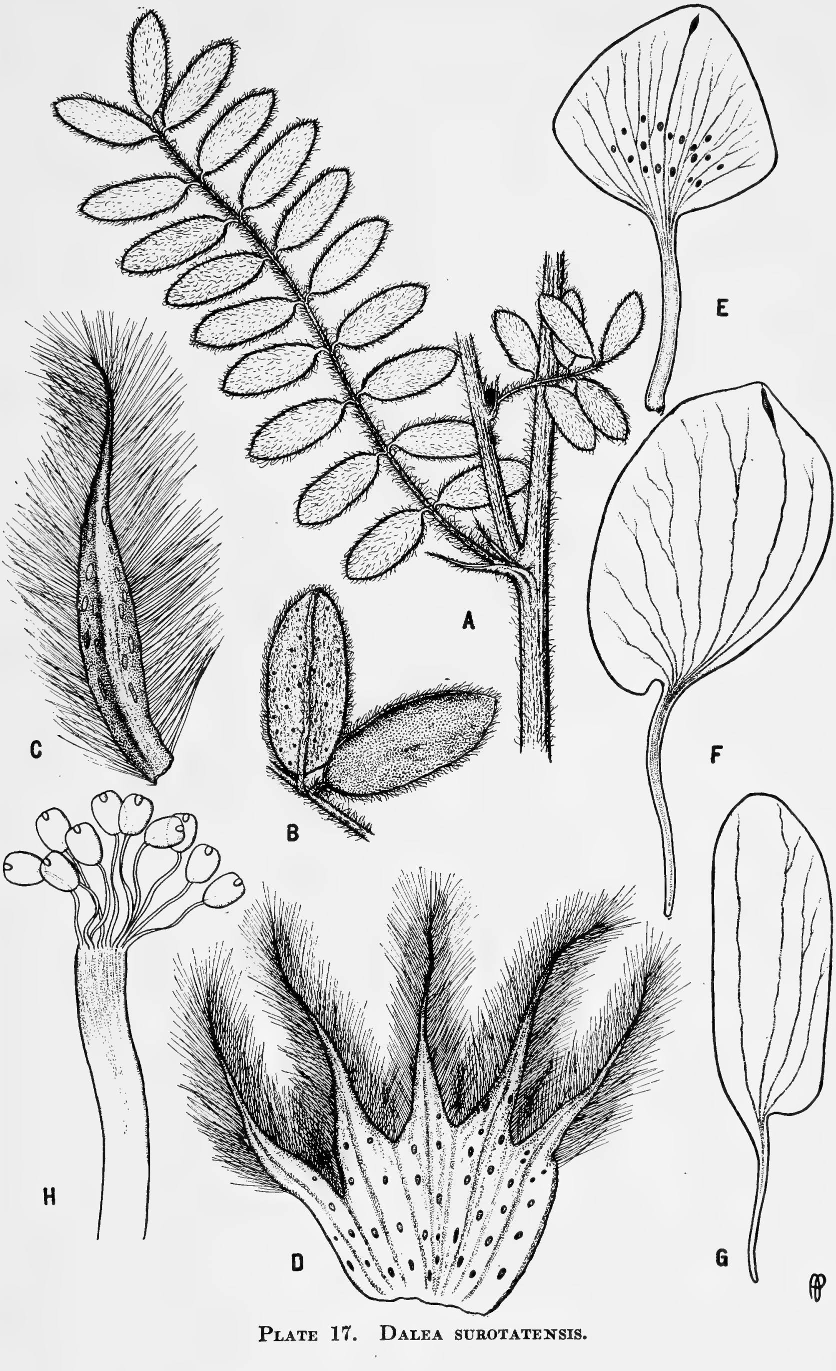

PLATE 17. DALEA SUROTATENSIS.

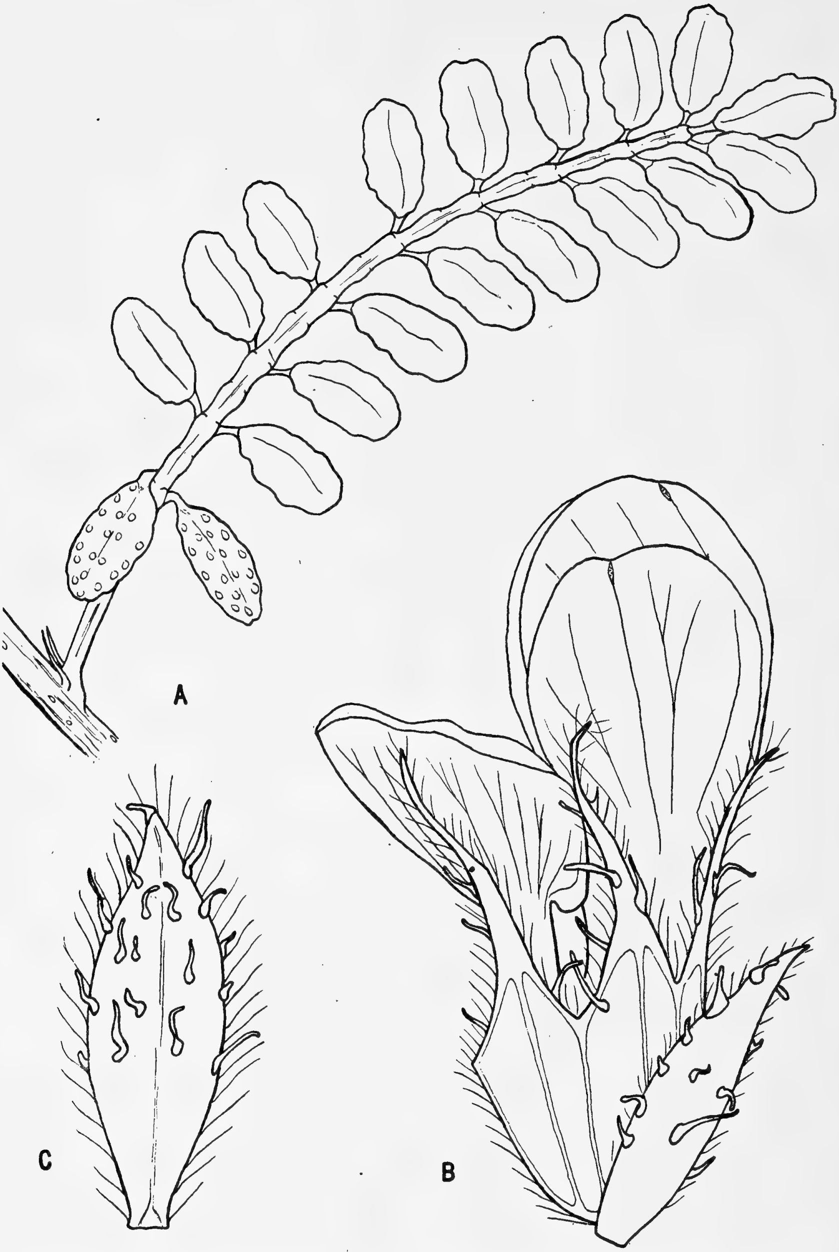

Plate 18. Dalea tentaculoides. Fig. A, stem section with leaf, ×10. Fig. B, flower and bract, ×20. Fig. C, floral bract, ×20. Drawn from type.

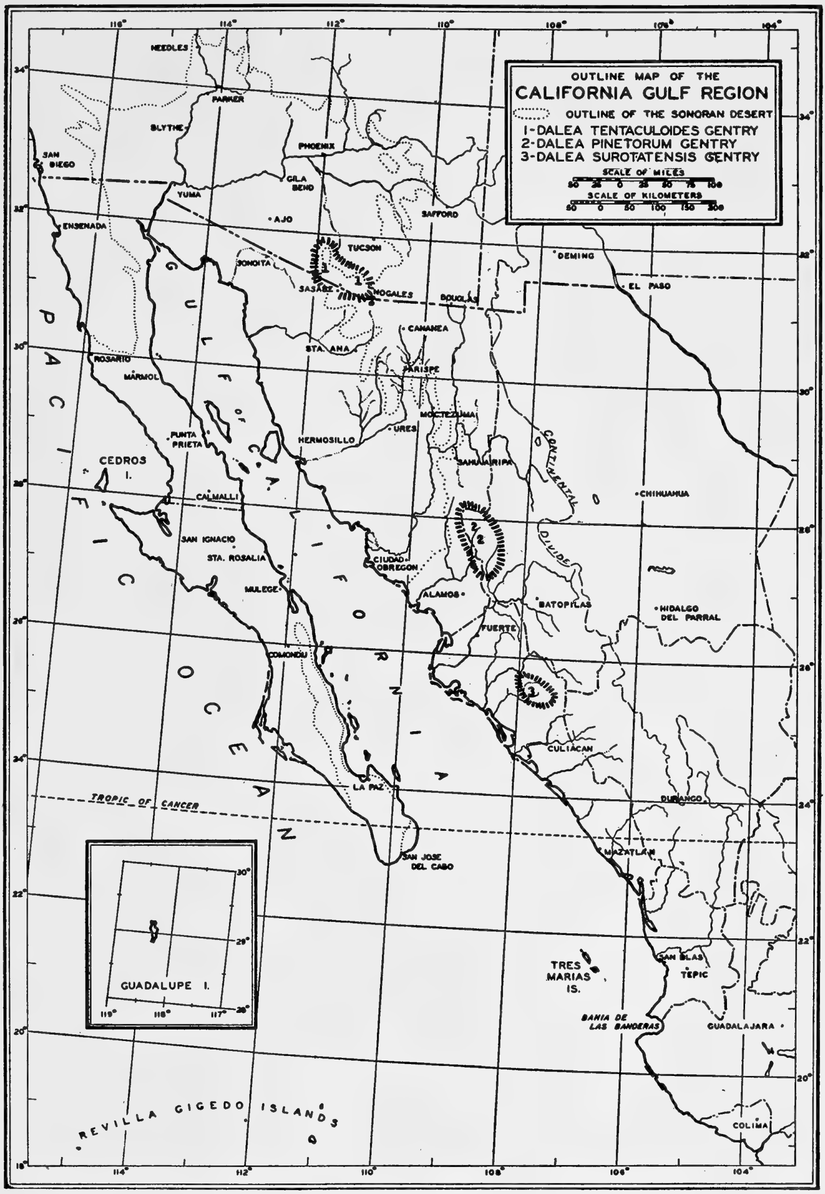

FIG. 2. Distribution of *Dalea tentaculoides, D. pinetorum,* and *D. surotatensis.*

without apical gland; blades of the keel obliquely ovate, 6–6.5 mm. long, 4 mm. wide rarely with apical gland; stamens 10, the column exserted beyond sepal tips; ovary pubescent; ovules 2; pod triangular, densely long white-pilose and minutely glandular distally; seed 1, reniform, smooth, yellowish brown.

Type. Above La Jolla, Sierra Surotato, Sinaloa, Mexico, on the open slopes in pine-oak forest, 5000–6000 feet, March 17–24, 1945, *Gentry 7291a* (DS; isotypes, US, A, NY, F, PH, MICH, Hancock Foundation, Gentry Herb.; topotypes, *Gentry 7291, 7180*, "Flowers lavender; 5–15 dm. high").

The long-pedunculate, large-headed inflorescences suggest *D. sericea* of section *Sericeae*, which is closely related to the section *Versicolores*, but the thin leaf, the woody branches, and lateral heads place it in *Versicolores*. Its nearest relative appears to be *D. pulchra*, from which it is amply distinct in its non-tuberculate stems, its larger, thinner less pubescent and more numerous leaflets, its homomorphic rather than dimorphic bracts, the monopodial virgate habit, the large heads, etc.

Dalea tentaculoides sp. nov. Herba perennis multicaulis 3–5 dm. alta, caulibus glabris viridibus; stipulis 1–2.5 mm. longis subulatis pallidis; foliolis 15–27, glabris vel glabratis, oblongis vel obovatis rotundatis undulatis vel integris, 2.5–5 mm. longis, 1.5–2.5 mm. latis, subtus glanduloso-punctatis; bracteis glanduloso-corniculosis, pilosis, 4–5 mm. longis, lanceolatis; calyce sessili, pubescente 5.5–7 mm. longo, lobis quam calycis tubus longioribus, lanceolatis, pilosis glanduloso-corniculosis; petalis purpureis, vexillo minus saturato. Plates 18, 19.

Erect polypodial herb perennial from a woody thickened root crown, essentially glabrous below the inflorescence, the bracts and calyx lobes with prominent tentacle-like glands; stems green to stramineous, pustulate-tubercled, lowly ribbed, 3–5 dm. tall, glabrous, branching from near the base; stipules 1–2.5 mm. long, subulate from a narrow base, deciduous, nearly white or somewhat colored; leaves apparently ephemeral, 2–3.5 cm. long, the rachis glabrous, rounded below, flattened or grooved above, thickish, glandular; petioles 2–4 mm. long; leaflets 15–27, oblong to obovate, rounded apically, rounded to obtuse basally, the margins undulate or entire, 2.5–5 mm. long, 1.5–2.5 mm. wide, sparsely pubescent to glabrate above, glabrous and coarsely or finely glandular dotted below; peduncles 1–4 cm. long, terminal and lateral; heads 1–2 cm. long, triangular to oblong; bracts broadly lanceolate, short acuminate, 4–5 mm. long, much shorter than calyx, sparsely pilose, with conspicuous tentacle-like, apiculate, and often bulbous-based glands on the backs; calyx sessile, subtended by small, subulate, hyaline glands, campanulate, 5.5–7 mm. long, eglandular between the weak ribs, sparsely pilose, lobes lanceolate, apiculate with a gland, 3.5–4 mm. long, elongate glands up to 1 mm. long, along and near the margins; banner 4 × 3.5 mm., ovate, retuse, "violet", with an apical gland and smaller

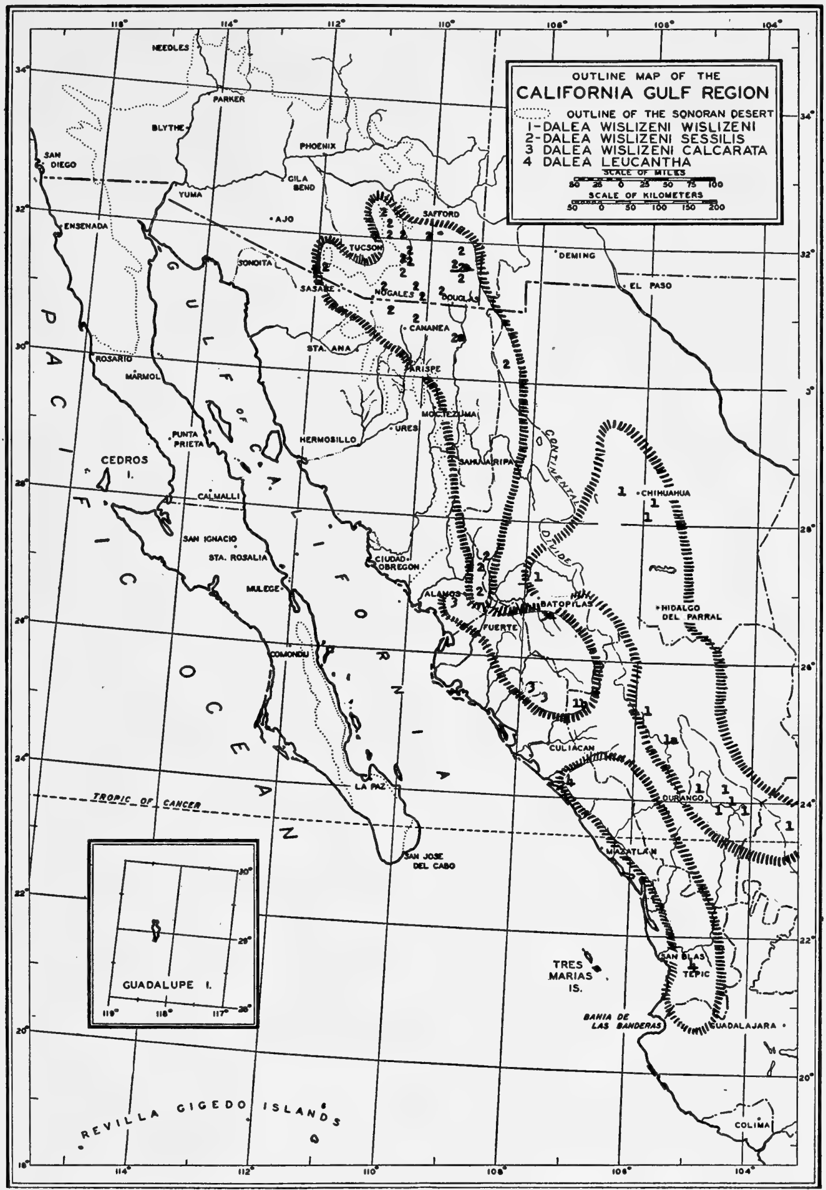

Fig. 3. Distribution of *Dalea Wislizeni* and *D. leucantha.*

scattered glands near the middle; wing blades oblong, ca. 5 mm. long, purple, with a narrow sinus below, a small gland apically; keel blades obliquely ovate, 5.5 mm. long, purple, with a gland near apex; stamens 10, the column not exserted beyond sepal tips; ovary pubescent, sparsely gland-dotted; ovules 2, one aborting.

Type. Sycamore Canyon, between Nogales and Ruby, Arizona, May 9, 1941, *Darrow s. n.* (ARIZ, no. 30239). Additional specimens examined are from the Baboquivari Mountains of southern Arizona: *Gentry 3386,* summer of 1937; *Gentry 3407,* west slope of Baboquivari Mountains, October, 1937, "rocky volcanic slopes 3000–4500 feet;" *Goodding 393 G,* April 17, 1935.

I am unable to associate this plant with a close relative and assign it tentatively to the *Versicolores* section, where it is somewhat out of character in having herbaceous shoots with glabrous and ephemeral leaves. In the apical glands and other characters, however, it appears to belong to the *Versicolores.* The striking specific character of the elongate tentacle-like glands on the bracts and calyx lobes, while unique, does not of itself alienate it from other members of *Versicolores.* Similar glands rarely occur near the base of bracts of *D. Wislizeni calcarata.* As with many other species of *Dalea* it is bifloral in that it may flower in both the spring and fall season following the winter and summer rainfalls. As with *D. Wislizeni sessilis,* the heads which develop in the fall are often much reduced in comparison with those produced in the spring and many contain only three, four or five flowers, as though the progressively lower temperatures and shorter days were definite inhibiting conditions. This species appears to be a montane-insular endemic, originating in isolation upon either the Baboquivari or the Sierritas mountains with subsequent migration to the other. Probably it originated on the Sierritas which appear to be older, judging from the extent of their leveling. It is remarkable that a plant so close to the botanic centers of the University of Arizona and the Carnegie Desert Laboratory was so long uncollected and unrecognized.

DALEA WISLIZENI subsp. **Wislizeni.** *Dalea Wislizeni* Gray, Mem. Am. Acad. Ser. 2, 4: 32, 1849.

Suffrutex gracilis 8–12 dm. altus; ramis gracilibus, ferrugineus, albo-villosis; ramulis terminalibus, adscendentibus, caule simplici prope basin, ramoso in inflorescentia; foliolis 15–25, ellipticis, acutis, 3–7 mm. longis, 1–2 mm. latis, nervis prominentibus dense pubescentibus; inflorescentiis plerumque terminalibus, 2–4 cm. longis laxifloris; bracteis quam calyx longioribus, lineari-lanceolatis. Plate 20.

Dalea Wislizeni is typically a polypodial perennial with strong but virgate stems 8–12 dm. tall, clearly ferrugineous and silvery pilose or villous, branched only in the terminal half or third to form a narrow flowering crown with terminal inflorescences. It is further characterized by the 15–25 elliptic, acute, villous leaflets with strong midvein below, the somewhat elongate rather lax

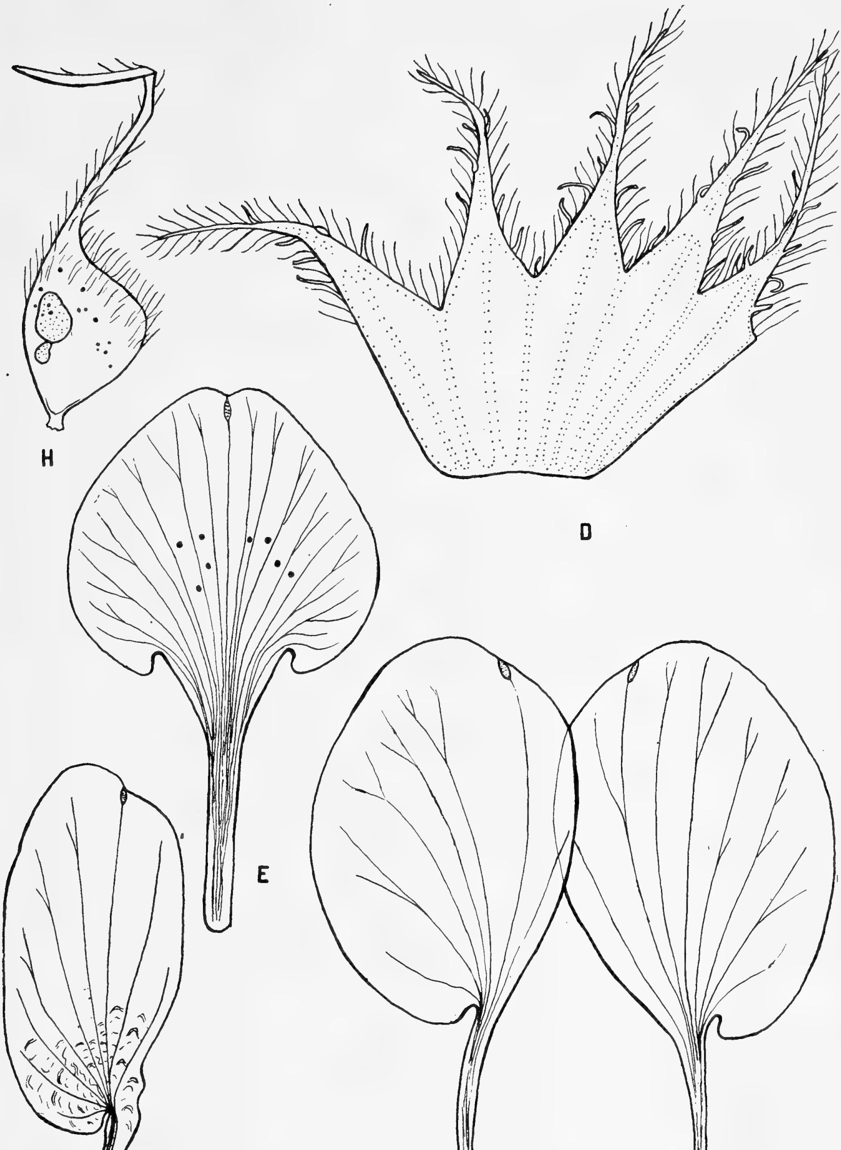

Plate 19. Dalea tentaculoides. Fig. D, calyx spread open, ×20. Figs. E, F, G, banner, keel, and wing petals, ×20. Fig. H, ovary, ×20. Drawn from type.

spikes, and the linear-lanceolate bracts equaling or exceeding the calyx lobes. Other characters separating it from allied species are given in the foregoing key. More than in most other members of the section *Versicolores,* the specific complex as a whole exhibits considerable variation in branching habit, leaf form, pubescence, in the length, size and shape of floral parts, and in other parts. It is primarily of the oak woodland and grama grasslands on the middle mountain slopes and the eastern piedmont plateau of the Sierra Madre Occidental from southeastern Arizona south to northern Zacatecas and northern Sinaloa in Mexico (fig. 3). The type was reported by Gray as collected by Wislizenus in October of 1846 in the plains west of Ciudad Chihuahua, but the label of the type sheet reads "Mts. west of Chiricahui, Mex. Wislizenus". I have been unable to locate the latter name on maps.

Dalea Wislizeni Wislizeni is apparently to be omitted from the flora of the United States. The accompanying map (fig. 3) shows it to range from the latitude of Ciudad Chihuahua along the eastern piedmonts of the Sierra Madre as far as northern Zacatecas, where field observations showed it to be common in the grama grasslands formation on the rocky oak slopes as well as out upon the plains in the grama climax association. It was never found in abundance but was encountered widely scattered, its silvery gray, slender, and graceful form over-topping the shorter grasses. On the basis of the specimens studied, the distribution has been plotted on the accompanying map (fig. 3). Some variants of subspecies *Wislizeni* are notable as follows:

A collection from near Santiago Papasquiaro in northern Durango (*Palmer 67 in 1896*) is extratypical and differs from all other segregates in the small vernicose calyx. It is a spring collection in advanced flowering state and shows the prolific lateral flowering that characterizes the spring form of *D. Wislizeni sessilis.* Perhaps it was this character which led Macbride to so annotate the collection in 1921. It is apparently worthy of a separate name, but I am reluctant to diagnose it with but the one sheet available for study. Another variant, appearing closest to subsp. *Wislizeni,* is represented by a specimen from San Ramon in extreme northwestern Durango (*Palmer 138 in 1906*). It also has the prolific lateral inflorescences of spring but has unusually broad leaflets and relatively sparse pubescence.

The following key separates the subspecies, as I understand them.

KEY TO SUBSPECIES OF DALEA WISLIZENI

Leaflets elliptic, acute, the mid-vein pronounced below and extending to tip of leaflet; stems virgate, but little branched below, densely villous or glabrous; leaflets mostly 15–35.
  Plants villous below the inflorescence; calyx tube notched about half way to the base by the banner, not exceeding 3 mm. long .... *D. Wislizeni Wislizeni*

Plants essentially glabrous below inflorescence; calyx tube not notched or only slightly so, over 3 mm. long .... *D. Wislizeni calcarata*
Leaflets elliptic obovate, cuneate, rounded at the tip, the mid-vein relatively weak; stems short, much branched below, sparsely pubescent; leaflets mostly 11–17 .... *D. Wislizeni sessilis*

Dalea Wislizeni subsp. **calcarata** subsp. nov. Suffrutex gracilis 8–15 dm. altus; ramis gracilibus, rubro-brunneis vel pallide griseis; ramulis adscendentibus, levibus, subsulcatis; foliis remotis, 2–4 cm. longis, glabris, petiolo 1–5 mm. longo; foliolis 13–35, ellipticis, acutis, 3–5 mm. longis, 1–1.5 mm. latis, subtus glanduloso-punctatis; inflorescentiis per caulis dissitis terminalibusque, brevi-pedunculatis; calyce pubescente et inter costulas glanduloso-punctato, 7–9 mm. longo, lobis quam calycis tubus longioribus, plumosis, calcaribus 1–3 lateralibus glandulosis ad medium insignitis; vexillo toto vel partim albo luteove, ad basin glanduloso-punctato, petalis caeteris pallide violaceis roseatisve. Plates 21, 22.

Slender subshrub 8–15 dm. tall with graceful bending branches rather profuse in an open crown, essentially glabrous below the inflorescence; stipules 1.5–2 mm. long, brownish, subulate, persisting on old branches; leaves mostly 2–4 cm. long, glabrous, the rachis rounded; stipels dark conic apiculate glands; leaflets 13–35, elliptic, acute or obtuse, 3–5 mm. long, 1–1.5 mm. wide, petiolulate, the mid-vein prominent and exserted below in a glandular tip, gland-dotted below; heads terminal and lateral, short pedunculate, 1.5–3 cm. long; bracts linear-lanceolate, silvery pilose, with 1–3 glands, the lower shorter than the calyx, the upper equaling or exceeding the calyx; calyx short-pedicellate, silvery pilose, glandular between the ribs, 7–9 mm. long, green-brindled; tube 3–4 mm. long, not notched by the banner or but slightly so; lobes subulate, 4–5 mm. long, calcarate with a pair of subulate glands on the margins, rarely one in the sinus; stamens 9–10, the column exserted; banner deltoid, 5 × 4.5 mm., dotted with glands centrally below the middle; all petals with an apical gland; blades of the wings sharply oblong, 6–7 mm. long; blades of keel petals elliptic-ovate, 7–8 mm. long; ovary narrow, silvery-pilose above, with 1 large gland near the apex.

Type. Los Pucheros, Sierra Surotato, northern Sinaloa, Mexico, on openly forested slope with pine-oak-madroño, elevation 5500–6500 feet, March 24, 1945, *Gentry 7182* (DS; isotypes; MICH, A, NY, F, US, PH, Hancock Foundation). Other specimens assignable here are: topotype under the same date, *Gentry 7186*, Puerto a Tamiapa, Dist. Badiraguato, Sinaloa, March 5, 1940, *Gentry 5811*, "Open slopes with deep clay soil, Oak Forest, 4500 feet;" Sierra de Alamos, Sonora, March 26 to April 8, 1890, ***Palmer 282;*** north wall of Barranca de Cobre [Rio Urique], south-

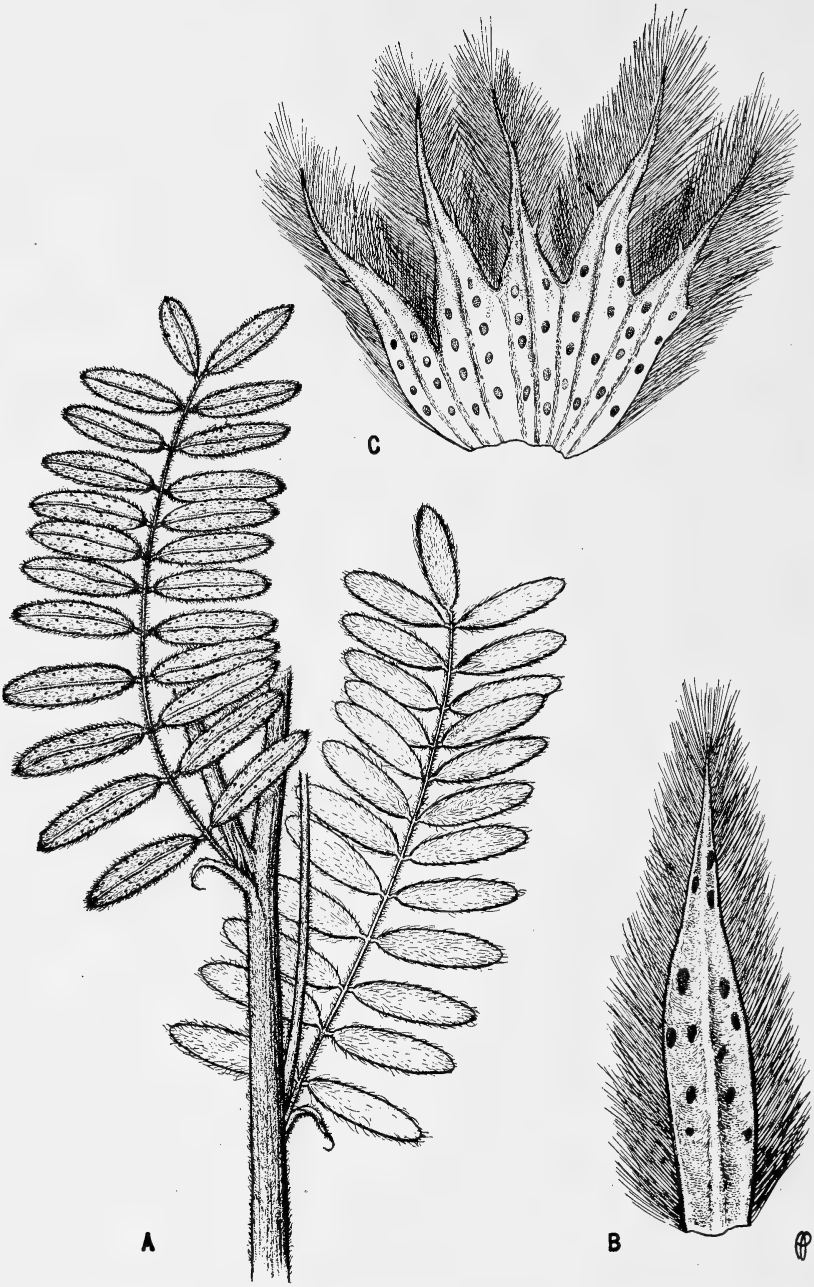

Plate 20. Dalea Wislizeni Wislizeni. Fig. A, stem and leaves, ×5. Fig. B, floral bract, ×16. Fig. C, calyx spread open, ×16. Drawn from *Palmer 374* in 1885 and *Gentry 8437a*.

Plate 21. Dalea Wislizeni calcarata. Fig. A, flowering shoot, ×5. Fig. B, detail of leaflets, ×8. Drawn from type and topotype (*Gentry 7186*).

western Chihuahua, February 15, 1945, altitude 6000 feet, *Hewitt 5.* The collector reports it used as a delousing lotion for animals: 0.25 kg. to 61.0 kg. water, "yerba de piojo." This is a pubescent form with silvery sericeous leaflets; approaching *D. Wislizeni Wislizeni.*

This plant, commonly monopodial, has the virgate habit and the elliptic-acute leaflets with strong mid-veins of *D. Wislizeni Wislizeni,* but resembles *D. Wislizeni sessilis* in its twiggy branching and short-pedunculate heads. It differs from both in the glabrous branches and leaves, in the more numerous leaflets, and in the longer calyx tube with little or no dorsal notch. It is also related to the more southern *D. leucantha* and resembles it in habit, but it is separable according to the preceding key.

DALEA WISLIZENI subsp. **sessilis** (Gray) comb. nov. *Dalea Wislizeni* var. *sessilis* Gray, Proc. Am. Acad. 16: 105, 1880. *Parosela Wislizeni sessilis* Vail, Bull. Torrey Bot. Club 24: 15, 1897. *P. sessilis* Rydb., N. Am. Fl. 24: 104, 1920. *P. sanctae-crucis* Rydb., ibid, p. 103. Plate 23.

Northern variants of *Dalea Wislizeni* were described by Rydberg (loc. cit.) as *Parosela sessilis* and *P. sanctae-crucis.* Rydberg's separation of these two entities rests primarily on whether the heads are terminal and pedunculate (*P. sanctae-crucis*), or lateral and subsessile (*P. sessilis*). Study of a series of specimens fails to demonstrate other corroborative characters. The sorting of forty-four collections on the basis of terminal and pedunculate heads versus subsessile and lateral heads, discloses twelve of the former, as being collected in the summer-fall period, and twenty-six of the latter, as having been collected in the spring. In other words, the long-pedunculate terminal heads represent the longer more vigorous shoot growth of the summer-fall growing season in response to the summer rains, whereas the lateral subsessile heads are the product of the cooler spring season. Six exceptions, fall collections with lateral subsessile heads, all show browsed or galled plants where the shoots had been damaged or chewed off. Obviously, seasonal growth response cannot support taxonomically even a form entity; I have accordingly placed *P. sanctae-crucis* Rydb. in synonomy.

Dalea Wislizeni sessilis is nearly confined to the oak woodland and grass associations of the northern Sierra Madre Occidental region (fig. 3). Its area is fairly distinct from those of the other subspecies, although an overlap with *D. Wislizeni calcarata* is indicated in the mountains about the Sonora-Sinaloa boundary.

EXPLANATION OF THE FIGURES. PLATE 22

PLATE 22. DALEA WISLIZENI CALCARATA. Figs. C and D, upper and lower floral bracts, ×16. Fig. E, calyx spread open, ×16. Figs. F, G, H, banner, keel, and wing petals, ×16. Drawn from type and topotype (*Gentry 7186*).

Plate 22. Dalea Wislizeni calcarata.

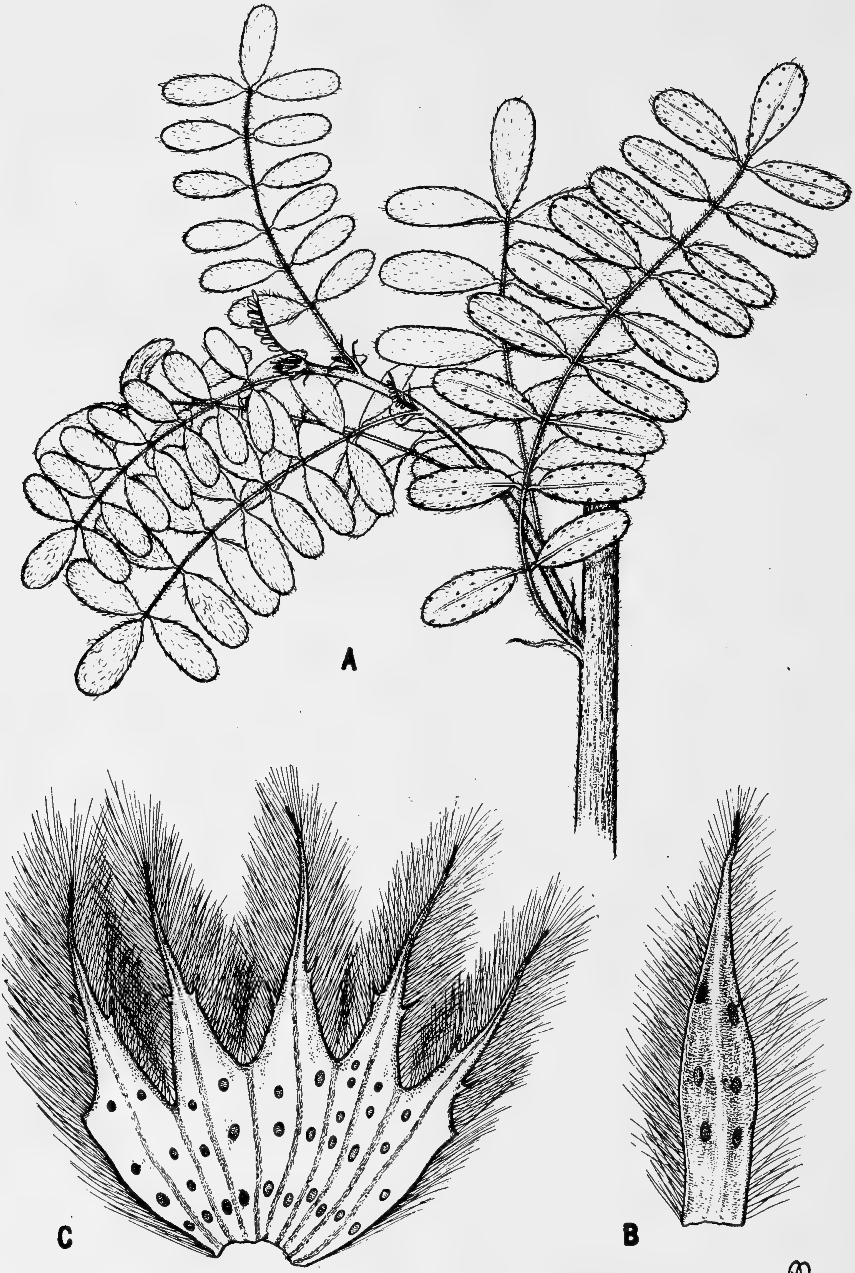

Plate 23. Dalea Wislizeni sessilis.

The principal variant noted in the *D. Wislizeni sessilis* population occurs in the Chiricahua Mountains of southeastern Arizona and adjacent northeastern Sonora; it is recognized by the strong midvein of the leaflets, a primal character of *D. Wislizeni Wislizeni* and *D. Wislizeni calcarata.* In other respects it is like the normal of the subspecies *sessilis.* The following collections have been noted as belonging to this variant form: Piñon, northeast Sonora, January 2, 1890, *Hartman 365;* Chiricahua Mountains, September 1919, *Eggleston 10896;* Chiricahua Mountains, road from Paradise to Sawmill, October 1906, *Blumer 1477;* Chiricahua Mountains, *Blumer 48.*

Although in general the mature leaves of *D. Wislizeni sessilis* are sparsely pubescent, obovate, cuneate, and with rounded apex, the young leaves (especially the drought-depauperate ones of early spring) are commonly rather densely pubescent and they are often elliptic-acute as in the subspecies *Wislizeni* and *calcarata.* As the leaflets of subsp. *sessilis* mature, however, they develop into the elliptic-obovate, rounded-tip form. This ontogeny of leaf suggests that the elliptic-acute form is the more primitive or original and that subsp. *sessilis* is, therefore, a recent segregate of the older north Mexican subsp. *Wislizeni* population. The strong central rib form of the Chiricahua populations in *D. Wislizeni sessilis,* usually correlated with the elliptic acute leaflet, appears as a survival character in a modern evolvement.

It is with considerable hesitation that I have treated these three closely related, but nevertheless coherent and distinct plant populations, as subspecies, leaving Rydberg's handy binomial system for a poorly tried modern tendency towards trinomials, quadrinomials, and worse. Just how much of classificatory burden should be placed on a system of names which has had almost 200 years of universal function because of its primal simplicity?

A forthcoming study of the Durango Grasslands makes it desirable to legitimize the following new combinations in *Dalea* since its adoption as a *nomen conservandum.*

Dalea fulvosericea (Rydb.) comb. nov. *Parosela fulvosericea* Rydb., N. Am. Fl. 24: 89, 1920.

Dalea lagopina (Rydb.) comb. nov. *Parosela lagopina* Rydb. N. Am. Fl. 24: 72, 1920.

EXPLANATION OF THE FIGURES. PLATE 23

PLATE 23. DALEA WISLIZENI SESSILIS. Fig. A, summer shoot, ×5. Fig. B, floral bract, ×16. Fig. C, calyx spread open, ×16. Drawn from *Harrison* and *Kearney 6227, Fish 18,* and ARIZ 02991.

Dalea Lloydii (Rydb.) comb. nov. *Parosela Lloydii* Rydb., N. Am. Fl. 24: 84, 1920.

Dalea lucida (Rose) comb. nov. *Parosela lucida* Rose, N. Am. Fl. 24: 74, 1920.

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A NEW SPECIES OF POLYGONUM FROM OREGON

MORTON E. PECK AND MARION OWNBEY

Polygonum heterosepalum sp. nov. Herba annua parva 1.5–5 cm. alta cauli rubrotincto subglabro omnino dense folioso floridoque simplice vel basi ramoso ramis simplicibus inter se subaequilongis foliis late linearibus vel elliptico-lanceolatis 1–2 mm. latis 4–10 mm. longis basi haud articulatis marginibus revolutis apice mucronibus subrigidis albidis instructis ocreis conspicuis albidis profunde laciniatis laciniis subulatis rectis subrigidis floribus plerumque 2–3 in axillis foliorum fasciculatis perianthii segmentis perinaequalibus linea viridi media tribus interioribus plus minusve furfuraceis albidis usque ad 2.5 mm. longis quam duobus exterioribus plus duplo longioribus staminibus antheriferentibus tribus segmentis interioribus oppositis filamentis tribus sterilibus alternatis achenio olivaceo nitido 1.5–2 mm. longo incluso.

A small annual herb, 1.5–5 cm. tall; stem reddish, nearly glabrous, densely leafy and floriferous throughout, simple or branched from near the base, branches simple, subequal in length; leaves broadly linear or elliptic-lanceolate, 1–2 mm. broad, 4–10 mm. long, not jointed at the base, apex with a stiffish white mucro, margins revolute, ocrea conspicuous, whitish, deeply laciniate, with subulate, straight, stiffish segments; flowers usually 2–3 together in each leaf axil; perianth segments very unequal, the three inner ones somewhat scurfy, whitish with a median green line, about 2.5 mm. long, more than twice as long as the two outer ones; anther-bearing stamens three, opposite the inner segments, alternating with 3 sterile filaments; achene olive-brown, shining, 1.5–2 mm. long, included.

Type. In disturbed soil, 12 miles north of Jordan Valley, Malheur County, Oregon, June 13, 1946, *Marion Ownbey* and *Gerald B. Ownbey 2774* (Herbarium of the State College of Washington; isotypes at New York Botanical Garden, University of Minnesota, University of Oklahoma, Willamette University, and in the herbarium of J. F. Brenckle; others to be distributed). Three earlier Oregon collections are to be found in the Herbarium of Willamette University, as follows: dry ground, 15 miles southwest of Burns, Harney County, June 23, 1925, *Peck 13911;* moist flat, 7 miles northeast of Wagontire, Harney County, June 25, 1941, *Peck 20912,* in part; moist flat, south base of Wagontire Mountain, Lake County, June 25, 1941, *Peck 20912,* in part.

Polygonum heterosepalum is an inconspicuous and superficially commonplace member of the genus. When carefully examined, however, its characteristics are such as to require not only an emendation of the section Duravia to which the authors would ally it, but of the genus *Polygonum* as well. The section Duravia is a well marked group of five species, all of which bear the flowers singly in the leaf axils. In *P. heterosepalum,* the flowers are usually in two's or three's in the leaf axils. The stamens are usually eight in Duravia; in *P. heterosepalum,* there are six, only three of which are antheriferous. Furthermore, in Duravia, the five perianth segments are subequal in size and similar in coloration; in *P. heterosepalum,* the outer two are less than half as long as the inner three, and correspondingly narrower. In this feature, *P. heterosepalum* is seemingly unlike any described species of the genus.

Notwithstanding these ostensibly important differences, *P. heterosepalum* appears more closely related to the species of the section Duravia than to those of any other section. With these species it agrees in its thick mucronate leaves and laciniate ocreae. Habitally, it resembles *P. Parryi* Greene of this section, and it is possible that it may be found under this name in herbaria.

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