MADROÑO

A WEST AMERICAN JOURNAL OF
BOTANY

VOLUME IV
1937 - - 1938

Published by the
California Botanical Society Inc.
4004 Life Sciences Building, University of California, Berkeley
North Queen Street and McGovern Avenue, Lancaster, Pennsylvania

CONTENTS

VOLUME IV NUMBER 1

MADROÑO

A WEST AMERICAN JOURNAL OF BOTANY

Contents

Published at Lime and Green Streets, Lancaster, Pennsylvania

January, 1937

MADROÑO

A WEST AMERICAN JOURNAL OF BOTANY

Entered as second-class matter October 1, 1935, at the post office at Lancaster, Pa., under the act of March 3, 1879.

Established 1916. Published quarterly. Subscription Price $2.50 per year. Volume I, Numbers 1 to 17, complete, $5.00. Volume II, Numbers 1 to 17, complete, $5.00. Volume III, Numbers 1 to 8, complete, $5.00. Single numbers $0.75.

Papers up to 15 or 20 pages are acceptable. Longer contributions may be accepted if the excess costs of printing and illustration are borne by the contributor. Articles may be submitted to any member of the editorial board and if accepted, are published in the order of receipt. However, accepted manuscripts may be included in the forthcoming issue provided that the contributor pay the cost of the pages added to the issue to accommodate his article. Reprints of any article are furnished at a cost of 4 pages, 50 copies $3.70; 100 copies $4.10; additional 100's .75¢; 8 pages, 50 copies $5.40; 100 copies $6.00, additional 100's $1.20. Covers, 50 for $2.50; additional covers at $1.50 per hundred. Reprints should be ordered when page proofs are returned.

Published at Lime and Green Streets, Lancaster,
Pennsylvania, for the

CALIFORNIA BOTANICAL SOCIETY

Annual membership dues of the California Botanical Society are $2.00, $1.50 of which is for a year's subscription to Madroño. Dues should be remitted to the Treasurer. General correspondence and applications for membership should be addressed to the Secretary.

THE REPRODUCTIVE STRUCTURES OF PLEURICOSPORA

Herbert F. Copeland

The genus *Pleuricospora,* with the single species *P. fimbriolata,* was described by Gray (7) as collected by Bolander "in or near the Mariposa *Sequoia gigantea* Grove" (Mariposa County, California). It is a saprophytic plant of the monotropoid alliance, not uncommon in the Sierra Nevada; but as it is less conspicuous than its allies *Sarcodes* and *Pterospora,* it is less familiar. It occurs also in the Coast Range of California and in Oregon and Washington. Two species have been described in addition to the one usually recognized. Of *P. longipetala* Howell, from Oregon, I have seen no material. As to *P. densa* Small (16), from the Sierra Nevada, neither the description nor a fragment of the type in the herbarium of the University of California shows any character by which it would be distinguished in the presence of a good range of specimens of *P. fimbriolata.* All herbarium specimens of *Pleuricospora* seem to have been collected during the months June to August inclusive.

I have been led to the study of pyroloid and monotropoid plants by a number of factors, one of which is the beauty and abundance of several species at Jonesville, in the Sierra Nevada in Butte County, California, at an altitude of about 5000 feet. It is by chance rather than for any definite reason that I am now ready to describe *Pleuricospora* rather than one of the others. I have seen it in the forests summer after summer, and have prepared microtome sections representing a considerable range of stages. Ordinary microtechnical methods were used; as a fixative, usually Bouin's fluid; as stains, Heidenhain's haematoxylin, Delafield's haematoxylin and safranin, safranin and light green, acetocarmine and aniline blue. The development of pollen was studied in plants dug up in the mountains and brought to Sacramento in the valley, where they developed rapidly; Belling's (3) iron-acetocarmine technique was applied, and impressed me by its usefulness. I cannot as yet elucidate some of the most interesting features of the plant; I have not worked out the detailed anatomy of stem and root; and experimental work will be necessary before one can say anything of the mycorrhiza with which the roots are clothed, of its relation to the life of the plant, or of the germination of the seeds.

It is a pleasure to acknowledge the many obligations which I have contracted in pursuing these studies. I am indebted to my father, Dr. E. B. Copeland, who made the observation of pollination noted below; to my colleagues, Dr. H. J. Child, Mr. George Kimber, and Miss Mary Cravens; and to our students, Mr. Frank

Madroño, Vol. 4, pp. 1–40, January 6, 1937.

Dutra, who identified the bee, *Bremus vosnesenskii,* and especially Mr. Taiichi Asami, who prepared the slides from which several of the drawings were made.

General Structure

The plant is found chiefly in forests of silver-tip fir (*Abies concolor* Lindl. and Gord.) in ground covered by masses of decaying needles. As seen, it consists of little subglobular inflorescences projecting two or three centimeters above the surface (text fig. 1). They are white in bud or young flower, later turn-

Fig. 1. *Pleuricospora fimbriolata* Gray. Fruiting plants *in situ* × ½. Photograph by F. S. van Eckhardt.

ing yellow, brown, or black. By digging, one finds that the inflorescences stand on peduncles several centimeters long, which arise from masses of slender roots. The roots are usually located in the soil beneath the decaying fir needles; their branching is, in part at least, exogenous; but the shoots arise endogenously. In July or August, young shoots, from a millimeter or so to several centimeters long, are to be found among the ones already in flower (pl. I, fig. 1); microscopic examination of the longer ones shows flowers with the parts already differentiated. If one marks the location of a cluster and digs early the next June (this is not summer, but early spring in the mountains), one finds them somewhat more highly developed; the anthers contain pollen mother cells. The sap of the shoots is sweet, and gives a strong positive reaction with Fehling's solution. In late June and along through July, when pollen is fully formed but before the ovules are ready for fertilization, the shoots appear above ground. The flowers open in acropetal order, but the uppermost ones often remain closed. Maturing and mature fruits are found in late July and in August.

The shoots are clad with scales, of which the lower may be called "leaves" on the "peduncle," and the upper "bracts" on the "rachis." They are all essentially alike, ovate to lanceolate, sharp pointed, more or less lacerate. The phyllotaxy is irregular and variable. Sometimes one finds a spiral, but not a typical spiral referable to the orthodox 1/2, 1/3, 2/5, etc., system; more often the scales are in whorls; on most shoots the number of members in the whorl is constant, and is either four, five, or six (pl. I, figs. 1, 2).

The flowers are solitary in the axils of the bracts, and are, of course, whorled as the bracts are (pl. I, fig. 2). In bud, the flowers are strictly sessile; but a pedicel grows as flower and fruit develop, and may reach a length of five millimeters. The cluster is, then, a spike or raceme; the lower pedicels show no tendency to bear lateral flowers, as in *Hypopitys, Newberrya,* and *Pityopus.*

The flowers (pl. I, figs. 3–14) are hypogynous and choripetalous, and with rare exceptions the parts are tetramerous. All parts are glabrous. Of sepals, one lies against the axis, that is, in a ventral position, and one against the bract, that is, in a dorsal position; these two are flattened; the other two, the lateral ones, are keeled. Sepals reach a length of 5 to 10 mm. The petals, placed alternately to the sepals, so that two of them may be regarded as ventral and two as dorsal, reach a slightly greater length. Sepals and petals, like the scales, are more or less lacerate. Details of the floral diagram—matters of the overlapping of one sepal or petal by another—vary from flower to flower. A stamen lies opposite each perianth segment. The anthers reach a length of three or four millimeters, and contain distinct pollen grains, before the filament begins to develop. As the flower approaches anthesis and finally reaches it, by the elongation of sepals, petals, and pistil, the anther grows but little; the filament grows to its full length, longer than the anther, in the course of a week or so, carrying the summit of the anther to about the level of the tips of the sepals. The flask-shaped pistil, about as long as the sepals and stamens, bears at the base a whorl of eight inconspicuous blunt nectaries, which, in the mature flower, project between the bases of the filaments. The style is short, not definitely marked off from the ovary; the stigma is narrow, its upper surface divided into four lobes. The style is traversed by an open channel, cruciform in cross section, and leading into the cavity of the ovary. The ovary contains (in almost all flowers) four placentae; these are densely covered with small ovules. The lobes of the stigma, and the placentae, are opposite the sepals. These structures mark the boundaries of the theoretical carpels, of which there are, therefore, four, opposite the petals.

The opening of the corolla is at first merely by a separation of the tips of the petals, affording but a narrow passage down to the viscid stigma (pl. I, figs. 12, 13). The flower remains in this state for two or three days. At this stage, it is found to have a faint, but definite, orchid-like odor; and nectar can be found about the base of the pistil. The anthers have developed in lateral contact with each other, and are now found to form a cylinder about the style, not projecting above the stigma. Dehiscence is approximately contemporaneous with the opening of the corolla. Two lengthwise rips are formed in each anther, by the contraction of a somewhat thick-walled, but not ribbed, exothecium. In fresh material, and in material preserved in liquid, the valves are not seen to gape widely; they separate to a distance about equal to the thickness of the anther, so that the spaces between each anther and the adjacent ones become filled with loose pollen grains. My microtome sections (pl. II, fig. 3) are of course made from completely dehydrated mature material, and show the valves completely straightened out.

It is evident that pollination is by insects; presumably by minute insects, or insects with a slender proboscis at least a centimeter long, to reach between the anthers to the base of the filaments and pick up the pollen on the way. Only one definite observation of a visit of an insect has been made; this was by a bee which has been identified as *Bremus vosnesenskii* (Radoszkowski). This is the common bee of the Sierra Nevada which is recognized by a large white patch on the back; it has been seen visiting other flowers of the neighborhood, both white and colored, as *Carum Gairdneri, Veratrum album,* and *Sidalcea spicata.*

After a few days, the flower opens more widely. This is accomplished chiefly by a movement of the two dorsal or abaxial petals; the two petals against the rachis remain erect. The flower is, it appears, definitely but obscurely zygomorphic (pl. I, fig. 14). The anthers are free to fall out of their compactly cylindrical arrangement, and may project above the stigma. Pollination is probably accomplished, under normal conditions, before this opening occurs; the complete opening of the flower seems merely to be the first stage of its withering.

The fruit (pl. V, figs. 1, 2) on its gradually lengthening pedicel, develops among the perianth segments. These gradually turn dry and yellow or brown, but scarcely shrivel or lose their shape. Fully mature, the fruit is ovoid, crowned by the shrivelled stigma, 5–10 mm. long, and conspicuously white. It is fleshy but utterly tasteless. Nothing is known of dissemination. The fruit seems not to attract animals; it dries up and turns black *in situ.* The abundant seeds (pl. V, fig. 3) are approximately 0.35 mm. long. They are ellipsoid in shape and of a shining chestnut-brown color, like minute footballs; the surface shallowly pitted by the collapse of external cell walls; the micropylar end somewhat contracted and darkened, the chalazal end obtuse, not tailed.

Tissues; Vascular Anatomy of the Receptacle

On all external surfaces of the shoot, excepting those of the anthers, the stigma, and the inside of the pistil, there is an epidermis with a cuticle which is minutely striate. The ground tissue shows no particular peculiarities except the presence of many cells containing some substance (tannin ?) which stains deeply red with safranin and deeply black with osmic acid. The same substance, apparently, is abundant in the cells of the epidermis of the anthers (the exothecium) and in the outermost cell layer of the ovules. The stigma is seen in sections of buds to be covered by an epidermis of columnar cells; as the flower matures, they become needle-shaped and separate from one another. They are evidently glandular and secrete a viscid material in which pollen grains catch.

Before describing the vascular system of the flower, one must say something of the anatomy of the stem. There is a thin vascular cylinder, with but few lignified cells, between the cortex and the large pith. The "nodes are unilacunar"; in the peduncle there are leaf traces from each gap, but no axillary bud traces; in the rachis, a flower trace of two bundles arises from the sides of each gap above the bract trace.

In all of the matters just mentioned, *Pleuricospora* agrees with *Newberrya* and *Pityopus* as I have already (5, 6) described them. A conspicuous difference is the complete absence of epidermal hairs in *Pleuricospora.*

The two bundles of the flower trace come together to form a vascular cylinder in the pedicel. In the receptacle, several whorls of bundles depart from this cylinder, not without considerable irregularity (pl. V, fig. 5). The typical picture is as follows: (a) First a whorl of four bundles passes out to the sepals. (b) Then, alternating with the sepal bundles, a whorl of four passes out to the petals. (c, d) Next, two whorls, each of four bundles, pass out to the stamens; the bundles to the stamens opposite the petals are immediately above the ones to the petals; the bundles to the stamens opposite the sepals are commonly a little higher. This lowering of the petalad stamen bundles is found also in *Pityopus,* where it is associated with the pairing of the nectaries opposite the petals; but there is no pairing of the nectaries in *Pleuricospora.* (e) A whorl of four carpel-dorsal bundles, placed above the petalad stamen bundles, ascends the walls of the ovary. (f) Finally, a whorl of four placental bundles ascends into the placentae. These use up the last of the vascular tissue.

Gaps may be either present or absent in the vascular cylinder above any particular bundle, or elsewhere; they are most usually present above the sepal and sepalad stamen bundles, most usually absent above the petal bundles. No carpel-lateral bundles, which would ascend the wall of the ovary in positions alternate with the carpel-dorsals, were mentioned above; but occasionally a more or less complete whorl of them may be found. Sometimes more than one bundle runs up the back of a single carpel. The supply to a placenta consists often of more bundles than one. My figure is based on several sets of serial sections; it represents the ideal receptacular vascular system as I understand it, rather than the actual structure of one individual.

Development of Stamens and Pollen

I failed to follow the development of internal structure in the stamen from August till June. In early June, the cells of wall and tapetum and the microspore mother-cells are already distinct (pl. II, fig. 1). The wall consists of two or three layers of thin-walled cells, those of the outermost layer (the exothecium, containing much material stainable with safranin) being very much the largest.

All tapeta are short-lived; but they live long enough, in various flowering plants, to show differences in behavior. Cooper (4) has studied the occurrence of nuclear divisions in tapetal cells of many species, and finds three types of behavior: either the tapetal nuclei remain undivided; or they divide once, and the cells remain binucleate; or they divide an indefinite number of times, and the cells become multinucleate. No Ericales were among the plants he studied. The present species, if my eyes have not deceived me, conforms to none of Cooper's three types. By the time the pollen mother nuclei are in synapsis, the tapetum has already begun to degenerate, but still mitotic figures may be seen in it; mitosis seems always to be followed by cell division, and the tapetum comes to consist of uninucleate cells of varied sizes. The tapetum shrivels away to nothing without becoming an amoeboid mass; it is of the "Sekretionstapetum" type of Schnarf (13).

The development of pollen mother-cells into pollen grains takes place, in the climate of Sacramento, during a period of a week or two, while the anthers are about 2–3.5 mm. long.

As the anther enlarges and the tapetum degenerates, the pollen mother-cells enlarge, and walls, gradually increasing in thickness, appear about them. They round up. The stages of synapsis, diakinesis, heterotypic metaphase and anaphase, and the phases of homeotypic division were observed in succession (pl. II, figs. 4–8). In the heterotypic anaphase it was possible to count the chromosomes; the haploid number is twenty-six (pl. V, fig. 4). It was not perfectly easy to be certain of the count. I became convinced that twenty-six is the correct haploid number when I was able to see both anaphase groups in a single cell, from a direction between equatorial and polar, and to find the chromosomes corresponding in position, individual by individual, in the two groups. They seem to be all alike, ovoid in shape, and show a tendency to arrange themselves in definite rows.

When reduction division is complete, the wall of the pollen mother-cell having developed considerable thickness, cell division follows by simultaneous furrowing (pl. II, figs. 7, 8); and soon afterward one finds separate pollen grains (pl. II, fig. 9). Exactly this process has been described in very many flowering plants. It raises a number of questions, to which the answers are probably known although I have not located them. The wall which develops about the pollen mother-cell, the wall which forms in the furrows between the pollen grains as fast as they cut in, and the walls about the separate grains, all seem to be of the same material: at least, they are all alike resistant to stain ing. What material is this? Does the wall of the pollen mother-cell become divided among the pollen grains, or does it dissolve, while each pollen grain forms its own wall?

I have not seen such a stage as Oliver (10) figures for *Sarcodes,* in which the original nucleus of the pollen grain has divided and a generative cell has formed against the wall of the pollen grain. It is quite possible that the generative cell originates in this fashion; I have seen it only in later stages, as a fusiform body of deeply staining cytoplasm lying free within the pollen grain and containing a nucleus which stains more deeply than the tube nucleus (pl. II, fig. 9). The mature pollen grain, mounted in liquid, is essentially spherical. The wall is marked by four lengthwise grooves (rarely five). Mounted in air, pollen grains become approximately cubical, as the four grooves on the sides and also the two ends are drawn in.

As was mentioned above, the final maturing of the pollen grains goes along with the elongation of the filaments, and is followed by the opening of the flowers and the dehiscence of the anthers.

Newly ripe pollen grains were tested for germination in hanging drops of tap water and of solutions of sucrose of concentrations from one to 30 per cent. There was no germination in tap water. Germination took place in every sugar solution tested; it was recognizable within five hours by the appearance of a little bump on one of the grooves of each pollen grain. It seemed most normal and abundant, and the growth of the pollen tube seemed most rapid, in the 20 per cent solution; here tubes 0.5 mm. long were seen after thirty hours. The more dilute solutions seemed hypotonic with respect to the contents of the pollen grains; they did not cause the grains to swell and burst, but caused the ends of the pollen tubes, where the walls must be weakest, to become swollen, sometimes to diameters as great as the pollen grains from which they had sprung. The more concentrated solutions caused no obvious damage but seemed to decrease the percentage of germination and to retard growth. The generative cell was seen to enter the pollen tube before its nucleus had divided (pl. II, fig. 10). Either the tube nucleus or the generative cell may enter the tube first.

Of the growth of the pollen tube under natural conditions, I know little. The pollen grains are caught on the stigma by some viscid substance secreted by the epidermal layer of needle-shaped cells. The pollen tubes grow along the cracks between the lobes of the stigma and down the style channel. In the ovary I have only occasionally been able to recognize pollen tubes, and I have not been able to see one growing from outside into an ovule. The plugs closing old pollen tubes, mentioned by Oliver as occurring in *Sarcodes,* were recognized.

Development of Ovule and Seed

Ovules are recognizable, up to about the time of reduction division in the anthers, as abundant hemispherical bumps on the placentae. I have missed seeing a series of stages including the differentiation of the archesporial cell, the "bending over" by which the ovule becomes anatropous, and the origin of the integument. As the pollen grains are ripening, one finds the archesporial cell (which, as is usual in Sympetalae, is itself the megaspore mother-cell) in synapsis or diakinesis (pl. III, fig. 1); the integument, of two layers of cells, is closing over the nucellus, which is a single layer of cells. Subsequently one finds a T-shaped megaspore tetrad (pl. III, fig. 2), of three minute cells and one large one in the chalazal position. In the latter, 2-, 4-, and 8-nucleate stages have been observed, and finally the mature embryo sac, consisting of an egg, two synergids, an endosperm mother-cell containing two polar nuclei, and three antipodal cells (pl. III, fig. 4). While the embryo sac develops, the three non-functional megaspores are absorbed, and so is the whole of the nucellus. There may be some increase in the number of cell layers of the integument; but the integument remains quite thin, and no jacket layer of columnar cells is formed about the embryo sac.

It has not been possible to follow the details of fertilization. It is clear that the pollen tube enters through the micropyle and creates a certain amount of wreckage in the micropylar end of the embryo sac. The egg remains clearly recognizable. In a single section I was able clearly to see one spherical sperm nucleus uniting with the egg nucleus, while another was uniting with the two polar nuclei (pl. III, fig. 5). These observations are in harmony, as far as they go, with those of Shibata (14) on *Monotropa uniflora,* in which he found the sperm nuclei, elongate when first discharged from the pollen tube, to become spherical as they reach respectively the egg nucleus and the polar nuclei, and only then readily stainable. Shibata (15) has mentioned the handsome strands of cytoplasm, extending from the original fusion nucleus in the endosperm, which he observed in living material of *Monotropa.* They are equally evident in microtome sections of *Pleuricospora* (pl. III, fig. 6).

The endosperm develops in the manner usual in Ericales. Before the zygote undergoes any divisions, the endosperm nucleus divides twice; each nuclear division is followed by a cell division, the walls falling at right angles to the axis of the embryo sac, so that a row of four cells is formed (pl. IV, figs. 1, 2). The zygote grows into the shape of a narrow tube, whose summit, in which lies the nucleus, penetrates into the second cell of the endosperm. Of the cells of the four-celled endosperm, some or all may divide by further transverse walls; the second cell (the one surrounding the summit of the embryo) and the fourth (the one at the chalazal end) almost always do this; the first and third more frequently remain undivided. By these divisions the endosperm is converted into a row of six to eight cells. Longitudinal divisions also take place, converting the cells of the row into tiers of cells. The standard number of cells in the tier seems to be four, but this number is not at all constant; thus one may find a tier of four between the developing embryo and the micropylar end of the endosperm; six or eight in a section cut through the embryo; four in sections cut farther back; and only one at the chalazal end.

The first division of the zygote separates, by a transverse wall, a cylindrical cell toward the micropyle from a nearly spherical one toward the chalaza (pl. IV, fig. 3). The protoplasm in the cylindrical cell is gathered at the end which is against the spherical cell, and in later stages it is found to have secreted a wall cutting off a brief suspensor devoid of contents from a conical cell which has been designated as the hypophysis. The spherical terminal cell divides by two vertical walls into a cluster of four. Possibly division sometimes goes farther than this, but I have not been able certainly to recognize it. As the seed approaches maturity, stainable material accumulates in the living cells of the endosperm and embryo. It is evidently the same material in both structures; they are distinguishable only by position, not by staining reactions (pl. IV, fig. 4).

At the time of fertilization the embryo sac is surrounded by an integument partly of two layers of cells, but of three or more against some parts of the sides of the embryo and of several layers at the ends. Even before fertilization the outermost layer, except for a broad gap at the micropylar end, becomes markedly different from the others by an accumulation of tannin (?) as a hollow vescicle within each cell. During development after fertilization, the inner cells against the sides of the endosperm become flattened and finally almost—not quite completely—disappear. A certain number of thin-walled inner cells at the ends remain intact into the ripe seed. A group of antipodal cells can be detected in the chalazal end for some time. The outermost layer of cells becomes very thick-walled, especially on their lateral and inner surfaces; the tannin (if tannin it be) by which these cells are distinguished in earlier stages is perhaps a plastic material from which these thick walls are built. No terminal haustoria are formed on the endosperm, and no tails are formed on the seed by the collapse of functionless inner cells.

Discussion

The most important contributions on the microscopy of the reproductive structures of Ericales have been those of Koch (9) on *Hypopitys;* Oliver (10) on *Sarcodes;* Stevens (17) on *Epigaea;* and Samuelsson (11) and Hagerup (8) on a variety of genera, chiefly Scandinavian. These contributions have been duly summarized by Schnarf (13). *Pleuricospora* conforms to the characters of the order in a whole range of characters, among which may be mentioned the following: (a) flowers formed the year before they are to open; (b) the absence of an endothecium in the anthers; (c) the non-amoeboid tapetum in the anthers; (d) reduction division occurring in the anthers sooner than in the ovules; (e) "simultaneous" division of the pollen mother-cells; (f) pollen grains with two nuclei; (g) the channeled style; (h) ovules with a single integument and a thin nucellus which is soon absorbed; (i) embryo sac developed in "normal" fashion; (j) a young endosperm of four cells in a row; (k) the inner cell-layers of the integument absorbed, for the most part, by the endosperm.

The tapetum in which the cells continue to divide for some time and do not become multinucleate may be an ordinal character; I know of no data on this point from other Ericales.

The pollen grains which are solitary, not in tetrads, are not typical of the order; but they are altogether typical of the monotropoid alliance.

I know of no previous count of the chromosomes in any plant of the monotropoid alliance. Hagerup counted the chromosomes in many other Ericales and concluded that the fundamental number is six; the twenty-six chromosomes of *Pleuricospora* may be a set of $4n+2$. This number is not in good harmony with the chromosome number of *Pyrola* ($n=23$); it harmonizes well with the numbers in *Rhododendron* (a genus in which Sax (12) has found the chromosome number remarkably constant) and *Ledum* ($n=13$) and in the Arbuteae ($n=13$ or 26).

In Ericaceae the integument is usually of several layers of cells at the time of fertilization; and the endosperm usually comes to consist of many cells. Most of the Pyrolaceae of Engler and Prantl (that is, the allies of *Pyrola* and of *Monotropa*) have a very thin integument; and in *Hypopitys* and *Pleuricospora* the endosperm is of very few cells. The nature of the endosperm in other Pyrolaceae, excepting *Sarcodes,* is not definitely known. In bulk both of integument and of endosperm, *Sarcodes* lies between the other Pyrolaceae and the Ericaceae.

The course of formation of the endosperm in *Hypopitys* and *Pleuricospora* shows striking identities, notably in the transverse divisions which take place in the second and fourth cells of the four-celled endosperm; but *Pleuricospora* differs from *Hypopitys*—and, indeed, from almost all other known Ericales—in the fact that the terminal cells of the developing endosperm do not take on a different appearance from the rest, and do not eventually collapse. Some of the details of the embryology of *Sarcodes* as figured by Oliver are different from corresponding stages of *Pleuricospora* and *Hypopitys;* Oliver has represented an embryo developing in the micropylar chamber of the four-celled endosperm, and a suspensor of two or three short, nucleated cells.

Hypopitys and *Monotropa* are closely related to a series of genera with parietal placentation, *Newberrya, Pityopus,* and *Monotropastrum* (Andres, 1, 2). *Pleuricospora* stands outside this circle, distinguished by a combination of characters of no great weight, but which nevertheless make it seem distinct: its completely glabrous character, the pattern of the anthers, its drying brown rather than black, its carpels almost constantly four rather than varying about eight as an average. I do not think that it is related to *Hypopitys* and its closest allies either as ancestor or descendant, but that it is a reasonably close collateral relative.

The direction of evolution by which these plants are related to the Ericaceae remains open for discussion. It is possible to conceive that *Pleuricospora,* with its simple endosperm and anthers opening through slits, is primitive; and that *Hypopitys* and its allies represent a line of evolution leading through *Sarcodes* and *Pterospora* to the Ericaceae, among which some of the Arbutoideae might be the nearest. I am much more inclined to read the series in the opposite direction, and to regard *Pleuricospora* as an end product of a line of evolution in which many of the specialized structures of the Ericaceae have been lost or reduced to their minimum essentials.

Sacramento Junior College,
Sacramento, California,
June, 1936.

Literature Cited

1. Andres, H. Über die Pirolaceen-Gattung Monotropastrum H. Andr. Notizblatt Bot. Gart. Berlin 12: 696–699. 1935.
2. ————. Pirolaceae. Symbolae Sinicae 7: 762–768. 1936.
3. Belling, John. The use of the microscope. New York. 1930.
4. Cooper, D. C. Nuclear divisions in the tapetal cells of certain angiosperms. Am. Jour. Bot. 20: 358–364. 1933.
5. Copeland, H. F. The structure of the flower of Newberrya. Madroño 2: 137–142. 1934.
6. ————. On the genus Pityopus. Madroño 3: 154–168. 1935.
7. Gray, A. Characters of new plants of California and elsewhere. . . . Proc. Am. Acad. 7: 327–402. 1868.
8. Hagerup, O. Morphological and cytological studies of the Bicornes. Dansk Bot. Arkiv 6[1]: 1–26. 1928.
9. Koch, L. Das Entwicklung des Samens bei Monotropa Hypopitys L. Jahrb. wiss. Bot. 13: 202–252. 1882.
10. Oliver, F. W. On Sarcodes sanguinea Torr. Ann. Bot. 4: 303–326. 1890.
11. Samuelsson, G. Studien über die Entwicklungsgeschichte der Blüten einiger Bicornes-Typen. Svensk bot. Tidskrift 7: 97–188. 1913.
12. Sax, K. Chromosome stability in the genus Rhododendron. Am. Jour. Bot. 17: 247–251. 1930.
13. Schnarf, K. Vergleichende Embryologie der Angiospermen. Berlin. 1931.
14. Shibata, K. Die Doppelbefruchtung bei Monotropa uniflora L. Flora 90: 61–66. 1902.
15. ————. Experimentelle Studien über die Entwicklung des Endosperms bei Monotropa. Biolog. Centralbl. 22: 705–714. 1902.
16. Small, J. K. Monotropaceae. North American Flora 29: 11–18. 1914.
17. Stevens, N. E. Dioecism in the trailing arbutus, with notes on the morphology of the seed. Bull. Torr. Bot. Club 38: 531–543. 1911.

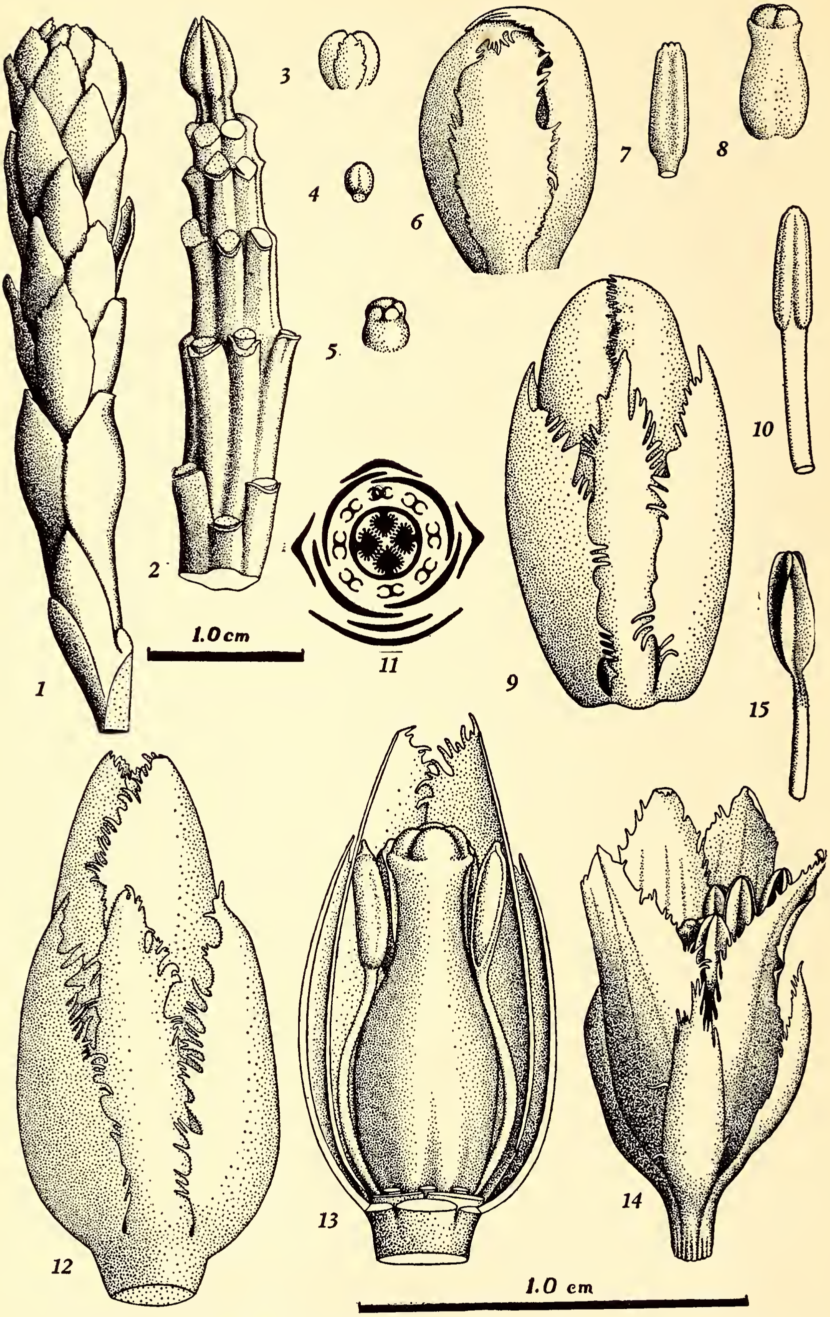


Plate I. Pleuricospora fimbriolata Gray. Fig. 1. Young shoot, with leaves in whorls of four, ×2. Fig. 2. Rachis of inflorescence, showing attachment of bracts and flowers in whorls of five, ×2. Figs. 3, 4, 5. Young bud, stamen, and pistil ×5. Figs. 6, 7, 8. Older bud, stamen, and pistil. Figs. 9, 10. Bud ready to open and stamen ×5. Fig. 11. Floral diagram. Figs. 12, 13. Open flower and longitudinal section ×5. Figs. 14, 15. Flower past anthesis and stamen ×5.

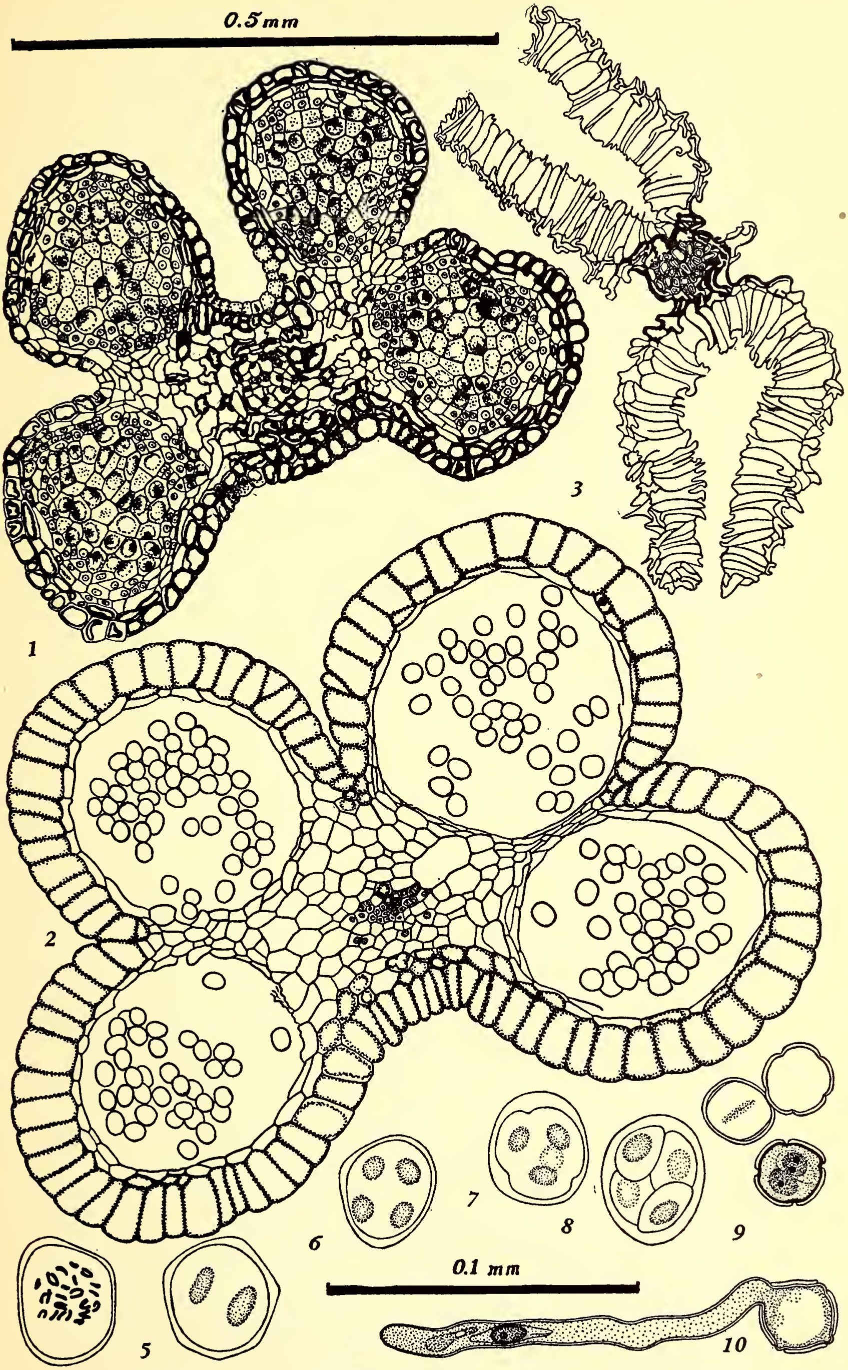


PLATE II. PLEURICOSPORA FIMBRIOLATA GRAY. Figs. 1, 2, 3. Cross sections of anther in successive stages ×125. Figs. 4–9. Development of pollen grain ×400. Fig. 10. Germinated pollen grain with pollen tube attached ×400.

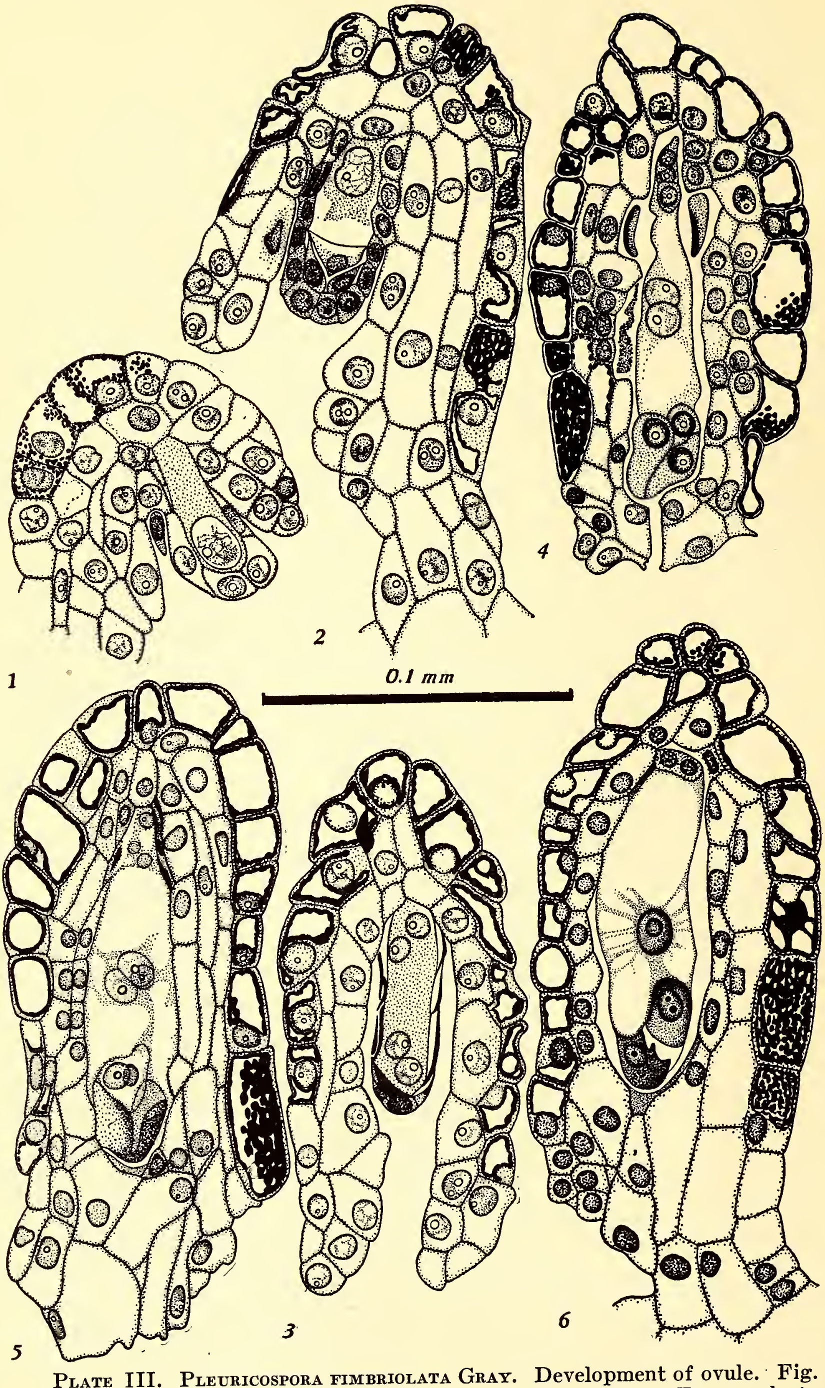


Plate III. Pleuricospora fimbriolata Gray. Development of ovule. Fig. 1. Megaspore mother cell. Fig. 2. Megaspore tetrad. Fig. 3. Four-nucleate embryo sac. Fig. 4. Mature embryo sac. Fig. 5. Fertilization. Fig. 6. One-celled endosperm. All × 400.

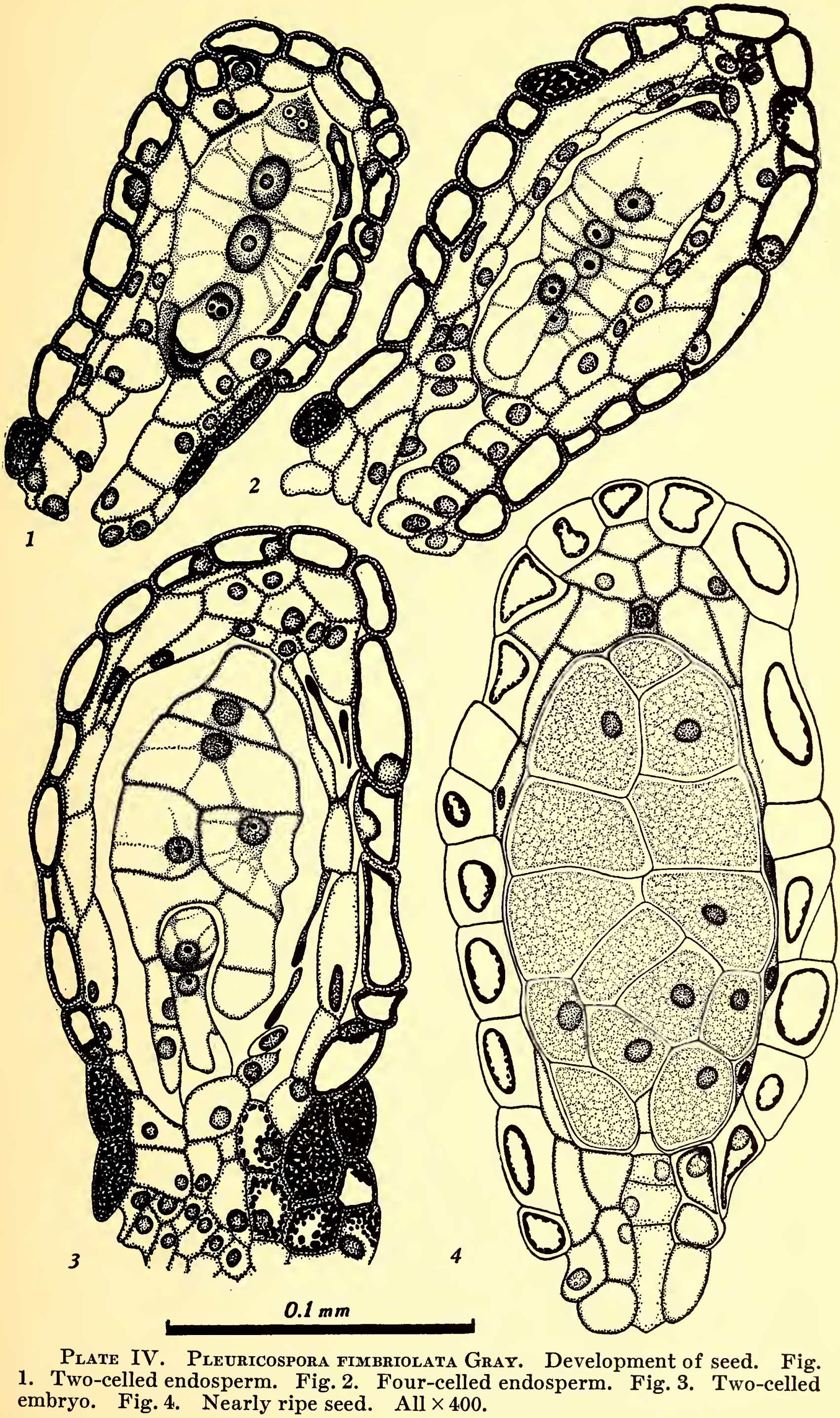


PLATE IV. PLEURICOSPORA FIMBRIOLATA GRAY. Development of seed. Fig. 1. Two-celled endosperm. Fig. 2. Four-celled endosperm. Fig. 3. Two-celled embryo. Fig. 4. Nearly ripe seed. All × 400.

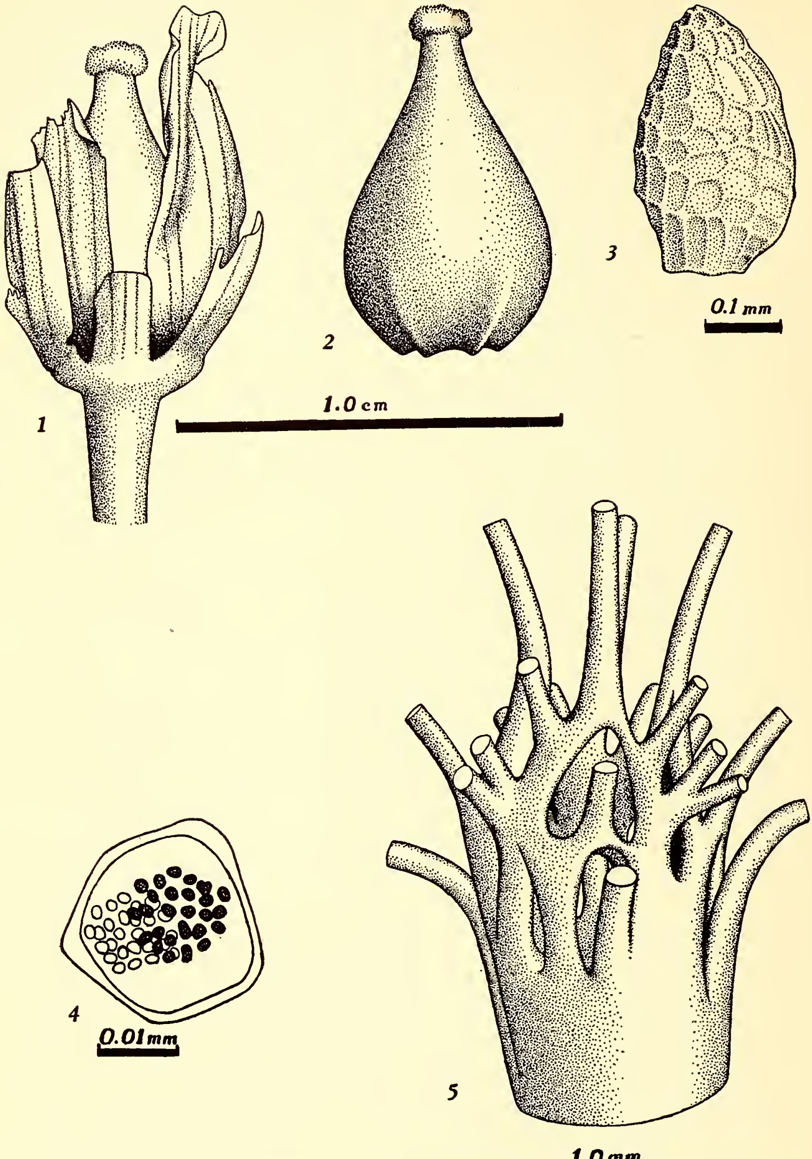


Plate V. Pleuricospora fimbriolata Gray. Figs. 1, 2. Fruits × 5. Fig. 3. Seed × 100. Fig. 4. Heterotypic anaphase in pollen mother cell × 840. Fig. 5. Reconstruction of the vascular system in the receptacle × 50.

THE IDENTITY OF AMELANCHIER FLORIDA LINDLEY

Etlar L. Nielsen

In connection with a current study of the genus *Amelanchier* in Minnesota, the question of the identity of *A. florida* Lindley has arisen. The exact status of this species and the probability of its occurrence in the middle western states has been a vexing problem for some time. This has led to a study of the type specimen and of Lindley's (2) original description and plate; also to a critical examination of herbarium specimens from the region of the type collection. The material upon which *Amelanchier florida* is based was collected by David Douglas in "northwest America" in 1826. The type specimen of this species is now deposited in the Herbarium of the Botany School, Cambridge, England. The following remarks concerning the type are from A. C. Seward's letter to the writer:

"There are two specimens on the sheet: a smaller one, against which is written 'N.W. Am. Douglas.' Below the larger is added 'Am. Florida' with a reference to the *Botanical Register* 1833, where it is figured and is said to be found by Douglas. In the left-hand bottom corner of the sheet is written 'N.W. America Douglas 1826.' . . . The writing is Lindley's, though I am not by any means sure that the words written against the smaller specimen which I quoted are in his handwriting. The specimens are described on a more recent label as the type of *Amelanchier florida* Lindley, Botanical Register 1833, Pl. 1589."

In 1833 Lindley (2) described the species as follows:

"*A. florida;* foliis oblongis utrinque obtusis versus apicem grossè serratis semper nudis, bracteis stipulisque apice plumosis deciduis, racemis strictis multifloris, staminibus calyce extùs glabro brevioribus.

"Frutex erectus, glaber, ramis viridibus v. fusco-viridescentibus. Folia oblonga, basi utrinque obtusa, nunquam pubescentia nisi aliquando sub vernatione, versus apicem grosse serrata. Stipulae brunneae, marcidae, lineares, intus ad apicem villis longis plumosae; citissime deciduae. Racemi terminales, cylindracei, multiflori, glaberrimi, stricti; bracteis linearibus, acutis, apice villosis, citissime deciduis. Calyx extùs glaber, intus pubescens; dentibus acuminatis, staminibus longioribus v. aequalibus. Petala lineari-spatulata. Stamina erecta, brevissima.

"A native of North-west America, where it was found by Mr. Douglas. It forms a handsome hardy shrub, in the way of the Snowy Mespilus, flowering in May. Like that species, it is best propagated by layers.

"It is at once recognised by the shortness of the stamens; otherwise it is very near *A. sanguinea,* already figured at fol. 1171 of the present work. But that species has moreover smaller and more capitate flowers, the teeth of the leaves are finer, the bracteae and the stipulae much more pubescent, and the calyx far more downy inside.

"The petals vary in length; in one of our wild specimens from Mr. Douglas they are more than ¾ths of an inch long."

Through the courtesy of the Botany School Herbarium, it was possible for Miss Sarah Dyal, Cornell University, to examine for me the type specimen and note certain critical features. These can best be described in Miss Dyal's own words (in lit.):

"Type of *Amelanchier florida* Lindley 1833 collected by Douglas 1826 in NW America. (Under *Aronia*). Leaves glabrous; twigs dark reddish-brown; inflorescence (a) length 5–7.5 cm., (b) glabrous, (c) lower pedicel 8–10 mm. to base of ovary, (d) ovary summit woolly, (e) width of hypanthium 4–4.5 mm., (f) length of sepals 3–4 mm. (2–3 times as long as wide) woolly above, both extended and recurved, (g) length of petals 8–11 mm. . . ."

From Lindley's description and Miss Dyal's observation there seems little doubt that *Amelanchier florida* is an entirely different entity from any of the several densely pubescent forms of the Great Plains region which have been referred to that species in the past, one of which is unquestionably *A. alnifolia* Nuttall (3) often cited as a synonym of *A. florida.*

With this concept in mind an examination has been made of a number of herbarium specimens from the general region of the type which were kindly placed at the writer's disposal by Professor M. E. Peck of Williamette University, Oregon, and Dr. T. C. Frye of the University of Washington. It has been found that *A. florida* is a well defined species occurring typically on the west side of the Cascade Range in Washington and Oregon. All of the typical specimens examined have a sparse evanescent pubescence. This is particularly true of plants that have not yet come into full anthesis while in the fruiting condition they are either glabrous or with a few hairs along the midrib near the leaf base. This agrees with Lindley's description since the statement "semper nudis" of the first paragraph is qualified in the next by "nunquam pubescentia nisi aliquando sub vernatione." From the study it has been possible to formulate the following more complete description.

Amelanchier florida Lindley

Leaves oblong (seldom oblong-elliptic), obtuse at both ends, fully expanded at anthesis; sparsely pubescent when young, the pubescence quickly evanescent, early glabrate or with a few hairs persisting on the petiole and lower midrib; blades about 4 cm. long, 2.5 cm. wide at flowering time, about 5.5 cm. long, 3 cm. wide at maturity, coarsely serrate toward the apex with acute sinuses, lateral veins 10–12 (9–13) on each side ascending and running into the serrations; petioles slender, often 1–1.5 cm. long at flowering time, 1–2.5 cm. long when fully mature; inflores-

1589

Miss Drake del. Pub. by J. Ridgway 169 Piccadilly June 1, 1833. S Watts sc

PLATE VI. AMELANCHIER FLORIDA Lindley. An exact outline drawing of Lindley's original figure prepared as recommended by Buchholz (1).

cence 3–7.5 cm. long, erect, at first sparingly pubescent but soon glabrate; lowermost pedicel 8–11 (14) mm. long; sepals 3–4 mm. long (2–3 times as long as wide), very acute, woolly above in flower, somewhat reflexed and glabrate in fruit; petals 8–13 (16) mm. long, linear-spatulate to oblanceolate; stamens shorter than the calyx lobes; ovary summit woolly at anthesis, sometimes nearly glabrate in fruit; hypanthium 4–4.5 mm. in diameter, shallowly cup-shaped, only slightly constricted in fruit; fruit globose.

A slender shrub about 15 feet high, of the forest, and more often the forest margin, on the west slope of the Cascade Range in Washington and Oregon.

Wiegand (4) in his first paper on the genus *Amelanchier* in eastern North America reported *A. florida* from Isle Royale and Keewenaw Point, Michigan. He (5) later became doubtful as to the occurrence of this species in the Great Lakes region as indicated in his second paper (5) dealing with this genus. In discussing *A. huronensis* he states "this species together with *A. humilis* probably forms the basis of records of *A. florida* Lindley from the region of the Great Lakes." Since a number of western species of plants actually do occur about Lake Superior, a careful study of the Isle Royale material, including some of the specimens cited by Wiegand, was made to determine whether *Amelanchier florida* has a similar distribution. A comparison of the Isle Royale material with specimens of typical *A. florida* shows the following differences: in *Amelanchier florida* the leaves are oblong, coarsely serrate toward the apex, the sepals 3–4 mm. long, 2–3 times as long as wide, very acute, the hypanthium shallowly cup-shaped. In the Isle Royale material the leaves are broadly oval to oblong-oval, usually serrate-dentate to the middle, the sepals 1.5–2.5 mm. long, about as long as wide, broadly acute, the hypanthium saucer-shaped. Other reports of *A. florida* from the region of the Great Lakes should be discounted because they apparently are based upon the earlier interpretation of Wiegand (4).

Amelanchier florida Lindley appears, therefore, to be a species of the west slope of the Cascade Range in Oregon and Washington. It should not be confused with forms of the Great Lakes or the Great Plains regions. The following specimens, which have been examined, may be considered as fairly typical. The letters (UW), University of Washington, and (W), Williamette University, indicate the herbaria where these specimens are deposited.

Washington. King County: Seattle, *E. S. Meassy* (UW). Pierce County: sandy soil, Reflection Lakes, Mt. Rainier, July 31, 1932, *F. A. Warren 1786* (UW); rocky soil, Gobbler's Knob, Mt. Rainier, July 17, 1932, *F. A. Warren 1604* (UW). Whidby Island: rocky shore, Cranberry Lake, June 2, 1934, *G. N. Jones 4897* (UW) (typical except for the sepals). Oregon. Lane County: Horse Pasture Mt., 10 miles south of McKenzie Bridge, alt. 5000 ft., July 1, 1934, *M. E. Peck 2593* (W); bank of Frog Lake, July 27, 1927, *M. E. Peck 15910* (W).

I wish to express my thanks to Dr. C. O. Rosendahl and Dr. F. K. Butters of the University of Minnesota for their counsel and suggestions given during the course of this investigation.

College of Agriculture, University of Arkansas,
Fayetteville, Arkansas,
March 11, 1936.

Literature Cited

1. Buchholz, Albert. Das Photo Allerlei. 32–33. Sept. 1933.
2. Lindley, John. Botanical Register, n. ser. 6: pl. 1585. 1833.
3. Nuttall, Thomas. The genera of North American Plants and a catalogue of the species to the year 1817. 1818.
4. Wiegand, K. M. The genus Amelanchier in eastern North America. Rhodora 14: 117–161. 1912.
5. ———————. Additional notes on Amelanchier. Rhodora 22: 146–151. 1920.

OBSERVATIONS ON THE WESTERN JUNIPER

Waldo S. Glock

A brief study of the western juniper (*Juniperus occidentalis* Hook.) in the high Sierra Nevada of Alpine and Tuolumne counties, California, has yielded some interesting information and has raised some important problems. The species was observed and core samples taken in Faith and Charity valleys southeast of Lake Tahoe, in the vicinity of Kit Carson Pass, and in the Sonora Pass and Dardanelles region. The writer's attention was directed to the juniper by Mr. Clarence K. Bennett and Dr. Ralph W. Chaney. Especial gratitude is due Mr. Bennett whose financial aid helped to make the field work possible.

Specific localities inhabited by the junipers are quite distinctive. These trees occupy relatively dry sunny slopes with westerly or southerly exposure. However, scattered trees were seen on a precipitous easterly slope whose individual jutting ledges of nearly bare granite provided sites which have approximately the same exposure time to the sun as have the westerly slopes. The junipers are most frequently found on gravel moraines, on slopes of coarsely weathered lava, or on bare granite ridges where their roots insinuate themselves with difficulty among the huge boulders and into crevices. Such habitats, rather than rich humus or moist meadow borders, are preferred.

In Faith Valley at an elevation just below 8000 feet, the trees grow upon a weathered lava slope and also upon the side of a gravel ridge. At Chipmunk Flat along Deadman Creek at an elevation of 8000 feet, they grow on a coarse boulder terrace fifteen to twenty-five feet above stream level. The north wall of Deadman Canyon, above Chipmunk Flat, rises to a bare granite shoulder and ridge at about 9000 feet. Here, scattered junipers, low, squat, and grotesquely gnarled, maintain what appears to be a precarious foothold in the crevices. In the vicinity of lower Relief Creek at 6500 to 7000 feet and on the upland west of the mouth of Deadman Creek (Dardanelles Quadrangle, United States Geological Survey) at 8500 feet the junipers grow on rock ledges and on gravel knolls and ridges. Here, on what is called East Flange Ridge, they probably have their best development.

On the whole the western juniper, in contrast with its relatives, inhabits the subalpine zone at comparatively high elevations near timberline. The California juniper (*Juniperus californica* Carr.) and the desert juniper (*Juniperus utahensis* Lemmon) are commonly among the first trees encountered above the Lower Sonoran zone, whereas the western juniper is commonly among the last encountered at the upper tree limit. In habit, in form, and in age the two types differ remarkably. The high altitude species possesses a more highly developed arborescent form than its lowland kin; it is in certain cases regal in its proportions. Its vitality is such that although the stress of weather and the presence of rock fragments may distort and malform it into weirdly grotesque caricatures of trees, it survives the wrack and stress until the last bit of cambium dies.

Western junipers, on the whole, are not only solitary as a species but also solitary as individuals. They are intolerant of shade and of crowding. Where grouped, the trees are spaced openly much in the manner of the western yellow pine (*Pinus ponderosa* Dougl.). Many of the veterans stand completely isolated on a sunny slope or knoll. Close association with other species of trees is rather uncommon in the localities of this study. However, in the same general area red fir (*Abies magnifica* Murr.) and lodgepole pine (*Pinus Murrayana* Balf.) are the most frequent associates; and Jeffrey pine (*Pinus Jeffreyi* Murr.) is a poor third. A surprising fact observed at once on the upland west of the mouth of Deadman Creek was the nearly exclusive presence of large trees, juniper, fir, lodgepole and Jeffrey pine. Seedlings and saplings were practically non-existent.

Several points deserve mention in connection with the reasons why these junipers occupy such inhospitable sites and how they manage to exist. (1) The junipers do not seem able to exist in close association. From observation, however, it does not seem likely that they crowd out other species. More probably the latter cannot gain a foothold on certain locations. (2) The extraordinary vitality of the junipers permits them to live on what appears to be almost sterile granite or on coarse gravels deficient in large quantities of mineral nutrients. (3) In addition, these junipers possess remarkable regenerative powers. An injury must be serious indeed even to cripple a tree, much less to destroy it. Injuries which are mortal to less hardy species, such as pine and fir, or which shorten their lives to a marked degree, may only deform the juniper. New wood may overlap a wound on the trunk so completely as to defy detection from the exterior. Root buttresses and multiple trunks become so closely compressed that the symmetry of the trunk is enhanced rather than lessened. Stumps and cores showed bark and decayed places where none would be expected from an exterior examination. Indeed, in some trees it was nearly impossible to secure an uninjured core eleven inches long. (4) A tree remains alive as long as a single root and branch function. It may be said that the junipers die by inches. Many specimens were seen which, save for one tuft of green, were gaunt gray skeletons. So numerous are the partially dead branches that one is tempted to say they are typical of all trees. The tops and sides of the main branches are commonly devoid of bark, dead, and deeply weathered. One-third or less of the girth of a branch, on the under side, may support bark, beneath which lies active cambium. One specimen showed only about 15 per cent of functioning wood. As a consequence of growth restricted to the under side, the branches are extremely eccentric, or hyponastic, and so much so that the vertical diameter may be three to five times the horizontal. (5) The ability to use soil moisture when it is available is an important feature that will be taken up in the discussion on the time of formation of the annual ring.

The western juniper merits distinction because of the size of its trunk and because of the great age attained by its individuals. Trees whose diameters range from four to eight feet are very common. On the Kit Carson road several miles west of Kit Carson Pass, the Forestry Service has erected a sign reading "California's Largest Juniper" near a tree which is stated to be 31 feet 8 inches in circumference. However, since it is a triple-trunked tree its age cannot be as great as this circumference would indicate. Several large specimens were measured at a height of five or six feet above ground on the upland west of the mouth of Deadman Creek. One, whose trunk is a single shaft, has a circumference of 27.5 feet. A second, triple-trunked above, has a circumference of 31 feet.

As a species the western juniper ranks well above its common associates in the matter of longevity. Trees five and six feet in diameter are not at all uncommon and those from which core samples were taken gave evidence of being between 900 and 1000 years old. The longevity of the species certainly equals that of the coast redwood and in a few instances rivals that of the giant sequoia. Perhaps it is significant that the sequoia, the juniper, and the bald cypress of Oaxaca, Mexico, all long-lived trees, belong to kindred families. These genera have tremendous durability of their woods coupled with vigorous tenacity of life and regenerative powers.

The Bennett Juniper, a magnificent specimen, with a single stately trunk approximately eighty feet high, is the giant of all those so far observed by Mr. Clarence K. Bennett[1] of Hillsborough, California, who has studied and hunted the juniper for many years. It stands on the upland west of the mouth of Deadman Creek, a tributary of the Middle Fork of the Stanislaus River. The dimensions of this large juniper are as follows:

Circumference at ground	57 feet, 6.5 inches
Circumference six feet above ground ..	42 " 9 "
Greatest diameter at ground	21 " 6 "
Average diameter five feet above ground	14 " 2 "

The diameter for working purposes may be taken as 13.5 to 14 feet.

It is highly appropriate that this monarch among junipers be named "The Bennett Juniper," not that Mr. Bennett was the first to see it (hunters saw it previously), but because he was the first man to take a lively sustained interest not only in the giant but also in all junipers of its kind wherever he has been able to find them in the high Sierra Nevada.

From the two or three stumps noted it was surmised that in this region the species has yielded but little to the saw commercially. Age, therefore, had to be determined wholly from cores which were obtained from trees of different diameters. Usually several cores, varying in length from six to fifteen inches, were taken from each tree. In computing age, due allowance must be made for increasing width of rings toward the center of the tree. This increase, however, is not nearly so striking as in the pine. All cases actually observed showed thinner rings at the center than several inches outside the center and in no case was there a uniform increase in width inward from the bark. Nevertheless, ample allowance for the "age curve" was made in order to keep estimates on the conservative side.

The age of the Bennett Juniper was computed in three ways, in the first two of which synthetic trees were built up by the substitution of progressively smaller trees for the inside of the big tree. For the first trial, four trees from the same upland which supports the big tree were united with five specimens from the big tree itself. The four trees included four cores from an 8.5-foot tree, three cores from a 4.5-foot tree, one core from a 27-inch tree, and a section of a 6-inch tree. The rings in the spaces between the cores and the next smaller tree were computed by interpolation. In round numbers, the age of the Bennett Juniper came out as 2900 years.

Entirely new material gave the basis for the second estimate. Seven cores, the longest fifteen inches, were taken from the big

[1] Clarence K. Bennett. The largest juniper? Sierra Club Bulletin 18: 115–116. 1933.

PLATE VII. THE BENNETT JUNIPER (JUNIPERUS OCCIDENTALIS HOOK.).

juniper at about equal intervals around the trunk, save for the northwest where there was some dead wood. These cores averaged more than seven hundred rings to the first foot of radius. Two trees from Charity Valley, one 8 feet and the other 5 feet in diameter, were inserted for the interior of the large tree. The first foot of the 8-foot tree had 476 rings and the first foot of the 5-foot tree had 510 rings. By computation and interpolation the age of the Bennett Juniper came out to be 3250 years.

The third estimate of age was based on the ring counts in the seven cores. Ring counts were plotted and the smooth curve drawn through the plotted points was continued inward to the center of the tree. The age so computed averaged 3000 years or slightly more.

From the data at hand, a fair estimate, in round numbers, of the age of the Bennett Juniper is 3000 years. There can be little doubt that the tree is well over 2000 years old, since the outer foot of the trunk averages seven hundred rings. The age curve would have to be steeper than any observed in other trees in order to hold the age below 2000 years. It may well be that the age is distinctly more than 3000 years, but until the entire stump is visible the exact age will not be known.

Two interesting problems that merit comment arose during the study of the western juniper: (1) circuit uniformity; (2) time of ring formation.

Circuit Uniformity. Annual rings are said to possess circuit uniformity if their relative thicknesses remain constant around the entire circumference. A juniper 19 feet high and 6.5 inches in diameter six feet above ground was felled on the upland west of the mouth of Deadman Creek, about seventy-five yards from the Bennett Juniper and up slope from it. None of the half dozen sections taken at different heights shows a high degree of circuit uniformity. In fact three or four rings show unusual thickening at one place on the circumference and groups of several other rings at other places. Few rings are uniformly thicker or thinner than their adjacent neighbors. This being true, it is to be expected that difficulty must attend the attempt to match rings in different trees or in different radii of the same tree. However, a few isolated cases of such matching, or cross-dating, were detected at this elevation.

The lack of perfect uniformity in the western juniper resembles somewhat that described by Shreve[2] for the Monterey pine (*Pinus radiata* Don), save that in the case of this single juniper vertical uniformity appeared to be better developed than circuit uniformity. On the other hand, extensive and detailed studies have shown remarkable uniformity in certain species, especially the western yellow pine of the southern part of the Colorado

[2] Forrest Shreve. The growth record in trees, Carnegie Inst. Wash. Pub. No. 350, 91–116. 1924.

Plateau. Is ring uniformity an environmental or a specific character?

Time of Ring Formation. In the case of the 19-foot juniper, on July 5, when snow had been off the ground less than two weeks, the ring for 1936 was one-third to one-half the thickness of the previous ring, or about equal in thickness to the average ring. Tip growth already exceeded three inches. Cores taken at the same time from junipers at the same locality and at Chipmunk Flat showed rings for the current season of one-tenth to more than one-half the average thickness of the last six rings. A lodgepole pine had grown a ring more than three-fourths the thickness of the average for the last six rings. Four cores from Digger pines (*Pinus Sabiniana* Dougl.) which grew six miles southwest of Sonora in the lower foothills gave evidence that their seasonal growth was practically completed by July 6. In at least two cases summer wood had been formed. Cores taken from the Bennett Juniper on August 7 possessed what seemed to be practically complete rings for 1936. The same was true for the junipers from Charity Valley. A lodgepole pine from the vicinity of the Bennett Juniper had its growth nearly completed but neighboring Jeffrey pines were a trifle behind in their growth. Lodgepole pines from Hope Valley had just begun the formation of summer wood as had also western yellow pine from Walker Canyon (6200 feet) near Sonora Pass Junction. Two lodgepole pines from Sonora Pass at 9650 feet elevation were beginning the formation of summer wood. Judgment as to the completeness of the annual ring was made not alone upon the amount of wood in relation to previous rings but also upon the two following criteria: diminution of cell size and deposition of dark materials on cell walls. In the Digger pines and one western yellow pine from Walker Canyon dark color had appeared. Certainty of the correct identification of cellular division for 1936 was enhanced by cross-dating, that is, the matching of characteristic rings from one tree to another.

In connection with the above observations three points have considerable significance. (1) Growth must certainly begin in the high-altitude trees here studied before the snow leaves the ground. (2) The evidence indicates that a considerable part (more than half in some cases) of the seasonal growth is completed within two weeks after the snow has melted. This applies in particular to the locality of the Bennett Juniper on the west end of East Flange Ridge. Where the water supply is unquestionably greater, as is the case for the trees at Chipmunk Flat, there are indications that growth was less than at the previously mentioned locality. Both Chipmunk Flat and East Flange Ridge are so situated that they no doubt receive cold air drainage, but the former much more so than the latter. (3) The time of maximum ring formation early in the season, before temperature has reached a maximum and before water supply has diminished to a serious extent, has important climatic significance. If the observations so far made are valid, then the length of the so-called growing season as based upon the interval during which temperatures are supposed to be advantageous for growth has little influence on the thickness of the annual ring. Apparently the trees must make their growth while water is available. If it is available all summer, growth continues for a longer time; but if water is dependent upon winter precipitation and receives no replenishment later, growth ceases sooner or later during the summer according to the availability of the water. The Digger pine from the foothills below Sonora was the most advanced in growth of all trees from which core samples were taken on July 5 and 6.

Such evidence as has been obtained suggests that the time of ring formation constitutes a problem which deserves study by taking core samples periodically during an entire growing season of trees from the lower forest border up to timber-line. The presence in any particular area of trees which depend solely upon winter precipitation has a climatic and ecologic significance different from the presence of those which depend upon a summer rainy season.

Carnegie Institution of Washington,
Division of Plant Biology,
Tucson, Arizona,
September 4, 1936.

A NEW SPECIES OF CHAETOMORPHA FROM CHINA

Nathaniel Lyon Gardner

On a recent visit to the California Academy of Sciences in Golden Gate Park, San Francisco, my attention was called by Dr. F. M. McFarland, President of the Academy, to a small tortoise which had been recently asquired through the generosity of Princess Olga Shahovski, who had brought it from China. Its back was densely covered with "green hair," so popularly designated. Such a symbiotic relationship, if such it may be called, is of very rare occurrence in western America, if indeed it has ever been observed and reported among our native species. However, it has been reported several times as occurring in the eastern part of the United States, and apparently is of common occurrence in parts of China and Japan. Wang (5) states that the "green haired tortoise" has been a well known animal in the provinces of Changshu, Kiangsu, and in the northern part of Yushan. In China the "green hair" grows on relatively small species of tortoise. These of course are not of the basking kind, and on account of the popular interest which they create in domestic aquaria they are commercialized to considerable extent.

The specimen in the public aquarium at the California Academy rarely fails to excite the interest and curiosity of visitors, often calling forth strange expressions indicative of total ignorance as to the real nature of the organisms, the visitors never having previously seen nor read of similar or like phenomena. It thus seems desirable to publish a few brief statements concerning them. The so-called "green hair" on the tortoise is of course not a part of the animal but is a distinct organism belonging to the plant kingdom, and to a group known as Chlorophyceae, or green algae. The determination of the species, however, is not in this case such a simple matter as it would seem at a glance.

A brief search through the literature revealed the fact that several papers have been written concerning the occurrence of species of green algae growing on the backs of the tortoise.

Collins (1) reports *Chaetomorpha chelonum* growing on the back of *Chrysemys marginata* and *Aromochelys odorata* found in Michigan. Evermann and Clark (2) later reported the same species growing on *Chrysemys marginata* in Indiana, and still later Tiffany (4) found it growing on *Chrysemys marginata belli* in Iowa. Hoffmann and Tilden (3) described a species growing on *Chelydra serpentina* found in Minnesota, which they considered related to Collins' *Chaetomorpha chelonum* but sufficiently different to warrant the establishment of a new genus, *Basicladia*. Various other authors in this country and in Europe have incidentally mentioned, in connection with their study of the tortoise, the occurrence of green algae growing on the backs of these animals but without any attempt to name the species to which the algae belong. Yendo (6) found plants in Japan growing on *Clemmia japonica* which he described as a new variety of *Chaetomorpha chelonum* Collins. The most recent paper with which the writer is familiar, dealing with the subject, is by Wang (5), who seems to have made the most exhaustive study of species growing in China. He states that he has examined four hundred and seventy-five specimens of the tortoise *Geoclemys reevesii*. He reports two species in this paper, viz., *Basicladia crassa* Hoffmann and Tilden, and *Cladophora glomerata* var. *nana* Wang.

The green alga on the "green haired tortoise" with which this paper is especially concerned is growing on a small tortoise, *Ocadia sinensis*. Only one living specimen is available for this study and this has been in captivity at the Academy some four or five months. Apparently the reproductive stage of the alga has passed. The presence of many empty segments, each with a specialized pore for the escape of reproductive cells, gives ample evidence of the fact that the plants are normal, but there seem to be no more fertile segments, hence I am unable to report on the character of the reproductive cells. Strange to note, not one of the authors dealing with these plants has described the reproductive cells, not even Mr. Wang, who examined the large number of specimens mentioned above. Knowledge of the character of these cells is of very great importance in connection with this species of plant, since it has morphological characters linking it closely with at least four different genera, viz., *Chaetomorpha* Kuetz., *Rhizoclonium* Kuetz., *Basicladia* Hoffmann and Tilden, and *Cladophora* Kuetz. The principal distinguishing characters of these genera may be noted as follows:

CHAETOMORPHA

Fronds rigid, septate coenocytes, unbranched, always attached in the juvenile stage by more or less branched, nonseptate rhizoids from the basal segment and whose walls become thickened and whose contents disappear in age; asexual reproduction by biciliated zoospores.

RHIZOCLONIUM

Fronds septate coenocytes, usually narrower and more flaccid, not attached, unbranched or producing few to many short, irregular, septate or nonseptate, rhizoidal branches from any of the segments; asexual reproduction absent.

BASICLADIA

Fronds consisting of numerous, multicellular, erect, somewhat rigid, sparingly branched, more or less cylindrical filaments arising from creeping rhizome-like filaments which are fastened to the substratum by hold-fasts having free or coalesced branches; . . . reproduction by zoospores (?). (An extract from the original description of the genus.)

CLADOPHORA

Fronds septate coenocytes, rigid to flaccid, always moderately to profusely branched, always attached in the juvenile stage by the discoidal basal segment, later often producing more or less abundant septate, rhizoidal filaments from the lower parts; asexual reproduction by four-ciliated zoospores.

The following is a diagnosis of the species under consideration:

Chaetomorpha sinensis sp. nov.[1] Erect fronds producing tangled, more or less rope-like masses, very sparsely branched, the branches being either similar to the main axes or rhizoidal in character, attached by relatively extensive, prostrate, irregular,

---

Chaetomorpha sinensis sp. nov.

[1] Frondibus erectis sparsissime ramosis structuram compositam funibus irretis aliquantum similis producentibus; ramis axis principalibus similibus vel rhizoideis, filamentis amplis, septatis, prostratis irregularibus plus minusve ramosis adjunctis; filamentis substrato superficiebus nec hapteris praecipuis nec ramis rhizoideis adhaerentibus; ramis filamenta secundaria, 8–12 cm. alta, 60–95 μ diametro, filamentis primariis similibus aliquando emittentibus; filamentorum erectorum segementis maximam partem etiam in generatione cylindriciis, sed interdum leviter doliiformibus longitudine maxime variabilibus basim 2 mm. superne diametro 3–4-plo longioribus; filamentorum parietibus comparate tenuis et tenacibus, hyalinis demum plus minusve lamellatis; chromatophoris densis; pyrenoidibus parvis, numerosis; cellularis generationis foraminibus caminis parvis similibus in regione equatoriale segmentorum fertilium discedentibus; cellularum generationis natura ignota.

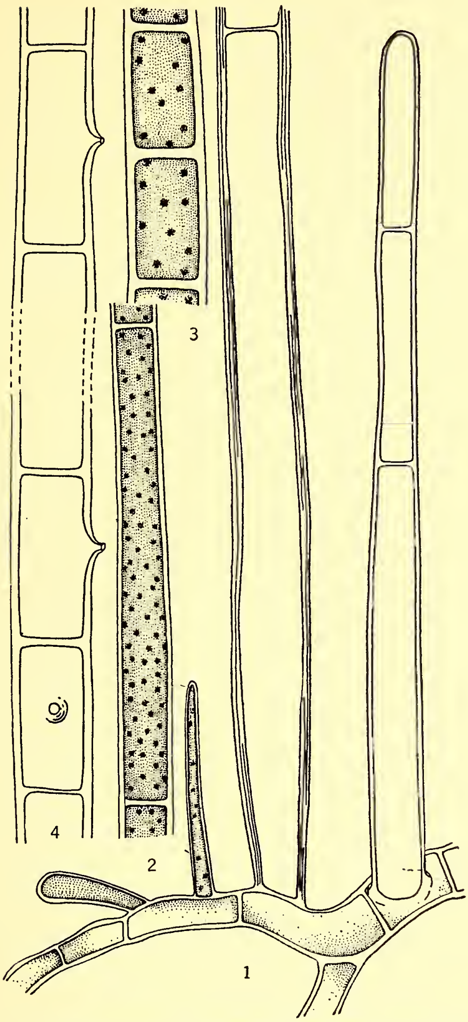


PLATE VIII. CHAETOMORPHA SINENSIS GARDNER. Filaments × 100. *1.* Fragment of a creeping filament, with one small juvenile erect filament, to the left; one segment of a normal erect filament showing laminated cell wall, in the center; and one dead erect filament with three segments, to the right. *2.* Single segment of a medium sized filament showing numerous pyrenoids embedded in normal chromatophores. *3.* Two wider, shorter segments. *4.* Fragment of a normal filament showing empty segments with the chimney-like pores through which the reproductive cells have escaped.

more or less branched, septate filaments adhering to the substratum by their surface and not by specialized hapteres or rhizoidal branches, and at times giving rise to secondary filaments similar to the primary ones, 8–12 cm. high, 60–95 μ diam.; segments of erect filaments mostly cylindrical, even in reproduction, but occasionally slightly dolioform, very variable in length, up to 2 mm. at the base to 3–4 times the diameter in the upper parts; walls relatively thin and tough, hyaline, more or less lamellate in age; chromatophore dense; pyrenoids small and numerous; reproductive cells escaping through specialized chimney-like openings formed in the equatorial region of the fertile segments; the nature of these reproductive cells not determined.

Growing principally on the back of a fresh-water tortoise, *Ocadia sinensis,* brought from Kiangsu Province, China. Type, Herbarium of the University of California no. 543979.

By comparison of the above diagnosis with the principal distinguishing characters of the four genera mentioned above, it may be seen that it has overlapping morphological characters. It is relatively harsh and rigid, like *Chaetomorpha;* an occasional true branch on the erect filaments links it with *Cladophora;* the more abundant rhizoidal filaments from the erect fronds are homologous with the same in *Rhizoclonium* and similar to those found at times in *Cladophora.* The extensive prostrate, attaching filaments are similar to those upon which, partially, the genus *Basicladia* was established. They differ, however, from these in the method of attachment as stated in the diagnosis of that genus. It is therefore essential to know the character of the reproductive cells before determining positively to which genus it should be associated. Are the reproductive cells gametes or zoospores, and if the latter, are they biciliated or quadriciliated? For the present I am placing it as a new and eccentric species of the genus *Chaetomorpha,* with a more extensive attaching system than the general run of species, and with an extremely occasional true branch on a very few plants.

University of California,
Berkeley, June 12, 1936.

Literature Cited

1. Collins, F. S. Some new green algae. Rhodora 9: 197–202. 1907.
2. Evermann, B. W., and Clark, H. W. The turtles and batrachians of the Lake Maxinkuckee region. Proc. Ind. Acad. Sci. 1916. 472–518. 1917.
3. Hoffmann, W. E., and Tilden, J. E. Basicladia: a new genus of Cladophoraceae. Bot. Gaz. 89: 374–384. 1930.
4. Tiffany, L. H. The filamentous algae of northwestern Iowa, with special reference to the Oedogoniaceae. Trans. Amer. Mic. Soc. 45: 69–132. 1926.
5. Wang, C. C. Algae growing on the pond tortoise. Contrib. Biol. Lab. Sci. Soc. China 10: 4–9. 1935.
6. Yendo, K. Nov. Alg. Japon. Decas 1–111. Bot. Mag. Tokyo 34: 1–12. 1920.

NOTES ON THE FLORA OF SAN DIEGO COUNTY, CALIFORNIA

Frank F. Gander

Extensions of Range

The extensions of known ranges of the species listed below seem worthy of record. Except where otherwise designated, collections were made by the writer. Numbers in parentheses refer to specimens in the herbarium of the San Diego Natural History Museum.

Smilacina stellata (L.) Desf. Collected in a low, wet place near Cuyamaca Lake at an elevation of about 4600 feet, in April, 1934, by Miss Eleanor C. Layman (722); not previously reported from this county.

Chorizanthe Orcuttiana Parry. Heretofore known only from the type locality on Point Loma, this species was found on Kearny Mesa north of San Diego, about nine miles from Point Loma, March 13, 1935 (10604). The somewhat similar *C. polygonoides* Torr. and Gray was found in the same vicinity.

Saxifraga californica Greene. This species was collected in San Diego by Daniel Cleveland in April, 1874 (8384), and in March, 1875 (8382). In recent years it has been collected in San Diego and at the Bear Valley School near Escondido. Previously it was not recorded south of the Santa Ana Mountains of Orange and Riverside counties.

Mentzelia micrantha (Hook. and Arn.) Torr. and Gray. This blazing star was found on Otay Mountain, just north of the Mexican boundary, June 26, 1935 (11696).

Jussiaea californica (Wats.) Jepson. San Luis Rey River, near San Luis Rey Mission, July 10, 1935 (12057).

Myriophyllum exalbescens Fernald. Collected in Lake Murray, July 27, 1935 (12083); probably introduced. The plants were in full flower.

Venegasia carpesioides DC. Although reported from San Diego County, there are apparently no definite records of locality for this species. It was collected in Moosa Canyon, north of Escondido, March 13, 1935 (10571), and in near-by Cole Canyon on September 18, 1935 (12150).

Records of Alien Plants

Most of the alien species listed below have not previously been reported from San Diego County, and one (*Echium*) is here reported from California for the first time.

Thlaspi arvense L. Collected in Balboa Park, San Diego, by Miss Fidella G. Woodcock; date not given (2009).

Coronopus didymus (L.) Smith. A number of specimens were collected on a parking lot in Balboa Park, San Diego, March 21, 1936 (14122).

Reseda alba L. Several plants were found growing along the bank of the San Luis Rey River across from Pala on April 25, 1935 (11302).

Gaura sinuata Nutt. Three stations for this species are represented by specimens in our herbarium, but it has also been observed at several additional localities. It was first reported in July, 1930, when W. V. Shear collected specimens at Carlsbad (3355). It was found growing along the highway two miles north of Lake Hodges on March 6, 1934 (3354), and was thoroughly established in a field at Santa Ysabel on July 10, 1935 (11940).

Echium plantagineum L. Not previously reported in California, this species was found growing abundantly in a meadow and around a spring by the roadside near DeLuz, May 1, 1935 (11321).

Lycium halimifolium Mill. Collected by Charles F. Harbison in the bed of the Tijuana River about two miles from its mouth, August 19, 1934.

Natural History Museum, Balboa Park,
San Diego, California,
January 30, 1936.

NEW RECORDS OF VASCULAR PLANTS IN WASHINGTON

George Neville Jones

Even in a region which has been as well botanized as Washington, there are many species of vascular plants whose known occurrence rests upon a single collection or a more or less definite statement. The following notes record eleven species of vascular plants not hitherto ascribed to this state. These include six recent immigrants and five indigenous species. The records are based on specimens in the Herbarium of the University of Washington.

Anemone ludoviciana Nutt. Gen. Am. Pl. 2: 20. 1818. This species is abundant on the prairies and plains east of the Rocky Mountains. Although recorded by Rydberg (3, p. 288) as occurring in Washington, until very recently there have been no specimens in local herbaria to substantiate the record. This spring, however, a number of plants of this anemone were sent to the University of Washington to be identified. The collection data are as follows:

Chelan County: foothills near Wenatchee, May 15, 1936, *Doris Mullen.*

Clematis Vitalba L. Sp. Pl. 544. 1753. During the last thirty years or so this European species of *Clematis* has become well established in various localities in western Washington. It is quite common at Seattle and Tacoma. It is sometimes mistaken for the indigenous *C. ligusticifolia* Nutt. of the Upper Sonoran zone east of the Cascade Mountains, from which it differs in its perfect flowers, more densely pubescent sepals, and less-notched leaflets. The following Washington specimens are at hand:

San Juan County: Roche Harbor, July 11, 1904, *A. S. Pope;* King County: Seattle, *Jones 8567;* Fall City, *Jones 9426;* Pierce County: Tacoma, *Jones,* December 23, 1927.

Polanisia trachysperma Torr. and Gray, Fl. N. Am. 1: 669. 1840. This species was noted (as *P. graveolens*) in the report of the Wilkes Expedition (5, p, 235) as occurring along the Walla Walla River in what is now the state of Washington. Piper dismissed it from the "Flora of Washington" (2, p. 307) with the remark that "There are no herbarium specimens of this plant from Washington to justify its inclusion in the flora." The record of the following collection will serve to establish the actual occurrence of the plant in Washington at the present time:

Walla Walla County: gravelly bank of the Columbia River near the mouth of the Walla Walla River, June 22, 1934, *Jones 5035.* The specimens show both flowers and fruit. The general range of this species is from British Columbia to Texas and as far east as Iowa and Saskatchewan.

Rosa rugosa Thunb. Fl. Jap. 213. 1784. At the time of the publication of my recent paper on the species and varieties of *Rosa* (1), *R. rugosa* was known to me from only one locality in Washington. I concluded, therefore, that this species was only an incidental "garden escape" and not of sufficient importance to be included in the rose flora of the state. Since that time, however, several additional reports of this rose have come to my attention. Apparently the species is becoming well established in various localities in western Washington, especially near the seashore. The following collections are at hand:

Island County: Useless Bay, Whidby Island, June 2, 1934, *Jones 6133.* Kitsap County: Restoration Point, Bainbridge Island, April 19, 1936, *Jones 8734.*

Viola lanceolata L. Sp. Pl. 934. 1753. The recent discovery of this violet in western Washington extends the known range of the species a thousand miles to the westward. It was previously known to range from Nova Scotia to Florida and westward to Minnesota, Nebraska, and Mississippi (4, p. 554). A report of such a remarkable extension of range is, I am aware, not above suspicion; but there is not the slightest doubt as to correctness of the identification of the plants from western Washington. That they could be adventive here is possible, though from the ecological evidence, highly improbable. They occur in abundance in several rather widely separated localities, in habitats apparently never disturbed by human activity. That they have not been previously discovered here is probably due to the fact that they are inconspicuous, except when in flower, and then most likely have been mistaken for *V. pallens* (Banks) Brainerd, or even for *V. palustris* L., both common species in the vicinity. In western Washington, *Viola lanceolata* may be a relictual species; at least its habitat is on the outwash plains near the southern limit of the Pleistocene glaciation.

Pierce County: in marshy ground between Tacoma and Roy, April 27, 1936, *Jones 8774*.

Ledum glandulosum Nutt. Trans. Am. Phil. Soc. 8: 270. 1843. This species ranges from British Columbia to California and eastward to Wyoming. It is known from several localities in Okanogan, Chelan, and Kittitas counties in eastern Washington, but has been unknown, until very recently, from the western side of the Cascade Mountains. This Labrador tea may be distinguished from the common *L. groenlandicum* Oeder by its oblong or oval plane-margined leaves which are green and glabrous on both sides. It has been collected at the following locality in western Washington:

King County: Delta Lake, *J. M. Broadbent,* August 5, 1935. Mr. Broadbent, a student of botany at the University of Washington, reports the shrub to be fairly abundant on moist ledges on the mountainside near the outlet of the lake. Prominent among associated species were *Rhododendron albiflorum, Salix* sp., *Vaccinium macrophyllum.*

Swertia perennis L. Sp. Pl. 226. 1753. Not hitherto collected in Washington, this gentianaceous perennial is known to occur in British Columbia and Alaska, and in the Wallowa Mountains in northeastern Oregon (August 25, 1898, *Cusick 2100*). The first record of the collection of this plant in Washington is as follows:

Snohomish County: on talus, Twin Lakes, altitude 4000 feet, (in full bloom) September 2, 1935, *J. M. Broadbent.*

Solanum rostratum Dunal, Hist. Solan. 234. 1813. Adventive in Benton County: Benton City, September 16, 1936, *Harold Stringer.*

Galium verum L. Sp. Pl. 107. 1753. Long since naturalized in the eastern half of North America, this Eurasian species can now be listed as adventive in western Washington on the basis of the following collections:

King County: weed in lawn, Seattle, October 20, 1932, *Jones 4314;* October 10, 1934, no. *6117*. This is the only uncultivated species of *Galium* in Washington with yellow flowers. The plants are perennial, with linear, deflexed leaves in whorls of six or eight.

Veronica Chamaedrys L. Sp. Pl. 13. 1753. This is a perennial with the stems pubescent in two lines, the leaves subsessile, cordate, incisely crenate, and the flowers blue, 4–6 mm. broad, appearing in May. The plant has been noted in several places in Seattle, where it occurs chiefly as a weed in lawns, introduced, probably, with grass seed. It is represented by the following collection:

King County: Seattle, weed in lawn on the campus of the University of Washington, May 2, 1933, *Jones 4374*.

Taraxacum laevigatum (Willd.) DC. Cat. Hort. Monsp. 149. 1813. Readily distinguishable from the more common *T. officinale* Weber by its bright reddish achenes and the leaves dissected almost to the midvein, this species is now established in several places in Washington. Probably it is frequently mistaken for *T. officinale* and for that reason is rarely collected.

King County: Seattle, March 17, 1934, *Jones 8721*.

University of Washington Herbarium,
Seattle, Washington,
October 20, 1936.

Literature Cited

1. Jones, G. N. The Washington species and varieties of Rosa. Madroño 3: 120–135. 1935.
2. Piper, C. V. Flora of the state of Washington. Contr. U. S. Nat. Herb. 11: 1–637. 1906.
3. Rydberg, P. A. Flora of the Rocky Mountains. 1917.
4. ————. Flora of the prairies and plains. 1932.
5. Torrey, J. U. S. Exploring Expedition 17 (Wilkes Expedition): 205–514. 1874.

REVIEWS

The Genus Arabis L. in the Pacific Northwest. By Reed C. Rollins. Research Studies of the State College of Washington, Volume IV, Number 1. Pp. 52, with 15 figures. Pullman, Washington, 1936. $.50.

Perhaps no western group of flowering plants has been in a more confused state than has the genus *Arabis,* and all systematists will be glad to know that an attempt has been, and is being, made to set this wing of the cruciferous house in order. More than sixty species have been described from, or attributed to, the states of Washington, Oregon and Idaho—Greene, Howell and Piper each having added his quota. Mr. Rollins has examined these critically, submitting them to the important test of geographical significance. After four species have been excluded, only twenty-one species and eleven varieties survive his scrutiny. The classical criterion of the uniseriate versus the biseriate condition of the seeds is examined and explained by observation of ontogenetic development. The kind of pubescence, when present, is found to have considerable diagnostic value, whereas degree of pubescence is significant only within broad limits.

Fifteen nearly full page original line drawings by Mr. Rollins depict representative and usually confused species, and two maps graphically show the geographical basis of this study. A number of subspecific populations, which have previously posed as species, have been reduced to varietal rank, making a total of seven new combinations.

It is gratifying to know that through an assistantship at Gray Herbarium Mr. Rollins will be enabled to expand his study to include *Arabis* of western North America.—Lincoln Constance.

Handbook of Northwest Flowering Plants. By Helen M. Gilkey. Pp. 407. Metropolitan Press, Portland, Oregon, 1936. $2.25.

The author describes her book as "an illustrated hand-book of the more conspicuous plants of the Northwest," designed especially for beginning students and interested laymen. The area covered is roughly that which Piper termed "the Vancouver Strip," that is, the region from the summit of the Cascades to the Pacific, and from the northern boundary of the California flora to northern Washington. The author considers technical questions of nomenclature and specific concept to be beyond the scope, and aside from the main purpose, of this volume. Insofar as possible, Dr. Gilkey has avoided technical terminology in keys and descriptions, and has omitted many of the groups of especial difficulty or of less interest to amateur flower lovers.

The illustrations constitute a most distinctive feature of the flora, text figures of more than three hundred species making the book invaluable for students of limited experience. The family and generic lines are closely in accordance with Jepson's "Manual of the Flowering Plants of California"; the nomenclature is conservative; rare and doubtful species are, for the most part, excluded or mentioned only briefly. There are no new names published in this work.

Despite its modest pretensions, the new handbook is a worthwhile effort to fill, in part, the void left by the exhausting of available copies of Piper and Beattie, "Flora of the Northwest Coast." —Lincoln Constance.

The Early Flowering of Plants in Lane County, Oregon, in 1934. By Louis F. Henderson. University of Oregon Monographs, Studies in Botany, Number 1. Pp. 16. Eugene, Oregon, June, 1936. $.25.

The precocious season of 1934 caused much speculation as to just how premature that spring and summer actually were. It has remained for Professor Henderson, speaking from fifty years' experience with the flora of the Northwest, to subject these conjectures to a scientific analysis. For each of 165 species the earliest date of blooming in 1934 was compared with the average date of blooming compiled from collections made during the last four or five decades. His general conclusions are that most early spring plants bloomed two months in advance of their usual time; trees, 1 month and 7 days; water plants, 1 month; Hudsonian-Alpine zone plants, 1 month and 2 days; bog plants, 1 month, 7 days; early spring herbs, 2 to $3\frac{1}{3}$ months; late summer flowers, 1 month to 1 day earlier, or even *later* than the average.—Lincoln Constance.

A Botanical Survey of the Olympic Peninsula, Washington. By George Neville Jones. University of Washington Publications in Biology, Volume V. Pp. 288, with 9 plates. Seattle, June 25, 1936. $2.00.

In this excellent study, Mr. Jones has produced the most thorough and successful treatment which any portion of the Pacific Northwest has received in the last thirty years. The Olympic Peninsula comprises some four thousand square miles, and contains the Washington expression of the Coast Ranges, the Olympic Mountains, which rise from sea-level to a height of nearly eight thousand feet and are completely isolated, by water or lowlands, from the neighboring Cascades and Oregon Coast Ranges.

Ever since Menzies collected briefly along this coast in 1792, the Olympics have been a prized ground for many collectors, including Henderson, Piper, Flett, Heller, Elmer, Thompson and many others. Several lists of species have appeared from time to time, beginning with Henderson's[1], and all the known species were included by Piper in his floras, but no prior attempt has been made to consider the area in question as a distinct vegetational and floristic unit.

Not the least satisfactory portion of the present paper is the introductory synecological and distributional discussion, modeled after that of Piper's *Flora of Washington,* and comprising nearly one-fourth of the volume. Jones has made an original contribution in attempting a correlation of the "life-zone concept" of Merriam with Raunkiaer's "biological spectrum." It will be recalled that Raunkiaer grouped plants into "life-forms," depending upon the mode of resistance of species to the critical period of the life cycle, and gauged by the position of the perennating organs. He defined the following groups: phanerophytes, chamaephytes, hemicryptophytes, cryptophytes and therophytes. Jones finds that the temperature and moisture conditions characterizing a given biotic belt are clearly indicated, in the main, by the definite proportional representation of these five different life-forms. The Arctic-Alpine zone, for example, lacks phanerophytes and therophytes, and has 21 per cent chamaephytes, 9 per cent cryptophytes and 69 per cent hemicryptophytes, whereas the neighboring Hudsonian zone exhibits the following proportions: 9 per cent phanerophytes, 10 per cent chamaephytes, 67 per cent hemicryptophytes, 13 per cent cryptophytes and 1 per cent therophytes.

According to the author: "The significance of the Raunkiaer system of life-forms as applied to the flora of the Olympic Penin-

[1] Henderson, L. F. Flora of the Olympics. Zoe 2: 253–295. 1891.

sula is threefold. By means of this system a statistical analysis can be made of the flora of the whole region, or of the flora of each of the four life-zones taken separately. By whichever method used the results are comparable with the flora of other regions, and a simple but biologically sound summary of the phytoclimate thus can be obtained. As applied to Merriam's life-zones, the Raunkiaer system yields corroborative data. Merriam was concerned chiefly with the factors of the climate which are effective during the season of growth and reproduction, whereas the Raunkiaer system is based on the adjustment of plants to the unfavorable, which is usually the dormant, season. By the application of both of these systems, a much clearer characterization of the life-zones or climatic formations may be obtained."

The outstanding characteristics of the region are its isolation and the wealth of climatic and altitudinal diversity which it manifests. The peaks of the range afford a serious obstacle to water-laden clouds, so that the 150-inch rainfall on the coast dwindles to fifteen inches at irrigated Sequim, on the northeast. It is not surprising, then, that the area presents a peculiar and interesting flora. Although 75 per cent of the flora is that of the adjacent Cascades, many Cascadian plants have not yet been found here, and many species extend their ranges northward or southward to the Olympic Peninsula, without occurring west of Hood Canal. Of especial interest is the occurrence of a small group of endemics, probably relicts, which are almost exclusively confined to unglaciated areas of high altitude, and which make up about 2 per cent of the total flora.

Over one thousand species and varieties are recognized for the Olympic Peninsula, which is over one-third of the known flora of Washington. The author exhibits laudable restraint in proposing only four new species, three new varieties, one new form and twenty-one new combinations, many of the latter being worthwhile reductions.

By his comprehensive study of the vegetation and the distribution of its species, with a consideration of the factors involved, in addition to the annotated catalogue of vascular plants (provided with keys and citations of specimens), Jones has produced a highly important piece of work. The prevalent attitude of the past has been to consider the whole region only as a promising field for the discovery of novelties. Similar attacks upon other mountainous areas in the Northwest will afford opportunity for significant comparisons with the flora of the Olympics. Now that Jones' study has revealed the necessity for more detailed investigations of the Cascades before any very satisfactory comparisons can be made between the two ranges, it is to be hoped that he will find time to give us a comparable study of Mount Rainier—a project which he has long had in mind.—Lincoln Constance.

VOLUME IV NUMBER 2

MADROÑO

A WEST AMERICAN JOURNAL OF BOTANY

Contents

Published at Lime and Green Streets, Lancaster, Pennsylvania

April, 1937

MADROÑO

A WEST AMERICAN JOURNAL OF BOTANY

Business Manager—Dr. David D. Keck
Lime and Green Sts., Lancaster, Pennsylvania
or
Carnegie Institution of Washington
Stanford University, California

Entered as second-class matter October 1, 1935, at the post office at Lancaster, Pa., under the act of March 3, 1879.

Established 1916. Published quarterly. Subscription Price $2.50 per year. Volume I, Numbers 1 to 17, complete, $5.00. Volume II, Numbers 1 to 17, complete, $5.00. Volume III, Numbers 1 to 8, complete, $5.00. Single numbers $0.75.

Papers up to 15 or 20 pages are acceptable. Longer contributions may be accepted if the excess costs of printing and illustration are borne by the contributor. Articles may be submitted to any member of the editorial board and if accepted, are published in the order of receipt. However, accepted manuscripts may be included in the forthcoming issue provided that the contributor pay the cost of the pages added to the issue to accommodate his article. Reprints of any article are furnished at a cost of 4 pages, 50 copies $3.70; 100 copies $4.10; additional 100's .75¢; 8 pages, 50 copies $5.40; 100 copies $6.00, additional 100's $1.20. Covers, 50 for $2.50; additional covers at $1.50 per hundred. Reprints should be ordered when page proofs are returned.

Published at Lime and Green Streets, Lancaster,
Pennsylvania, for the

CALIFORNIA BOTANICAL SOCIETY

Annual membership dues of the California Botanical Society are $2.00, $1.50 of which is for a year's subscription to Madroño. Dues should be remitted to the Treasurer. General correspondence and applications for membership should be addressed to the Secretary.

VEGETATIONAL SURVEY OF THE LOWER RIO GRANDE VALLEY, TEXAS[1]

Elzada U. Clover

Botanical Exploration

Southern Texas has been known to botanists since 1826. The earliest botanist was the Swiss, Dr. Luis Berlandier (4). He was sent as naturalist of the Mier Terán Expedition or Comisión de Límites by the Mexican Government to determine the character of the country along the proposed United States and Mexican boundary in 1828. Thomas Drummond, upon seeing a set of Berlandier's collections, was impressed by the vegetation of the region and while on a collecting tour to America went to Texas in 1833–1834 and spent some time collecting in the vicinity of Galveston Island (38). W. J. Hooker (26) published notes on this expedition.

Ferdinand Lindheimer began collecting in Texas in 1836 but because of conditions in the early days of the Republic did no extensive work until 1842. Dr. George Engelmann, a friend and German schoolmate of Lindheimer, suggested to Asa Gray that they take the burden of classification and distribution off his hands, permitting him to devote his entire time to field work. Lindheimer contributed much to the botanical knowledge of the state and well deserves the title "Father of Texas Botany." His plants were described by Gray and Engelmann (18, 22).

In 1854 the work of making a United States-Mexican Boundary Survey was begun. Major William H. Emory (17) was placed in charge of this project. Vegetational and geological reports of this survey by Dr. C. C. Parry and Assistant Arthur Schott give interesting information on the Lower Rio Grande region. Charles Wright, who, in connection with the movement of troops to western forts, had made his first collections of plants in Texas in 1847 to 1848, was in 1851 sent as botanist and surveyor on the United States-Mexican Boundary Survey Commission from the Rio Grande to the Pacific, under Emory. Collections of plants (exclusive of the Cactaceae) made during this survey were determined and distributed by John Torrey (34). George Engelmann (19) determined the Cactaceae.

John M. Coulter (13) published on the plants of an expedition to the region of the Rio Grande made in 1887: "Mr. G. C. Nealley was engaged by the Division of Botany (U. S. Department of Agriculture) to make collections of plants during 1887, 1888, and 1889 in the more unexplored parts of Texas, chiefly in

[1] Papers from the Department of Botany and the Botanical Gardens of the University of Michigan, No. 625.

Madroño, Vol. 4, pp. 41–72, April 7, 1937.

the counties bordering the Rio Grande. It was hoped that many of the rarer plants of the Mexican Boundary Survey and the early collections would be rediscovered, that additional Mexican types would be found to be members of our flora, and that species new to science would be brought to light." A large and valuable collection was made on this expedition.

Valéry Havard (25) made extensive collections along the valley of the Rio Grande and in the adjacent territory. His report on this work really marks an important step in Texas botany from pure description to a study of plants in relation to their environment, ecology, and pathology. An account of Havard's work is given by Winkler (38).

C. Hart Merriam (28) in his much discussed "Life Zones and Crop Zones of the United States," by mapping the Brownsville region as "Tropical" called attention of botanists to the special interest that the region might hold for them. Cultivated as well as wild plants of the Rio Grande Valley are listed in the paper.

In an account of changes of vegetation in the south Texas prairies, O. F. Cook (11) concluded that elimination of prairie fires as a result of intensive grazing is the principal cause of the spread of chaparral vegetation over much of the coastal prairie.

Dr. J. N. Rose made investigations in the Lower Rio Grande Valley in connection with his studies in the family Cactaceae. The great monograph of this family by Britton and Rose (7) incorporates many notes and photographs by Robert Runyon of Brownsville, an amateur botanist who has contributed valuable notes on distribution as well as on new species. He was coauthor of "Texas Cacti" (30) and published also an article in *Desert*, May, 1936, on "Cacti of the Lower Rio Grande Valley." Another student of the flora of this region is Father Chateau of Mission, Texas.

In this brief summary many collectors and authors who have contributed to the knowledge of the botany of the Lower Rio Grande have had to be neglected. However, the reader who has a particular interest in the region may turn to Charles H. Winkler's account (38) of botanical investigations in Texas. He includes an annotated list of 121 publications.

Climate

The temperature variation in this region is not great. At Fort Ringgold it averages by months from 57.7° F. in January to 88.7° F. in July; and at Brownsville, from 59.1° F. in January to 83.7° F. in August. These figures were compiled from statistics of the U. S. Weather Bureau over a period of about forty-seven years (35). Killing frosts are rare, but frequent enough to make the commercial growing of bananas and other tropical fruits impossible.

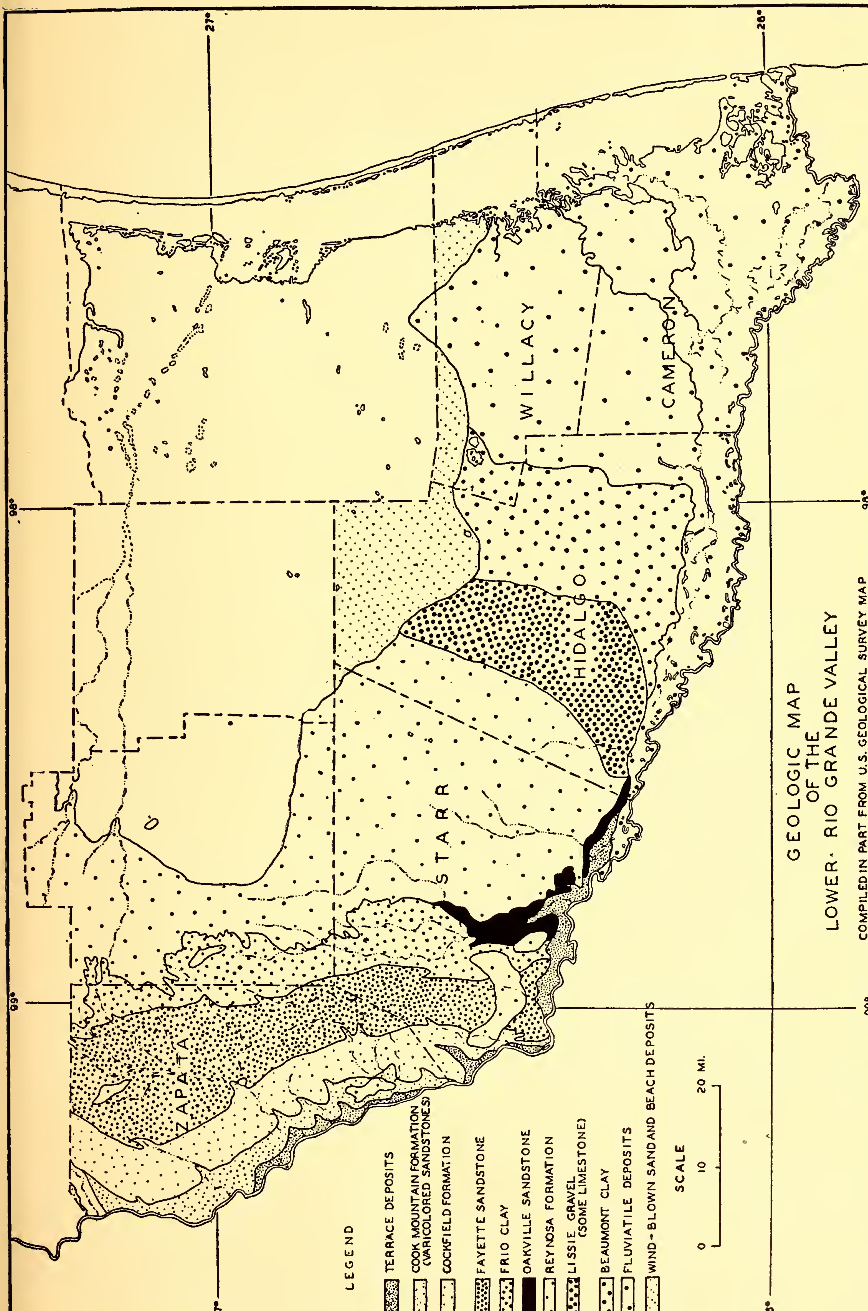


Fig. 1. Geologic Map of the Lower Rio Grande Valley.

Average monthly rainfall at Fort Ringgold varies from 0.29 inches in February to 3.13 inches in September, with a total of 17.46 inches annually; at Brownsville, from 1.27 inches in March to 5.62 inches in September, with a total of 26.89 inches annually. This record was made over a period of thirty-nine years at Brownsville and thirty-seven years at Fort Ringgold (35).

The weather is usually clear with a brilliant sun; but in June and September there are such violent thunder storms that the usually dry, deep arroyos in Starr and Zapata counties become impassable torrents. The prevailing wind in the Lower Rio Grande Valley is from the southeast. It blows almost steadily in the summer but decreases during the winter. It is of the monsoon type. "Northers" occur with varying frequency from late October until March, causing a very sharp drop in temperature within a short space of time. They are called "dry" or "wet" northers, depending upon whether or not the wind is accompanied by precipitation. Since rainfall in this region is so irregular, farming as a rule is very uncertain in unirrigated sections. However, cotton raised by dry farming methods seems to be quite successful because the plants are less injured by the boll-weevil and the cotton root rot fungus (*Phymototrichum omnivorum*) than if grown under moist conditions.

Topographic Features

Beginning at sea-level in the low grassland and swampy areas of the coast, the Rio Grande Plain on the average rises at the rate of approximately five feet per mile. The coast is protected by Padre Island, a very narrow strip composed mostly of dune sand, extending along the coast from the mouth of the Rio Grande to Corpus Christi, and separated from the mainland by Laguna Madre, which is four to ten miles wide and rather shallow. In general the coastal area consists of beach with low dunes, beyond which are barren salt flats and salt marshes. On the surface of the delta there are numerous low mounds locally known as "clay dunes" (21). In northern Willacy County the wind piles up true dunes (some of them twenty-five feet high) and blows out depressions, making the topography irregular. All of Cameron, most of Willacy, and a small portion of Hidalgo counties are included in the Rio Grande delta.

The greater part of Hidalgo and Starr counties is included in the Hebbronville Plain. There is a low rise which includes the towns of Mission, McAllen, San Juan, Pharr, and Donna, and a limited area near Raymondsville. This is known as the Mission Ridge. All of the Rio Grande Delta with the exception of this ridge has been subject to flood in the past. The delta begins at Peñitas, and in ordinary floods the water breaks out here, covering the streets of the village and filling in all of the low places south of the Mission Ridge. Most of the sand belt occurs north

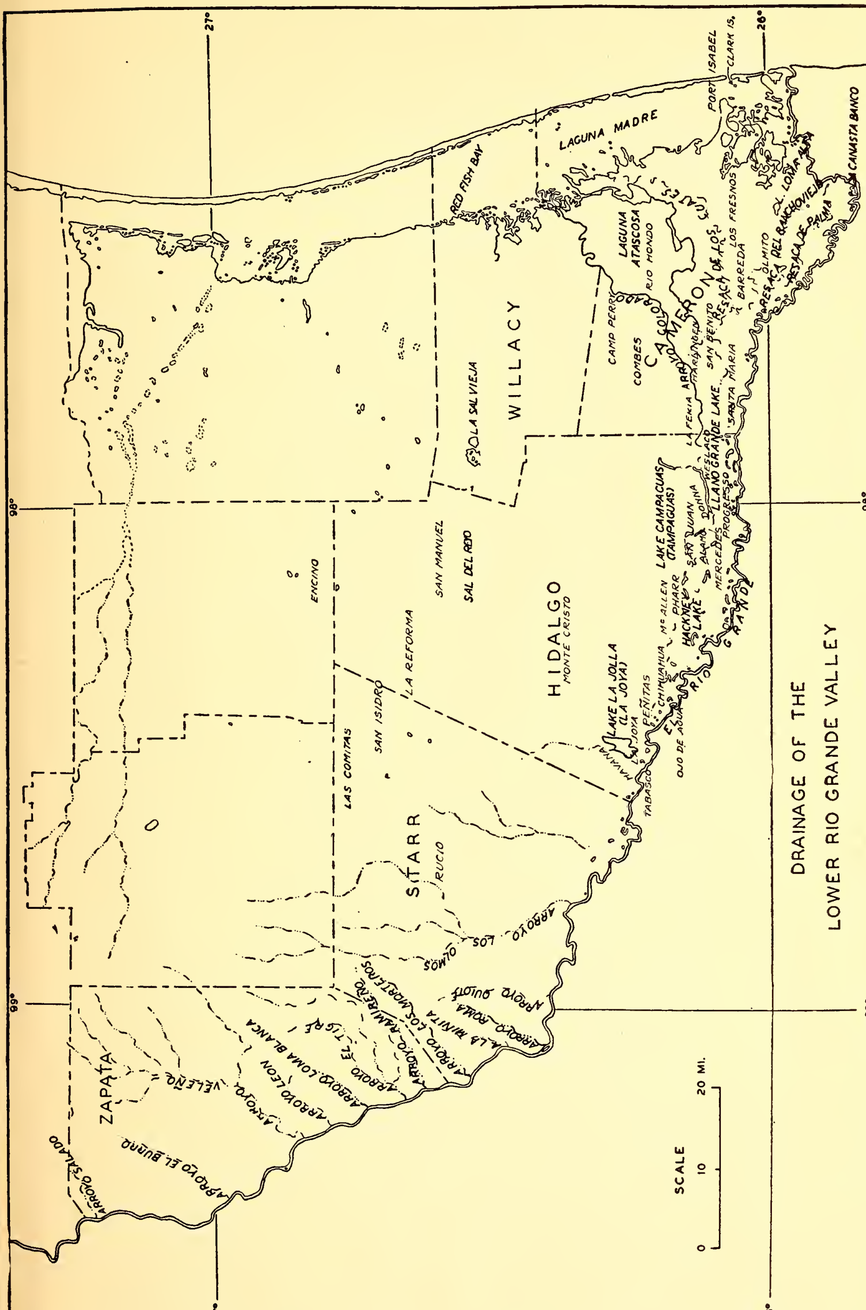


FIG. 2. Drainage of the Lower Rio Grande Valley.

of the Lower Rio Grande area, but the southern end extends into northern Hidalgo County and covers a small corner of Starr and a portion of Willacy County (text fig. 1). The bed rock of this region is covered by wind-blown sand. There are some migrating dunes; others have been stabilized by growth of grass or shrubs.

The Hebbronville Plain extends from the sand belt and the Rio Grande Delta west and north to a rather spectacular topographic feature known as the Bordas Scarp. The west face of this escarpment averages sixty or seventy feet in height and is composed of Oakville Sandstone and Frio Clay (text fig. 1). The absence of erosion on the east side is probably accounted for by the type of soil, which is a porous *caliche* overlain with loose sand (35). The water leaches through so rapidly that little or no erosion takes place. Looking at the Bordas Scarp from the west, it is not unlike some of the flat-topped buttes of New Mexico. More than half of Zapata County is included in the Aguilares Plain (35), which is sixty or seventy feet lower than the west side of the Hebbronville Plain and largely covered with grass and mesquite.

The erosional valley of the Rio Grande begins at Peñitas and extends through Zapata County. Numerous arroyos drain this part of the area, and the rough, broken region where they join the river is known as the "Breaks of the Rio Grande." This belt varies in width from one to fifteen miles, averaging about seven. In a portion of its course the river lies on an older valley filled with detritus in which terraces have been cut. At other points, particularly near Zapata and San Ignacio, the river runs along high cliffs and bluffs of the Reynosa formation.

La Sal Vieja and Sal del Rey (text fig. 2) are salt lagoons. It is thought (35) that the salt has been blown inland from the Gulf.

Geology

The oldest formations are the Cook Mountain and the Cockfield formations (35). They belong to the Claibourne group in the Eocene and extend beyond the limits of Zapata County to the north. The Fayette Sandstone, probably Oligocene, outcrops in western Starr County and covers about one-half of Zapata County, conforming somewhat in extent to the Aguilares Plain. A rather narrow, irregular area of Frio Clay, with an outcropping of Oakville Sandstone near Rio Grande City, overlies the Reynosa formation forming the Bordas Scarp. The Oakville belongs to the Miocene, and the Frio Clay is probably Oligocene.

The Reynosa formation covers the greater part of Starr County and extends along western Hidalgo County. There are small outcroppings elsewhere (text fig. 1). This formation comprises a greater part of the Hebbronville Plain. The Reynosa is probably Pliocene and is composed of an indurated gravel

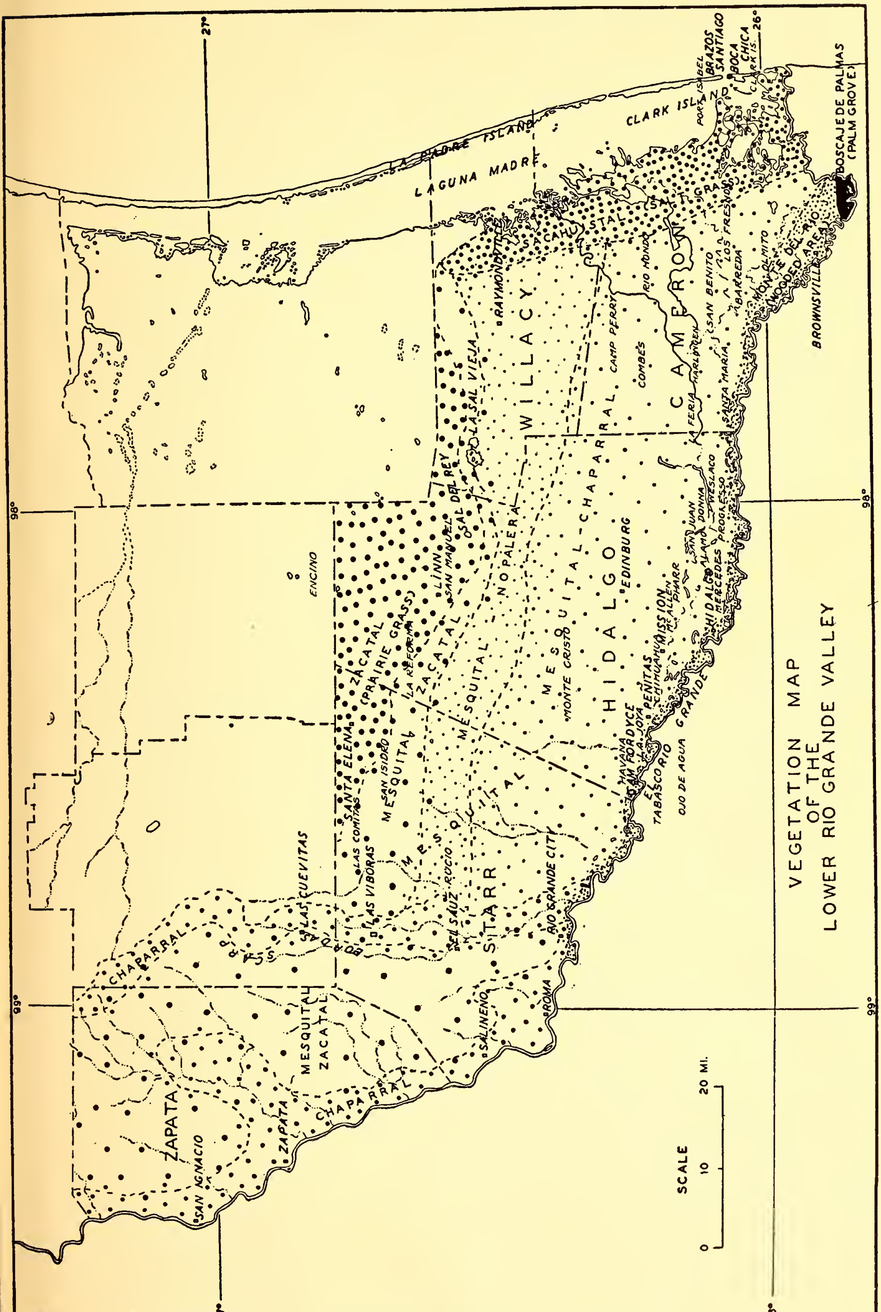


Fig. 3. Vegetation Map of the Lower Rio Grande Valley.

cemented by limestone, limestone with embedded pebbles, sand, gravel, and sandstone. Lissie gravel occupies the central part of Hidalgo County. It is of Pleistocene age and is composed chiefly of unconsolidated gravel, balls of clay or irregular masses, lenses and beds of sand and thin beds of limestone. Gravel from pits near Sam Fordyce and Havana has been used for road-making throughout the Valley.

The area of wind-blown sand and beach deposits is a wide stretch reaching beyond Falfurrias and appearing in the Lower Rio Grande Valley. The Prairie-Grass region and this area almost coincide. Beaumont Clay of the Pleistocene begins at Peñitas, lying east of the Lissie Gravel region and joining the fluviatile deposits which have their origin near Rio Grande City as a narrow strip along the river. These deposits widen out to many miles toward the coast.

Drainage

With the exception of the Arroyo Colorado, the Rio Grande is the only permanent stream. The upper part of the Lower Rio Grande Valley is drained by arroyos (text fig. 2), in which there are streams only following infrequent downpours, the deep, ragged cuts testifying to the force of the torrents. Since these arroyos are not bridged, traffic is sometimes forced to wait for hours for the water to go down.

The poor drainage near the coast has been improved within recent years by the construction of large, open drainage ditches. Poor drainage has been a problem of great concern because much of the irrigated land with insufficient drainage became so impregnated with alkali salts that some crops could no longer be grown. New flood channels and levees, better canal systems and more efficient handling of irrigation water have improved this condition appreciably.

The Arroyo Colorado, a distributary of the Rio Grande, is a deeply cut flood channel starting near Mercedes in eastern Hidalgo County, and continuing in a northeasterly direction through Cameron County to Laguna Madre. The water is salty as far inland as Harlingen because the bottom of the channel is below sea-level and there is little flow (3). Nearly all of the run-off water of Cameron County flows into the estuaries of Laguna Madre.

In part of Zapata County there is no valley on the Texas side of the Rio Grande, the river flowing against high cliffs (pl. IX). In western Hidalgo County the valley has attained the width of perhaps a mile. Lower down it becomes eight miles wide. In western Cameron County the delta is many miles wide, and excess water moves in poorly defined channels across the almost flat surface toward the coastal lowlands. Some of these are *resacas* and *esteros,* low places formed by the old river channels.

The writer's survey of the vegetation of the Lower Rio Grande Valley is based upon field studies made at three different periods and extending over most of the four seasons. The periods of study were as follows: June 30, 1932, to September 15, 1932; February 25, 1932, to July 8, 1933; November 30, 1933, to February 18, 1934. Information necessary for making a vegetational map was obtained by traverses on roads and trails. In general, the roads are fairly good, but some transportation difficulties were encountered, especially in Zapata County. The seasons of the study happened to be very dry; consequently, many herbaceous plants which normally occur during favorable seasons were missing. It was found that in this area vegetation is influenced markedly by edaphic factors, and that it conforms, more or less, to geological formations (text figs. 1, 3).

Local Ecological Nomenclature

The Spanish-speaking people of Mexican stock in southern Texas have developed a very definite and satisfactory classification of the vegetation. Professor Bartlett (ms.) introduced local nomenclature into the description of vegetational types in his account of the botany of the San Carlos Mountains of Tamaulipas. He (2) and Lundell (27) have adopted this system in a phytogeographical study of the Yucatan Peninsula. In the present article local Spanish nomenclature is used to designate phytogeographic divisions, associations, and societies within the association. The writer has spent many years along the Rio Grande and has learned these names directly from Texans and Mexicans.

Frequently the association or society is named for the dominant species. For instance, *mesquital* applies to the association dominated by the mesquite (*Prosopis juliflora* var. *glandulosa*).[2] A society within this association in which the mesquite is dominant is also called *mesquital. Zacatal* derived from *zacate* ("grass") designates the grassland association. This name is used particularly for prairie grass. The grassland area is known as *los llanos.* The coastal marsh grass (*Spartina Spartinae*) is known as *sacahuista,* so the community which this species dominates is a *sacahuistal,* and the area is called *llano salitroso.* That part of the salt marsh occupied by water, and in which aquatic plants occur is designated as *badilla salitrosa,* and sometimes as *pantaño.* A *charco* is a depression or low place which supports a growth of cat-tails (*Typha latifolia*), charas, sedges, and other aquatics; while the *resaca* is a larger, more permanent body of water formed by the old river channel. The borders of the *resacas* are sometimes dominated by *Parkinsonia aculeata* (*retama*), and the plant group is called a *retamal.* Other *resaca* communities

[2] Since a systematic list of the species referred to forms a part of this paper, space is saved in the ecological discussion by omitting the authorities for scientific names.

are named *huisachal* for *Acacia Farnesiana* (*huisache*); or *mimosal* for *Mimosa strigillosa.* One *resaca* in Cameron County near Rio Hondo has *Ipomea fistulosa* (*amor*) growing abundantly with both *Parkinsonia aculeata* and *Acacia Farnesiana.* This is a rather unusual situation, since *Ipomea fistulosa* is an escape and even though the species is equalled in dominance by the other two, the plant group receives the name *amoral.*

Hilly territory, chiefly the Bordas Scarp region, is known as *lomeria;* and the high dry land in the upper counties and away from the river is the *mesa.* The *lomeria* and parts of the *mesa* have a characteristic growth consisting mostly of spiny shrubs and stunted trees including many species. The Mexicans call this growth *chaparral,* named from *Acacia amentacea* or *chaparro prieto* (black chaparral) which is usually an important part of the vegetation. A small area, usually a limestone or gravel hill, dominated by this species is also a *chaparral.*

This use of the term chaparral differs from that of Cooper (12) who refers to broad-sclerophyll scrub. He explains that the word "chaparral" is of Spanish origin meaning oak scrub. In California and parts of Mexico this is generally true, but it is not in south Texas. *Chaparro prieto* or black *chaparral* is the Spanish name for *Acacia amentacea,* and any phytogeographic division large or small which this species dominates is referred to as *chaparral.* This term is also used to designate an area covered by a scrubby growth in which the mesquite is inconspicuous or absent. Authors usually include the mesquite in a *chaparral* especially in localities in which the species is stunted and scrubby. Since this paper is following the local Spanish nomenclature for these ecological areas it is necessary to exclude the mesquite. The author feels justified in using the name *chaparral* for the semi-desert brush in view of the fact that it has been used in this sense by several ecologists and other botanists for many years. Emory (17) refers to the vegetation along the Rio Grande as *chaparral.* Warming (36), Drude (16), Bray (5), Engler (20), Harshberger (23), and Tharp (33), are other authors giving this interpretation to the word.

Palma is the Spanish name for palm, and the palm grove or small forest formation near Brownsville is known as *boscaje de palma.*

In general the suffix *-al,* added to the Spanish name of the plant in dominance (sometimes with vowel elision) designates the plant group. An exception to this is *nopalera,* the name used for an association and also for a society of Opuntia (*nopal*).

Such nomenclature as described will have no value in regions where the Spanish language is not spoken; but in Spanish-speaking localities an acquaintance with this method is important. Bartlett (2) considers that much of this folk knowledge can be systematically formulated in an ecological study. It is

Figure 1

Figure 2

Plate IX. Fig. 1. Near San Ignacio in Zapata County the Rio Grande flows along steep bluffs. This hilly area broken by arroyos is known as the "Breaks of the Rio Grande." Fig. 2. *Yucca tenuistyla* (in the foreground) growing in open brush-land. This plant is abundant in the vicinity of San Ignacio.

my purpose to use it in connection with terms ordinarily applied to vegetational groups.

The writer is intentionally avoiding the use of many ecological terms in English since they are often confusing even when not accompanied by a local terminology. The *association* is used in this paper to designate the larger, distinct plant groups, and *society* for smaller groups within the association. The word *community* is used for groups in which the rank is uncertain (37).

Phytogeograpic Study

There is no true tropical area in Texas. The freezing temperatures which sometimes occur limit genuine tropical life to a few insects, reptiles, and birds (1). However, near the mouth of the Rio Grande and extending inland some distance are a few plants of generally tropical distribution. One would place *Sabal texana* foremost in this list. Others are *Daubentonia longifolia, Lantana horrida, Malphigia glabra, Amyris parvifolia, Helietta parvifolia, Schaefferia cuneifolia, Serjania incisa, Cardiospermum Halicacabum, Ruellia tuberculosa,* and *Avicennia nitida.*

The Rio Grande Valley is of much interest botanically because plants representing western desert, northern, coastal, and tropical floras are all found in a relatively small area.

I. The Mesquital Climax

Prosopis juliflora var. *glandulosa* is classed as a *chaparral* plant in parts of the United States where it is shrubby. In the Rio Grande Valley it often reaches a height of thirty-five feet and is sometimes two feet or more in diameter. Here the mesquite is a tree, and any association or plant group in which the mesquite is dominant or especially conspicuous is known as *mesquital.* The *mesquital* covers most of the area and exhibits several phases (text fig. 3).

Mesquital-zacatal. This phase covers the greater part of Zapata County, conforming rather closely to the area known as the Aguilares Plain. It is interrupted by the Bordas Scarp, but continues on the other side as a narrow strip through the northern part of Starr County and across Cameron County to the Gulf.

Most of this territory is a flat sandy plain. Even though the area west of the Bordas Scarp has the same dominating ecological characters as that on the east side, the composition of the vegetation is quite different. The dominants in this western part in Zapata County are: *Prosopis juliflora* var. *glandulosa,* with *Bouteloua barbata* and *Aristida purpurea* probably dominant among the grasses, although it is difficult to name dominants where overgrazing interferes. Other grasses enter this phase of the *mesquital* and there are many societies of mixed shrubs occurring with varying dominance. The most important dominants are:

Zizyphus obtusifolia, Leucophyllum frutescens, Acacia Berlandieri, Bumelia lycioides, Celtis pallida, Schaefferia cuneifolia, Forestiera angustifolia, Acacia amentacea, and *Cercidium texanum.* These shrubs are often scattered through the open mesquite woods and occasionally form a heavy growth near an arroyo.

Yucca tenuistyla is rather abundant northeast of San Ignacio forming societies in open grassy areas. Such a society is known as an *aguapal.* This species is often found in open brushland (pl. IX).

Herbaceous plants form many of the societies. The most important of these are: *Gaillardia pulchella, Lupinus texensis, Oenothera laciniata* var. *mexicana, Parthenium Hysterophorus, Verbesina encelioides, Aphanostephus skirrobasis* var. *Hallii,* and *Jatropha spathulata.*

By far the greatest portion of the *mesquital-zacatal* lies east of the Bordas Scarp. The dominants here are: *Prosopis juliflora* var. *glandulosa* and probably *Aristida purpurea, Eragrostis curtipedicellata,* and *Eragrostis secundiflora.* It is difficult to name a single grass which dominates the entire phase, for there is varying dominance depending upon edaphic factors and light conditions. In poorer soil the grama grasses (*Bouteloua*) grow with little competition; in other situations they form the layer under taller grasses such as *Eragrostis curtipedicellata, Eragrostis secundiflora, Chloris cucullata,* and *Aristida purpurea.*

Other herbaceous plants forming societies are: *Callirrhoë digitata, Commelina crispa,* and *Jatropha stimulosa.* Shrubs invading this phase are: *Celtis pallida, Zizyphus obtusifolia, Leucophyllum frutescens, Acacia amentacea.* Societies and clans of *Opuntia Lindheimeri* and *Opuntia leptocaulis* are occasionally found.

Echinocereus angusticeps, recently described (10) as a species distinct from *E. papillosus,* occurs near Linn, and is found nowhere except in this limited area. It would be interesting to know the conditions which make this locality especially favorable for the growth of this species. The only other cacti found here are: *Dolicothele sphaerica, Neomammillaria hemisphaerica, Opuntia Lindheimeri,* and *O. leptocaulis.* Plants other than cacti are: *Convolvulus incanus, Jatropha spathulata, Prosopis juliflora* var. *glandulosa, Zizyphus obtusifolia, Celtis pallida, Aristida purpurea,* and *Bouteloua barbata.*

The mesquite trees are often infested with mistletoe, *Phoradendron flavescens.* In the region of Zapata and San Ignacio many of them have been seriously damaged by this parasite (6). Around Aguilares the infestation is particularly heavy, and many trees are dying.

Mesquital-nopalera. It is impossible to draw a definite line between the phases of the *mesquital* area. An attempt has been made (text fig. 3) to show the merging of one phase into the other. There is a narrow strip from east to west in which conditions seem optimum for the growth of opuntias. They vie with mesquite for dominance, and, in some places, crowd out most other species. *Celtis pallida, Viguiera stenoloba, Lippia ligustrina, Lantana horrida,* and *Bouteloua barbata* are commonly found even in the densest growths. Cleared land which has been abandoned is soon covered by a heavy growth of *Opuntia.* The opuntias readily reproduce vegetatively, a single joint being capable of giving rise to one or more new plants. Since these joints are rather easily broken from the parent plants the spread of the genus in a free area is extremely rapid. The soil is a deep sandy loam. There is a gentle slope to the east, providing good drainage, and here the mesquite is probably more abundant than in any other part of the Rio Grande Valley.

Included in the *mesquital-nopalera* there are two depressions known as Sal del Rey (Hidalgo County) and La Sal Vieja (Willacy County). The sparse vegetation at the margin of the lake is of the beach and coastal prairie type. *Monanthochloë littoralis, Strombocarpa cinerescens,* and *Chenopodium album* are most abundant.

Mesquital-chaparral. The invasion of the chaparral vegetation is comparatively recent and thought to be the result of overgrazing and drought. The *mesquital-chaparral* is by far the most important phase of the *mesquital.* It covers the greater part of the territory in the Lower Rio Grande Valley, and in general typifies the vegetation which is found in much of southwestern Texas.

There is a marked variation in soil conditions here, and this difference affects the size and luxuriance of the growth. Many species occur throughout the range, and others are limited in extent.

On the surface of the delta in eastern Cameron County there are numerous small mounds locally known as "clay dunes." They project several feet above the coastal plain and are often covered with a dense growth of chaparral and mesquite (pl. X). This growth is similar in structure to much of the vegetation between Brownsville and San Benito, but the shrubs near the coast are characteristically twisted as a result of heavy winds. The association has no general dominant. Some definite societies within it are dominated respectively by the following species: *Siderocarpos flexicaulis, Leucophyllum frutescens, Zizyphus obtusifolia, Castela Nicholsonii, Randia aculeata, Forestiera angustifolia, Prosopis juliflora* var. *glandulosa,* and *Celtis pallida.* A high ridge near the Rio Grande supports a much sparser growth of shrubs interspersed with mesquite and the following cacti: *Ferocactus hamatacanthus, Echinocereus pentalophus, Ancistrocactus Scheeri, Hamatocactus setispinus,* and *Neomammillaria hemisphaerica.*

These "islands" of chaparral are separated from the main *chaparral-mesquital* area by the *sacahuistal* and a transition zone. There is at first an invasion of mesquite into the coastal prairie area. *Lycium carolinianum, Celtis pallida,* and *Zizyphus obtusifolia* are usually the first shrubs to enter. The composition of the

FIGURE 1

FIGURE 2

PLATE X. Fig. 1. Chaparral vegetation covering a "clay dune" near the coast. The dominant shrub with dark foliage is *Siderocarpos flexicaulis.* (See also Pl. XIII, fig. 2.) Fig. 2. The *chaparral-cenizal* near Roma, Starr County. The light areas are dominated by *Leucophyllum frutescens;* the dark areas are dominated by *Acacia amentacea.*

mesquital-chaparral farther inland is similar in parts of Hidalgo and Willacy counties and in Cameron County. The brush is usually five to eight feet tall and rather dense. Dominance is dependent on several conditions, and is difficult to determine in much of this area. The flora is more or less characteristic throughout, but it is varied in its distribution and aspects by several factors.

Soil and drainage have a decided effect upon the distribution of plants in this association.

Limestone outcrops occur as hills surrounded by the Reynosa formation. *Leucophyllum frutescens* and *Acacia amentacea* are dominant on these hills in a society known as *chaparral-cenizal* (pl. X). Other prominent plants are *Bouteloua trifida, Panicum Hallii, Jatropha spathulata, Prosopis juliflora* var. *glandulosa, Karwinskia Humboldtiana, Hamatocactus setispinus, Neomammillaria hemisphaerica,* and *Opuntia Lindheimeri.*

Three species, *Leucophyllum frutescens, Acacia amentacea,* and *Acacia Berlandieri* share dominance on limestone and Reynosa gravel near the Rucio ranch, northeast of Rio Grande City. Other plants occurring in abundance are *Aristida purpurea, Bouteloua barbata, Condalia obovata, Karwinskia Humboldtiana, Bumelia angustifolia, Echinocereus papillosus, Opuntia Lindheimeri,* and *Aphanostephus skirrobasis* var. *Hallii.*

Mortonia Greggii (pl. XI) is dominant in societies on hillsides in a limited area five miles north of La Joya. A few plants are also found near Lake La Joya. The outcrop in the La Joya vicinity is Lissie Gravel. A few stunted plants of the above named species also occur in a small outcrop of Lissie Gravel near Rio Grande City.

A sandstone and gravel outcrop on a hill south of Mission, known as La Lomita, shows no dominant. There is a dense growth of mixed vegetation which contains a greater variety of plants than is usually found in an equal area in the *mesquital-chaparral.* The following plants are prominent or abundant in this society: *Adelia Vaseyi, Bernardia myricaefolia, Schaefferia cuneifolia, Coursetia axillaris, Acacia amentacea, Prosopis juliflora* var. *glandulosa, Randia aculeata. Coursetia axillaris* is extremely rare, probably occurring nowhere else in the Rio Grande Valley.

The *amargosal* is an area dominated by *Castela Nicholsonii.* This species is particularly abundant in Lissie Gravel near Peñitas and La Joya (pl. XI). Sub-dominants are *Acacia amentacea* and *Zizyphus obtusifolia.* Other plants of importance are *Celtis pallida, Karwinskia Humboldtiana, Schaefferia cuneifolia, Ancistrocactus Scheeri, Dolicothele sphaerica, Echinocereus enneacanthus, E. pentalophus, Hamatocactus setispinus, Homalocephala texensis, Neomammillaria hemisphaerica, N. Heyderi, Opuntia leptocaulis, O. Lindheimeri, O. Schottii, Guaiacum sanctum, and Viguiera stenoloba.*

High dry land included mostly in the Hebbronville Plain is known as the *mesa.* The soil is sandy loam with limestone and

FIGURE 1

FIGURE 2

PLATE XI. Fig. 1. A limestone outcrop. *Mortonia Greggii* (foreground) dominant, with *Leucophyllum frutescens, Cordia Boissieri* and *Acacia Berlandieri* present. Fig. 2. Lake La Joya bordered by a dense growth of *Castela Nicholsonii.* This society is known as *amargosal.*

gravel outcrops. Much of the vegetation is mixed, with no outstanding dominant. The *ebanal* is dominated by *Siderocarpos flexicaulis;* the *nacahuital* by *Cordia Boissieri* and the *comal* by *Bumelia lycioides. Cordia Boissieri* is usually found to prefer limestone and gravel hillsides. *Lippia ligustrina* and *Celtis pallida* are usually prominent here. *Bumelia lycioides* usually occurs on high level land in sandy loam soil, although single specimens are scattered throughout the Rio Grande Valley.

Prosopis juliflora var. *glandulosa* often dominates societies throughout the *mesa,* especially in sandy soil or in lower places between hills or near arroyos. In this *mesquital* the usually prominent species are *Celtis pallida, Opuntia leptocaulis,* and *Opuntia Lindheimeri.* The latter likewise attains dominance in certain localities, often almost excluding other species.

East of the *mesa* and in the western part of the Rio Grande Delta there is a variety of societies largely determined by soil and moisture conditions. Much of the vegetation in this area is mixed, with no outstanding dominant. Prominent plants growing in the Harlingen Clay near San Benito are given below grouped according to layers: (1) lower layer, *Setaria macrostachya, Trichloris pluriflora, Croton Cortesianus, Opuntia Lindheimeri, Salvia coccinea, Parthenium Hysterophorus,* and *Viguiera stenoloba;* (2) upper layer (shrubs 5–8 feet high, mesquites 10–15 feet high) *Celtis pallida, Forestiera angustifolia, Leucophyllum frutescens, Pithecolobium brevifolium, Prosopis juliflora* var. *glandulosa, Bumelia angustifolia, Zizyphus obtusifolia, Opuntia Lindheimeri, Lantana horrida,* and *Heimia salicifolia.*

Acanthocereus pentagonus (pl. XII), commonly called "nightblooming cereus", with the mesquite forms an association within the *mesquital-chaparral* in the vicinity of Rio Hondo. This association is several miles in extent. About four miles east of Rio Hondo the cactus is dominant, climbing in mesquites and forming such a dense tangle that it is almost impossible to get through without a "machete." Farther north, in an open mesquite wood it is frequent with *Spartina Spartinae* and *Opuntia Lindheimeri.* In places where the cactus and mesquite share dominance the following are prominent in the upper layer: *Celtis pallida, Zizyphus obtusifolia, Xanthoxylum Pterota* and *Opuntia Lindheimeri.* The lower layer is composed largely of the following: *Rivina humilis, Malvastrum caromandelianum, Sida paniculata, Heliotropium indicum, Gilia incisa, Hamatocactus setispinus* and *Salvia coccinea.*

Depressions anywhere in the lower part of the Rio Grande Valley in which run-off and flood waters gather often have a growth of *Parkinsonia aculeata* (*retama*). A society dominated by this species is called *retamal. Acacia Farnesiana* is often second in dominance here, and in depressions which are periodically dry it is apt to be dominant. *Typha latifolia, Scirpus Hallii, Atamosco texana* and *Castalia elegans* (pl. XII) are usually present growing

FIGURE 1

FIGURE 2

PLATE XII. Fig. 1. *Acanthocereus pentagonus.* This cactus requires much more water than most species. It extends over an area of several square miles east of Rio Hondo and often stands in water for weeks after a gulf storm without serious injury. Fig. 2. A shallow resaca near Alamo. *Scirpus Hallii* and *Castalia elegans* are shown here. *Parkinsonia aculeata* is in the background.

in the water. Some societies also contain *Echinodorus cordifolius* and *Sagittaria variabilis.*

The *huisachal* is dominated by *Acacia Farnesiana.* Besides the ones mentioned above there are other societies dominated by this species near the Rio Grande. It survives flood water, in which it stands for months, and the soil when drying out often develops deep cracks making conditions difficult for the growth of small plants. *Rumex mexicanus, Hartmannia speciosa, Ambrosia elatior, Parthenium Hysterophorus* and *Aster exilis* are among the first to enter.

The *charco* is a small low area covered with shallow water. *Typha latifolia* is dominant associated with *Cyperus articulatus, Scirpus validus, Marsilia vestita, Naias guadalupensis, Hartmannia speciosa* and *Aster exilis.*

Resacas formed by cut-offs in the old river channel usually contain shallow water. These resacas have practically the same type of vegetation which is found in other depressions. A resaca near Rio Hondo has an abundance of *Ipomea fistulosa* (probably an escape) occurring with the usual dominants. This society is called *amoral.* Aquatics here are *Chara praelonga, Marsilia vestita, M. macropoda, Typha latifolia, Lemna minor, Heteranthera limosa, Eichornia crassipes, Castalia elegans, Utricularia subulata, Radicula Walteri* and sedges (named at end of paper). Wet bank vegetation includes various sedges, *Cynodon Dactylon,* and *Aster exilis. Lepidium virginicum, Hartmannia speciosa, Urtica chamaedryoides* and *Lycopersicon cerasiforme* occur in the moist shady zone.

Irrigation has had some effect on plant distribution. Seeds are carried by the water and become established along the banks. The moisture added to the soil permits the growth of plants ordinarily excluded by dry conditions. The main canals are always filled with water and such species as *Cynodon Dactylon, Holcus halepensis, Paspalum Langei, Commelina longicaulis* and *Parthenium Hysterophorus* grow along the banks. Artificial depressions, locally called "barrow pits" at the sides of the canals, always contain some seepage water, and usually have the following species: *Marsilia vestita, Typha latifolia, Echinodorus cordifolius, Phragmites communis, Cyperus acuminatus, Cyperus oxycarioides, Scirpus validus, Castalia elegans,* and *Jussiaea diffusa.* Some of the smaller canals which carry water only periodically are choked with *Eichornia crassipes. Typha latifolia, Salix longifolia, Celtis pallida,* and *Cynodon Dactylon* also flourish in this environment.

There is a heavily wooded area along the Rio Grande in Cameron County in which trees reach a height of fifty feet or more. Near Alamo in such a situation the upper layer consists of *Celtis mississippiensis, Ulmus crassifolia, Siderocarpos flexicaulis* (pl. XIII), *Sapindus Drummondii* (pl. XIII) and *Fraxinus Berlandieri.* These trees are festooned with *Tillandsia usneoides. Tillandsia recurvata* and *Tillandsia Baileyi* are also present. Promi-

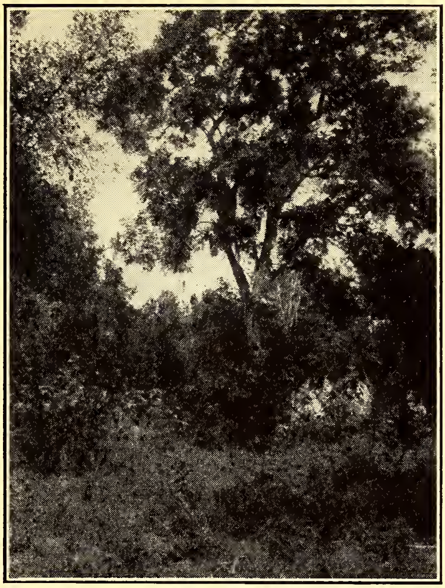


FIGURE 1

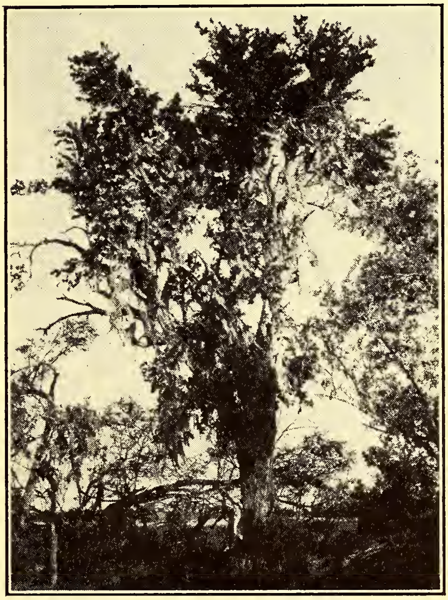


FIGURE 2

PLATE XIII. Fig. 1. Wooded area near the Rio Grande, Alamo. The large tree is *Sapindus Drummondii.* Fig. 2. *Siderocarpos flexicaulis* in woods near the Rio Grande, Alamo. This same species is a small shrub in dry areas.

nent species in the middle layer are *Celtis pallida, Zizyphus obtusifolia, Porlieria angustifolia, Malphigia glabra, Diospyros texana* and *Bumelia angustifolia.* The lower layer is a tangle of vines and weak-stemmed, herbaceous plants. The most prominent ones are *Rivina humilis, Clematis Drummondii, Urtica chamaedryoides, Cuscuta indecora, Cardiospermum Halicacabum, Plumbago scandens, Capsicum baccatum* and *Monarda dispersa* (pl. XIV).

Flood waters disturb and destroy the smaller vegetation along the river leaving stretches of deep sand. These stretches are soon covered by almost pure stands of *Baccharis* which are often swept away before being replaced by other species.

A single specimen of *Taxodium mucronatum* stands in the woods south of Havana. The tree is approximately forty feet tall. Mexican residents report that it has been there for at least a hundred years. Emory (17) states that cypress was found near the mouth of the Rio Salado, which is a tributary of the Rio Grande, and expressed the hope that some future day this species would spread down the river, furnishing building material for inhabitants.

II. The Chaparral Climax

The Bordas Scarp and a strip along the Rio Grande between Roma and San Ignacio is covered with a low shrubby growth which seems fairly stable. There are societies of mesquite on flats and along arroyos, but in general the hilly broken territory known as the "Breaks of the Rio Grande" is a distinct *chaparral,* as the term is used in this paper. *Acacia amentacea* is probably a general dominant with subdominants varying with the locality. Some of the most outstanding associations, societies and communities are given below.

Cenizal. This association is dominated by *Leucophyllum frutescens* with subdominants *Acacia amentacea* and *Acacia Berlandieri.* The presence of *Leucophyllum* usually indicates a limestone outcrop, and *Acacia Berlandieri* is often found on gravel hills. A *cenizal* occurs about two miles west of Roma and is several miles in extent (pl. X). The following plants were collected in this area: *Ephedra antisiphilitica, Atriplex acanthocarpa, Bouteloua barbata, B. trifida, Cenchrus pauciflorus, Pappophorum mucronulatum, Talinum angustissimum, Acacia Berlandieri, A. amentacea, Parosela nana, Croton ciliato-glandulosus, C. fruticulosus, Jatropha spathulata, Schaefferia cuneifolia, Karwinskia Humboldtiana, Microrhamnus ericoides, Abutilon incanum, Gayoides crispum, Sida filipes, Ancistrocactus Scheeri, Hamatocactus setispinus, Echinocereus enneacanthus, Neomammillaria hemisphaerica, Opuntia leptocaulis, O. Lindheimeri, Heliotropium confertifolium, Marilaunidium hispidum, Goniostachyum citrosum, Nicotiana repanda, Leucophyllum frutescens, Actinea odorata.*

Barettal. This occurs on gravel and limestone hills. The dominant species is *Helietta parvifolia* (pl. XIV). It is a rather

Figure 1

Figure 2

Plate XIV. Fig. 1. A society of *Monarda dispersa* in a mesquite wood, Havana. Fig. 2. *Helietta parvifolia* on a low hill east of Rio Grande City.

large community extending over several hills east of Rio Grande City. A few scattering plants are found as far east as Peñitas, and some grow in the region of the petrified forest east of Roma. Other prominent plants in this community are as follows: *Bouteloua barbata, Setaria macrostachya, Agave Lechuguilla, Acacia amentacea, Cercidium floridum, Castela Nicholsonii, Koeberlinia spinosa, Ancistrocactus Scheeri, Coryphantha Runyonii, Opuntia leptocaulis, O. Lindheimeri, Thelocactus bicolor, Coldenia canescens, Cordia Boissieri, Lippia ligustrina. Agave Lechuguilla* is not abundant but is worthy of mention as this locality seems to be the eastern limit of its range. A new species, *Coryphantha Pirtleana,* was recently found here by Pirtle brothers of Alamo.

Hechtia Texensis Society. The soil may be somewhat saline since *Varilla texana,* which is a halophyte (14), is always present. Burros enjoy eating the succulent flower stalks of *Hechtia,* many of which are prevented from seeding by being nipped off early. New plants are produced at the base of the parent plant, forming large mounds so dense that no other species can gain a foothold (pl. XV). Some of the plants besides *Varilla* that are commonly found with *Hechtia* are *Panicum Hallii, Zizyphus obtusifolia, Sida filipes, Schaefferia cuneifolia, Jatropha spathulata, Porlieria angustifolia, Pappophorum bicolor, Echinocereus enneacanthus,* and *Opuntia Lindheimeri.*

Agave Society. This society occurs on sandy loam and limestone hills. Agaves are found in only a few localities in the two upper counties. Probably the largest group is five miles south of Zapata. The vegetation growing with this species is characteristic of that found in much of the *chaparral* (pl. XV).

Bordas Scarp Vegetation. The approach to the Bordas Scarp is a gentle slope toward the west. The vegetation is of the *mesquital-chaparral* type, changing to the lower, sparse *chaparral* found on gravel. An area about a mile in length was chosen as representative of the *chaparral* of the escarpment. An interesting cactus, *Astrophytum asterias,* is found here, which, as far as known, occurs nowhere else in the United States (9). The following species were collected in this locality: *Ephedra antisiphilitica, Aristida purpurea, Chloris cucullata, Eragrostis curtipedicellata, Yucca* sp., *Runyonia longiflora, Celtis pallida, Talinopsis frutescens, Acacia amentacea, Prosopis juliflora* var. *glandulosa, Jatropha spathulata, Schaefferia cuneifolia, Karwinskia Humboldtiana, Zizyphus obtusifolia, Koeberlinia spinosa, Menodora heterophylla, Astrophytum asterias, Coryphantha Runyonii, Dolicothele sphaerica, Echinocereus enneacanthus, E. Fitchii, E. pentalophus, Hamatocactus setispinus, Lophophora Williamsii* (pl. XVI), *Neomammillaria hemisphaerica, N. Heyderi, Opuntia leptocaulis, O. Lindheimeri, Thelocactus bicolor, Wilcoxia Poselgeri, Lippia macrostachya, Ibervillea Lindheimeri, Varilla texana, Verbesina encelioides, Zinnia pumila.* The following plants were found at the base of the escarpment: *Triodia mutica,*

FIGURE 1

FIGURE 2

PLATE XV. Fig. 1. A society of *Hechtia texensis* near an arroyo between Roma and Zapata. Fig. 2. *Agave melliflua* in flower. This society occurs in a mixed *chaparral* near Zapata.

Sporobolus Wrightii, Rivina humilis, Jatropha Berlandieri, Abutilon Wrightii, Amoreuxia Wrightii, Aphanostephus skirrobasis var. *Halli, Dyssodia tephroleuca, Simsia calva, Zexemenia hispida.*

Costillal. The distribution of this society is mostly in Zapata County. The dominant is *Microrhamnus ericoides.* In places this species is so dense as to almost crowd out competitors. Low mesquites, *Zizyphus obtusifolia* and *Colubrina texensis* are frequently associated with it.

Palo Verde Society. The dominant species are *Cercidium texanum* in the region of Zapata, and *Cercidium floridum* near Peñitas. These species usually occur on dry mesas in open brushland. They thrive in dry gravel soil as the leaves are early deciduous and the stems carry on photosynthesis. *Bouteloua barbata, B. trifida, Coldenia canescens, Heliotropium confertifolium, Parthenium Hysterophorus* are some of the herbaceous species commonly associated with *Cercidium.* The shrubs of this society vary with the locality.

Gobernadoral. The dominant, *Covillea tridentata,* has invaded northern Zapata County from the northwest. The fact that it is most abundant on very dry and unproductive soil might give the impression that it prefers that habitat, but it does not. *Covillea* is easily crowded out by other vegetation in more favorable situations. Spaulding (32) states that it is capable of adapting itself to desert conditions by reducing leaf surface and by abstracting water from very dry soil, but it is capable of living and does live as an ordinary mesophyte if a suitable supply of water is available.

Vegetation along Arroyos. Shrubs inhabiting areas cut by arroyos are often larger near the banks where water stands after a storm. Species such as *Acacia Farnesiana* and *Parkinsonia aculeata* grow near these water-holes. *Cynodon Dactylon, Pappophorum bicolor, P. mucronulatum, Sporobolus argutus, Trichloris mendocina, Triodia pilosa, Panicum Hallii, Lepachys columnaris* var. *pulcherrima, Nicotiana longiflora, Parosela nana, Verbesina encelioides,* and *Chamaesyce laredana* are plants growing in dry arroyo beds. At Arroyo Loma Blanca *Ferocactus hamatacanthus* (pl. XVI) is abundant. One plant has persisted in the crotch of a tree for at least four years in spite of the fact that water has washed away all the soil in which it originally grew. *Echinocereus enneacanthus,* the species of cactus which has a greater distribution than any other in the Lower Rio Grande excepting the opuntias, often grows to the very edge of arroyos.

There are other societies in the chaparral which may also be found in the *mesquital-chaparral* phase. *Bumelia lycioides* and *B. angustifolia* occur in societies, clans and families throughout the area. Such plant groups are known as *comales* (singular, *comal*). *Diospyros texana* forms a *zapotal,* and *Yucca* a *pital.* There are few areas in which *Yucca* grows abundantly. It is usually scattered singly or in very small groups.

(*To be concluded*)

EARLY CALIFORNIA PLACE NAMES USED BY DANIEL CLEVELAND

A copy of the following letter was received recently from Dr. L. R. Abrams. Written in California thirty years ago by one of the early botanical collectors, it gives important information concerning certain old place names then in use. An account, by Dr. W. L. Jepson, of the life and botanical work of Daniel Cleveland has been published in this journal (Madroño 1: 267–268. 1929).—H. L. M.

San Diego, Cal., Feb. 7th, 1906

Mr. Le Roy Abrams,
U. S. National Herbarium, Washington, D. C.

My dear Sir:—

Your letter of the 2nd. inst. is just received. I take pleasure in answering it. "Larken's" ("Pete Larkens," it used to be called locally) is, as you surmise, what is now known as Jacumba Hot Springs, between 75 and 80 miles east of this city and some half mile north of the Mexican Boundary line. Peter Larkin, an American, owned and occupied this cattle ranch from about 1870 to 1887. About the latter year he removed to another ranch some 20 miles west of "Jacumba." The Jacumba Indian tribe lived in the immediate vicinity of "Larkins." The Jacumba Hot Spring is on the old Larkin ranch. Mountain Spring is about 10 miles east of Larkins, or Jacumba and on the edge of the desert. "Tighe's"—so named from the owner of the ranch who settled and lived there about 1875 and until about 1882—is situated some six to eight miles east of the town of Ramona, which is nearly 40 miles from San Diego. This ranch was owned and occupied before Tighe's occupation by Billingsly, about 1873–5, and before 1873 by Luckett, by whose names this ranch was also known, and is so named by collectors. Dr. Edward Palmer and I used the name of "Luckett" for this locality in connection with our plants collected in that vicinity. The name of Larkin was used by Dr. Edward Palmer, by me and other collectors for the country within 10 miles of Larkin's ranch. Tally's ranch lies in a valley at the base of the South Cuyamaca Mountain peak some 8 miles southward from the town of Julian in this county. The name as used by collectors covers quite a large valley section surrounding the old (James) Tally farm house. . . .

Sincerely yours,
Daniel Cleveland.

THE OCCURRENCE OF TALINUM PULCHELLUM IN TEXAS

V. L. Cory

On a field trip to the southwestern part of the Glass Mountains, northwest of Marathon, Brewster County, Texas, April 11, 1936, a plant with a solitary, purplish-red, showy flower, borne just above the surface of the ground, was seen for the first time by the writer. Six of these plants were taken for observation under cultivation, of which three were grown by H. B. Parks at San Antonio and the other three by the writer at Sonora. These grew readily, and proved to be species of *Talinum.* The solitary, showy flowers with a spread of as much as three centimeters indicated that the species was *T. pulchellum* Woot. & Standl. (Contr. U. S. Nat. Herb. 16: 121. 1913).

Referring to the original description of this species and comparing the plants in our care, which were growing under favorable conditions, discrepancies were noted: the peduncle was 15 millimeters long or, together with the pedicel, 30 millimeters long; for the most part also, the peduncles were cymosely 3-flowered, as contrasted with the original description in which the peduncles were described as 2–3 millimeters long and only 1-flowered. Furthermore, a count of stamens revealed 34 instead of about 20. In the treatment of this species by Percy Wilson (N. Am. Fl. 21: 284–285. 1932) the number of stamens was corrected to read 25–38, but still it was stated that the flowers were solitary.

Transferring attention now to C. H. Mueller's publication of *Talinum Youngae* ("A New Species of Talinum from Trans-pecos Texas," Torreya 33: 148-149. 1933) the description is seen to fit our plant except in minor matters of measurement and in the number of stamens, stated as being about 18. The separation of the two species by C. H. Mueller (Torreya 34: 40–41. 1934) is based upon the flowers being on longer peduncles and usually 3 in cymes in *T. Youngae,* while in *T. pulchellum* the flowers are solitary on pedicels about 1 centimeter long. A study of our material transplanted from the Glass Mountains shows that these differences do not hold constant. It is indicated therefore that only one species is involved. The plants vary according to the conditions under which they grow, longer peduncles and 3-flowered cymes tending to develop under favorable conditions. It seems possible, also, that specimens taken late in the season may show uniformly a reduced number of stamens.

In C. H. Mueller's original publication (1933) the following references are made to earlier collections of *T. Youngae* by Dr. M. S. Young: "Summit of Mt. Livermore, Davis Mountains, August 15, 1914," and "Very abundant on high, rocky slopes, Pine Canyon, Guadalupe Mountains, August 15, 1916." The type locality of the original collection of *T. pulchellum,* by Dr. E. O. Wooton, was also in the Guadalupe Mountains, "near Queen, New Mexico, August 2, 1909." It seemed desirable therefore, to collect the plant on Mt. Livermore, and this was done on May 3, 1936. Several plants were taken on high rocky slopes. Each had a solitary flower; a typical flower revealed 34 stamens, or exactly the same as in the plant from the Glass Mountains. There is no reasonable doubt that this plant is the same as that formerly collected by Dr. Young. To the writer, there seems to be sufficient evidence that both these collections should be referred to *T. pulchellum* Woot. & Standl. *T. Youngae* C. H. Mueller therefore becomes a synonym of *T. pulchellum* Woot. & Standl.

The following revised description of *T. pulchellum* includes characters which develop under favorable conditions of growth.

Talinum pulchellum Woot. & Standl. Contr. U. S. Nat. Herb. 16: 121. 1913. *T. Youngae* C. H. Mueller, Torreya 33: 148. 1933.

Leaves up to 28 mm. long, 3 mm. in diameter, terete (not even slightly flattened except under adverse conditions of growth), blunt, densely and evenly distributed along the stem, but under adverse conditions appearing basal; not narrowed at the base, at point of attachment three-fourths to four-fifths the diameter of the stem, subtended by a rounded, flattened margin, extending around the base below the point of attachment; peduncles axillary, stout, under favorable conditions 3-flowered, under other conditions commonly 1-flowered, or sometimes 2-flowered; when more than 1-flowered commonly with only one bloom open at one time, flower opening about mid-afternoon and closing at sundown; when 3-flowered, peduncle up to 15 mm. long, at the apex marked by a definite ring or sunken joint, which is subtended by a pair of opposite bracts 5–6 mm. long, linear-lanceolate, more or less fleshy, and scarious-margined, each bract subtending a lateral pedicel; lateral pedicels equal in length to the middle or terminal pedicel (15 mm. long), likewise terminating in a solitary flower and bearing 5 mm. from the base a pair of opposite bracts, similar to but shorter (4–5 mm. long) than the bracts subtending the pedicels; middle pedicel ebracteolate.

The report that *T. pulchellum* is known only from the type locality, which is near Queen, New Mexico, may now be modified to show the distribution of this species throughout the mountains of southwestern Texas.

Agricultural Experiment Station,
Sonora, Texas, August, 1936.

NOTES AND NEWS

Dr. Albert Levan of Lund University, Sweden, arrived in Berkeley February, 1937. He will spend six months in California continuing cytogenetical studies on the genus *Allium.* He is at present engaged in field work in southern California and while there, will make his headquarters at the California Institute of Technology, Pasadena.

At a meeting held in Santa Barbara on February 19, 1937, plans were laid for the establishment of a branch of the California Botanical Society in that city. Director Maunsell Van

Rensselaer of the Blaksley Botanic Garden and Miss Ruth Hartwell of the Santa Barbara Museum of Natural History were appointed as a committee to perfect the plans of organization. The meeting was attended by forty-five enthusiastic botanists and amateurs. Dr. Herbert L. Mason of the University of California addressed the meeting on the subject of "The flora of the Carpinteria asphalt deposits and its bearing on the history of the Monterey forest." The following Sunday a field trip was made to Pine Canyon and Burton Mesa in northern Santa Barbara County, a region little explored botanically. The following persons attended the field trip: Dr. Herbert L. Mason; Professor Woodbridge Metcalf; Mr. and Mrs. Sydney Anderson; Mr. and Mrs. Charles C. Christiansen; Jan Christiansen; Meredith Christiansen; Dr. Frances Long; Miss Louisa M. Long; Miss Ella Mae Ottery; Miss Gil C. Pope; Mr. Emmett Martin; Mr. E. D. Rowe; Miss Ruth Hartwell; Rev. Seraphin Muller; Mr. and Mrs. Hugh Dearing; Mr. and Mrs. Maunsell Van Rensselaer; and Miss Patricia Van Rensselaer.

The following distributional notes have been contributed by Mrs. Dorothy R. Harvey of San Diego State College. *Agave Shawii* thought to be extinct along the coast near the Mexican boundary was found on Point Loma, San Diego, about three miles west of Ocean Beach. The colony extends about seventy-five yards along the cliff and is from twenty to thirty yards wide. On February 20 and 21, 1937 a large number of "Elephant Trees," *Bursera microphylla,* was observed spread over the foothills on the east side of the Vallecito (Piñon) Mountains, eastern San Diego County, for a distance of five or six miles northwest of the gypsum mine near Split Mountain. It was estimated that there were at least two thousand trees in the region. This species ranges from Arizona to Sonora and Lower California but has been considered rare in the Colorado Desert.

Part one, volume two, of the "Flora of California" by Willis Linn Jepson was issued on September 17, 1936. This fascicle, consisting of pages 1 to 16 and 337 to 684, completes the volume which includes the families from Capparidaceae to Cornaceae. An historical sketch of descriptive floras for California from 1838 to 1880 introduces the volume; an index of families and genera concludes it. Part two of volume two, consisting of pages 17 to 176, was issued February 15, 1936, and part three, pages 177 to 336, July 20, 1936. (Associated Students' Store, University of California, Berkeley. Unbound, $7.00; bound, $8.00.)

Dr. Yukio Yamada, a director of the Department of Botany, Hokkaido Imperial University, Sapporo, Japan, has been in Berkeley since the latter part of January of this year. On February 26 he left for Los Angeles and from there will sail for Japan for the opening of the college term in April. Dr. Yamada made a special trip to this country, bringing with him collections of *Sargassum* and *Liagora* for comparison with material in the algae collection of the herbarium of the University of California at Berkeley.

Professor H. E. McMinn, of the Department of Botany, Mills College, California, is taking advantage of his sabbatical leave to further his knowledge of California shrubs by study of the type specimens deposited in various herbaria in this country and abroad. His itinerary from March 1 to August 1, 1937, includes: Rancho Santa Ana Botanic Garden, Pomona College Herbarium, and Blaksley Botanic Garden, Santa Barbara, in California; in the east, Notre Dame University where Dr. E. L. Greene's type specimens are deposited, Gray Herbarium, and other leading botanical institutions; in Europe, Kew Gardens and the British Museum, important botanical institutions on the continent, and a month in Norway and Sweden. He hopes to study especially the shrubs of northern Norway.

Dr. Mildred E. Mathias, who formerly worked at the Missouri Botanical Garden, Carnegie Museum, and Pennsylvania State College, recently moved to Berkeley and is continuing her studies on the Umbelliferae at the Herbarium of the University of California.

After nearly two and one-half years of botanical collecting in South America, Mrs. Ynes Mexia disembarked at San Diego, California, en route to San Francisco, on January 28, 1937.

She was in Ecuador from September, 1934, to September, 1935, collecting for the Bureau of Plant Introduction and Exploration of the United States Department of Agriculture certain palms, cinchonas, and plants suitable for soil binders. Approximately five thousand herbarium specimens, as well as seeds and bulbs, were secured from along the coastal plains, on the eastern slopes of the Andes, and on the cold highlands of northern Ecuador to the borders of Colombia.

From October, 1935, to January 1, 1936, Mrs. Mexia collected for the University of California Botanical Garden Expedition to the Andes, which was engaged in obtaining native *Nicotiana* species and plants of ornamental value. In addition to nearly two thousand herbarium specimens, she secured seeds of practically all the *Nicotiana* species collected. During this period Mrs. Mexia collected in Cerro de Pasco, Peru, then, returning to Lima, went, by way of Lake Titicaca, to La Paz, Bolivia. After a collecting trip into the hot provinces of Las Yungas, she left La Paz and passed over the Bolivian highlands, through northern Argentina and the warm plains of central Argentina to Tucuman, and finally to Mendoza.

After terminating her connection with the California Botanical Garden Expedition, Mrs. Mexia obtained approximately twelve thousand herbarium specimens besides seeds and living plants. These included, in addition to her Peruvian collections, a representation of the antarctic flora of Tierra del Fuego, and of the wet tropical vegetation of the province of Esmeraldas in northwestern Ecuador.

PROCEEDINGS OF THE CALIFORNIA BOTANICAL SOCIETY

Wednesday, December 16, 1936. A meeting was held in Room 2093, Life Sciences Building, University of California, Berkeley, at 8:00 p. m. The report of the nominating committee, read by Professor D. R. Hoagland, chairman, was as follows: president, Dr. F. W. Foxworthy; first vice-president, Dr. Ira L. Wiggins; second vice-president, Dr. P. A. Munz; treasurer, Dr. David D. Keck; secretary, Miss E. Crum. Dr. George J. Peirce was nominated for president from the floor. Mr. Leo D. Whitney gave an illustrated lecture on "Botanical Work in Hawaii."

Thursday, January 28, 1937. A meeting was held in Room 2093, Life Sciences Building, University of California, Berkeley, at 8:00 p. m., Miss Alice Eastwood, first vice-president, presiding. Dr. George J. Peirce having withdrawn his name, the officers nominated at the previous meeting were unanimously elected. Following the business meeting Dr. Peirce spoke on his recent European tour.

Saturday, February 27, 1937. The annual dinner of the California Botanical Society was held at the Hotel Durant, Durant Avenue near Bowditch, Berkeley, at 6:30 p.m. Dr. George J. Peirce, past president, introduced the new president Dr. F. W. Foxworthy, chief forest research officer, retired, of the Federated Malay States, now a resident of Berkeley. Dr. Foxworthy then called upon Mrs. Ynes Mexia, Dr. Herbert L. Mason, and Dr. David D.Keck to respond to toasts. A lecture followed: "Domestication of plants under primitive cultures," by Dr. C. L. Alsberg of the Food Research Institute, Stanford University. Violin music offered under the direction of Mr. W. W. Carruth, Mills College, was much appreciated. About sixty-five members and guests attended the meeting.

VOLUME IV NUMBER 3

MADROÑO

A WEST AMERICAN JOURNAL OF BOTANY

Contents

Published at Lime and Green Streets, Lancaster, Pennsylvania

July, 1937

MADROÑO

A WEST AMERICAN JOURNAL OF BOTANY

Entered as second-class matter October 1, 1935, at the post office at Lancaster, Pa., under the act of March 3, 1879.

Established 1916. Published quarterly. Subscription Price $2.50 per year. Volume I, Numbers 1 to 17, complete, $5.00. Volume II, Numbers 1 to 17, complete, $5.00. Volume III, Numbers 1 to 8, complete, $5.00. Single numbers $0.75.

Papers up to 15 or 20 pages are acceptable. Longer contributions may be accepted if the excess costs of printing and illustration are borne by the contributor. Articles may be submitted to any member of the editorial board and if accepted, are published in the order of receipt. However, accepted manuscripts may be included in the forthcoming issue provided that the contributor pay the cost of the pages added to the issue to accommodate his article. Reprints of any article are furnished at a cost of 4 pages, 50 copies $3.70; 100 copies $4.10; additional 100's .75¢; 8 pages, 50 copies $5.40; 100 copies $6.00, additional 100's $1.20. Covers, 50 for $2.50; additional covers at $1.50 per hundred. Reprints should be ordered when page proofs are returned.

Published at Lime and Green Streets, Lancaster,
Pennsylvania, for the

CALIFORNIA BOTANICAL SOCIETY

Annual membership dues of the California Botanical Society are $2.00, $1.50 of which is for a year's subscription to Madroño. Dues should be remitted to the Treasurer. General correspondence and applications for membership should be addressed to the Secretary.

TRACYINA, A NEW GENUS OF ASTERACEAE FROM NORTHERN CALIFORNIA

S. F. Blake

Dr. Herbert L. Mason of the University of California has recently referred to me for examination specimens of a composite collected in Humboldt County, California, in 1916 by Mr. Joseph P. Tracy. The plant is superficially similar to *Rigiopappus leptocladus* Gray, with which it occasionally grows, in stem and foliage, and particularly in its habit of developing not far below the terminal head a group of filiform 1-headed branches which surpass the main stem and often branch similarly themselves. In its technical characters, however, the plant shows a close relationship to *Pentachaeta,* although it differs so strikingly from all members of that genus in its slender-fusiform short-beaked achene, its graduate pappus of numerous capillary bristles, and various minor characters that it must be regarded as the representative of a new genus. In *Pentachaeta* the involucre is 2-seriate and subequal, or strongly graduated and about 5-seriate (in *P. aurea*), of mostly oblong or lance-oblong, rarely lance-linear, thin and submembranous, greenish-centered, scarious-margined phyllaries, which persist even after the fall of the achenes; the achenes are oblong or obovoid, somewhat compressed, weakly 5-nerved or nerveless, truncate, not at all narrowed or rounded and slightly contracted at the apex; the pappus is variable, of 3–24 strictly 1-seriate slender rigid hispidulous bristles, typically shortly paleaceous-dilated at base, persistent or fragile and easily detergible, sometimes reduced to short bristles or cusps, or even wanting; and the style branches have a short stigmatiferous portion and much longer, linear, obtuse to acute, hispid or hispidulous appendages. In the new genus the involucre is strongly graduate, about 4-seriate, of narrowly linear readily deciduous phyllaries; the achenes are slenderly fusiform, subterete, and weakly about 5-nerved, drawn out above into a more or less distinct beak with slightly dilated pappiferous apex; the distinctly graduated pappus is composed of about 36–38 fragile but rather persistent, hispidulous, capillary bristles; and the stigmatiferous portion of the style branches is about equal to the lance-subulate acuminate hispid appendage.

The "Herba Impia" habit of the new plant, so suggestive of *Rigiopappus,* is rarely seen in *Pentachaeta aurea* but can be matched in occasional examples of that plant, for example *G. B. Grant 924* (Strawberry Valley, San Jacinto Mts., in U. S. Nat. Herb.). In this collection the peduncles and tips of branches are glabrous at apex, but in other specimens they are loosely pilose precisely as in the new plant. The leaves of the new plant are a little broader

Madroño, Vol. 4, pp. 73–104, July 1, 1937.

and firmer and perhaps more stiffly ciliate than the average of *Pentachaeta aurea,* but, considering the variation exhibited by this species as a whole, I can find in herbarium specimens no constant distinctive character until one comes to the heads. Somewhat similar cases of "mimicry" are shown by other California Asteraceae—particularly *Crockeria chrysantha* Greene and *Lasthenia glabrata* Lindl., *Monoptilon bellidiforme* T. & G. and *M. bellioides* (Gray) Hall (the two latter very distinct in their extreme forms, but too intimately connected by apparently individual variation for satisfactory generic separation)—but in these cases the ranges of the members of each pair overlap. *Pentachaeta aurea,* however, is a plant of southern California, not known within about three hundred miles of the area of the new plant, although other, not "mimetic" species of *Pentachaeta* range north to Marin and Mendocino counties. Mrs. Katherine Brandegee,[1] discussing the case of *Crockeria* and *Lasthenia,* suggested hybridity as the explanation of the origin of one of the forms in question, but in the present case this explanation cannot be invoked. The one likely parent is absent and no candidate for the place of the other is evident. *Pentachaeta aurea, Rigiopappus leptocladus,* and the new plant all occupy, apparently, much the same sort of habitat—dry grassy hillsides—and their resemblances in habit and foliage can probably be correlated with this fact, reinforced in the case of the new plant by a probable genetic connection with the *Pentachaeta* stock. The structural differences separating it from *Pentachaeta* are, however, too significant to permit its inclusion in that genus.

Although the natural relationship of the new genus is undoubtedly with *Pentachaeta,* its much more copious and graduated pappus would place it in the accepted arrangement of the subtribe Solidagininae next to *Aplopappus,* from which its beaked achene at once distinguishes it. The genus may appropriately be named for its discoverer, Mr. Joseph P. Tracy of Eureka, California, whose extensive collections in northwestern California, made over a period of more than thirty years, have contributed materially to our knowledge of the flora of that part of the state. A nearly complete set of his collections, amounting to over twelve thousand numbers, is deposited in the Herbarium of the University of California.

Tracyina Blake, gen. nov. Herba annua parva tenuissima prope apicem pauciramosa praeter apices caulis ramorumque et margines foliorum glaberrima, foliis alternis lineari-lanceolatis integerrimis hirsuto-ciliatis, capitulis mediocribus solitariis multifloris heterogamis flavis inconspicue radiatis, radiis erectis. Involucri subcylindrici (sicc. turbinati) gradati ca. 4-seriati phyllaria linearia acuminata appressa plana 1-vittata submembranacea viridescentia anguste scarioso-marginata. Receptaculum parvum planum nudum scrobiculatum. Radii 1-seriati feminei fertiles

[1] Zoe 5: 95. 1901.

flavi dorso plusminusve rubicundi, tubo elongato, lamina parva erecta elliptica bidenticulata. Flores disci flavi quoad numerum radiis subaequales hermaphroditi fertiles, corollis tubulosis anguste cylindrico-infundibuliformibus, tubo in faucem sensim ampliato, dentibus 5 parvis ovatis erectis. Stamina 5, antheris basi integris, apice appendice parva triangulari acuminata munitis. Styli rami lineari-lanceolati, appendice lanceolato-subulata acuminata hispida partem stigmatiferam aequante donati. Achenia tenuiter fusiformia subteretia tenuiter ca. 5-nervia hispidula basi paullum angustata sursum longe angustata breviter rostrata, apice ipso pappifero paullum dilatato. Pappi persistentis sed fragilis gradati setae ca. 36–38 capillares hispidulae.—Species typica *T. rostrata,* sp. nov.

Tracyina rostrata Blake, sp. nov. Annua erecta pedalis saepius paene ad apicem simplex, prope apicem pauciramosa, ramis filiformibus supra medium bracteatis prope apicem saepe iterum ramosis; caulis glaber foliosus; folia alterna anguste lineari-lanceolata acuminata sessilia integra erecta laete viridia 1-nervia hirsuto-ciliata; capitula ca. 30–48-flora in apicibus caulis et ramorum et ramulorum solitaria mediocria v. parva, primarium pedunculatum cetera subsessilia; phyllaria anguste linearia glabra; radii ca. 15–22, corollis ligulatis erectis disco paullo longioribus; achenia radii sparsissime, ea disci dense hispidula; pappus albidus achenio brevior.

Plant 15–30 cm. high; stems solitary, erect, whitish, usually simple nearly to apex or occasionally with a few erect branches from near the base, terete, not striate, 1 mm. thick or less, strictly glabrous, terminated by a single head and usually bearing about 1.5–5 cm. below this head 2–4 filiform ascending branches 2.5–10.5 cm. long, these arising close together (within 0.5–2 cm.), naked below, rather densely leafy from about the middle to apex with reduced, bract-like, subulate or lance-subulate leaves and often branched in the same fashion as the main stem; leaves appressed or erect, narrowly lance-linear, the larger 1.2–2.4 cm. long, 1–2 mm. wide, acuminate, acutely callous-apiculate, sessile by a slightly narrowed base, entire, plane or somewhat involute toward tip, light green, densely hirsute-ciliate, otherwise glabrous, or obscurely hirsutulous on upper face, 1-nerved and with 1 pair of weak lateral veins; terminal head usually on a more or less distinct, sparsely setaceous-bracteate peduncle 1.5–2.5 cm. long, those of the branches usually sessile, the peduncle or branch somewhat thickened and striate below the head and there loosely pilose; heads about 30–48-flowered, turbinate when pressed, subcylindric when moistened, 9–10 mm. high (in fruit), the larger 1.5 cm. thick (in fruit, as pressed); involucre 6–7 mm. high, the phyllaries narrowly linear (0.3–0.5 mm. wide), passing into the bracts of the branch, readily deciduous; rays about 15–22, the tube about 3 mm. long, glabrous or slightly hispidulous above, the

Fig. 1. *Tracyina rostrata* Blake. *a,* upper part of plant, ×1; *b,* disk achene, ×8; *c,* disk flower, ×8; *d,* style branches, ×28; *e,* two stamens, ×32; *f,* ray flower, ×8; *g,* head, ×3; *h,* ray achene, ×8, part of the pappus omitted. All drawn from the type.

lamina narrowly elliptic, about 1.5 mm. long, 0.4 mm. wide, bidenticulate, glabrous, in the dried state pale yellow, reddish on the back; disk flowers about 15–26, pale yellow, sparsely hirsutulous on throat and teeth, slenderly cylindric-funnelform, 4 mm. long (tube 1.4 mm., throat 2.3 mm., teeth ovate, 0.3 mm. long); mature achenes slenderly fusiform, shortly rostrate, not filled by the seed, 5.5 mm. long, 0.3–0.4 mm. thick, those of the ray very sparsely, those of the disk densely hirsutulous with bidenticulate hairs; pappus of about 36–38 graduated persistent hispidulous bristles, the inner 3.8 mm., the outer about 1 mm. long.

CALIFORNIA. Dry grassy hills, Alder Point, alt. 245 m., 23 May 1903, *Tracy 1892* (Herb. Univ. Calif.); on warm grassy slopes, Alder Point, on Eel River, southeastern Humboldt Co., alt. 300 m. (1000 ft.), 20 June 1916, *J. P. Tracy 4735* (type no. 549767, Herb. Univ. Calif.; duplicate, U. S. Nat. Herb.); grassy slopes, Dobbyn Creek, Humboldt Co., alt. 150 m., 15 June 1930, *Tracy 8762* (U. S. Nat. Herb.)

According to information furnished by Mr. Tracy, the plant is frequent but inconspicuous in short grass on warm grassy slopes at elevations of 300 to 1000 feet from about two miles south of Alder Point northeast about five miles to Dobbyn Creek. It is very similar in habit to *Rigiopappus leptocladus,* but taller, and generally grows in better soil, although occasionally the two are found together. The fruiting heads resemble those of *Agoseris heterophylla,* which grows abundantly in the same places.

Bureau of Plant Industry, Washington, D. C.
March, 1937.

VEGETATIONAL SURVEY OF THE LOWER RIO GRANDE VALLEY, TEXAS

ELZADA U. CLOVER

(Concluded from page 66, issue of April 7, 1937)

III. COASTAL CLIMAX ASSOCIATIONS

This area includes the sandy beach, sand dunes (*medaños*), salt flats (*badilla salitrosa*) and the salt grass region known as the *sacahuistal.* There are certain differences in the types of vegetation at different points along the coast. At Red-Fish Bay (Willacy County) where the Sand Belt dips down to the coast, the *zacatal* vegetation persists to the water's edge. Some *Spartina Spartinae* may be found, but in general the typical coast flora is lacking. Just south of the Bay, long estuaries reach inland for some distance and the Raymondville and Port Isabel Clays support the flora common to salt marshes.

Boca Chica offers an excellent opportunity for a study of coast phytogeography. The beach is sandy with shifting dunes. Back of these low dunes there are others sometimes twenty to twenty-five feet high which are stable and covered with vegetation. Barren salt flats and salt marshes reach out into the grassland along the coast, and small islands lie between Brazos Santiago Island and the mainland.

BEACH VEGETATION. There are few plants along the beach which are not found on the dunes. In fact the dunes usually are reached by high tides. *Cakile maritima* var. *aequalis, Portulaca* *pilosa,* and *Oenothera Drummondii* are found on sandy flats between dunes.

SHIFTING DUNES. *Uniola paniculata, Fimbristylis castanea, Ipomoea Pes-Caprae,* and *Sesuvium verrucosum* serve as sand binders on the shifting dunes.

PERMANENT DUNES. These dunes are covered by a prairie phase of the coastal vegetation. A list of plants found on permanent and shifting dunes at Boca Chica is listed below: *Distichlis spicata, Spartina Spartinae, Eleocharis albida, Sisyrinchium longipedunculatum, Batis maritima, Suaeda conferta, D. multiflora, Atriplex matamorensis, Cladothrix lanuginosa, Philoxerus vermicularis, Portulaca oleracea, Sesuvium verrucosum, Cakile americana, Hoffmanseggia densiflora, Indigofera leptosepala, Mimosa strigillosa, Petalostemon emarginatus, Strombocarpa cinerescens, Samodia ebracteata, Abutilon incanum, Oenothera Drummondii, Limonium Nashii, Sabbatia carnosa, Podostemma* sp., *Ipomoea Pes-Caprae, Ipomoea stolonifera, Opuntia Allairei, Agalinis heterophylla, Aplopappus phyllocephalus, Borrichia frutescens, Gaillardia pulchella, Erigeron repens.*

THE SALT-FLAT. Salt flats which are covered with water by gulf storms are almost barren. Most vegetation occurs near the margins with a few straggling plants, mostly of *Salicornia,* invading the salt-incrusted flat. *Paspalum distichum, Monanthochloë littoralis,* and *Chamaecrista littoralis* venture beyond the margins and an occasional sand dune out in the barren flat has the usual dune vegetation.

LOW ISLANDS. Hurricanes are of infrequent occurrence, sometimes doing little or no damage to the south Texas coast for periods of ten or fifteen years. The flora farther inland becomes fairly well established. Minor storms keep the vegetation of the salt flats and marshes and some of the low islands in stages of both progressive and retrogressive succession (8, 15). Clark Island which lies one mile west of the northern end of Brazos Island is an exception. It is somewhat higher, at least parts of it, than the others, and is also protected by Brazos Island, thus escaping the violent action of the waves. This island is roughly elliptical in shape, measuring about one mile in length and one-half mile across. The north end is several feet above water-level, and is covered with mesquite trees which are ten to twelve feet high. This is a nesting place for herons, and the trees are weighted down with bulky masses of sticks which constitute the nests. A single specimen of *Yucca Treculeana* measuring ten feet grew on the island, but was blown down in the hurricane of 1933. About one-third of the island is covered by a coastal prairie and upland vegetation, and the southeast portion is low and covered with water in places. The southeast margin is bordered by a low growth of *Avicennia nitida* (black mangrove). *Salicornia, Atriplex* and *Suaeda* inhabit the wet area. It is interesting to find a coastal flora such as that of *Avicennia nitida* with gradations to

FIGURE 1

FIGURE 2

PLATE XVI. Fig. 1. *Lophophora Williamsii* growing on the Bordas Scarp eight miles north of Rio Grande City, Starr County. This is the cactus used for religious purposes by the Indians. Fig. 2. *Ferocactus hamatacanthus.* This cactus is fairly abundant along the Rio Grande near Zapata.

the semi-desert vegetation. A complete list of the island flora is given below: *Andropogon littoralis, Aristida purpurea, Cenchrus pauciflorus, Chloris Petraea, Eragrostis secundiflora, E. sessilispica, Monanthochloë littoralis, Polypogon monspeliensis, Spartina Spartinae, Sporobolus argutus, Vaseyochloa multinervosa, Cyperus uniflorus, Eleocharis albida, Commelina crispa, Yucca Treculeana, Batis maritima, Cladothrix lanuginosa, Atriplex matamorensis, Suaeda linearis, Salicornia ambigua, S. herbacea, Lepidium virginicum, Baptisia leucophaea, Dolicholus americanus, Hamosa Nuttalliana, Indigofera leptocephala, Prosopis juliflora* var. *glandulosa, Sophora tomentosa, Strombocarpa cinerescens, Kallstroemia parviflora, Polygala alba, Croton ciliato-glandulosus, Galpinsia tubicula, Sabbatia carnosa, Opuntia Alleirei, Avicennia nitida, Verbena Hallii, Physalis mollis, P. viscosa, Calceolaria verticillata, Solanum triquetrum, Stemodia lanata, Plantago rhodosperma, Aphanostephus skirrobasis, Baccharis texana, Coreopsis cardaminifolia, Gaillardia pulchella, Othake robustum.*

The Sacahuistal. This area extends several miles inland. The dominant is *Spartina Spartinae,* in the marshes associated with *Suaeda, Salicornia,* and sedges, and farther inland by *Eupatorium odoratum, Aplopappus phyllocephalus, Franseria confertifolia, Pluchea camphorata, Senecio glabellus, Setaria macrostachya,* and *Sporobolus argutus.* Mesquite trees invade this coastal grass area, with *Opuntia* and some *Yucca.* Finally shrubs, especially *Lycium carolinianum, Zizyphus obtusifolia, Celtis pallida,* and *Forestiera angustifolia* help form the transition zone between the *sacahuistal* and the *mesquital-chaparral.*

Yucca Treculeana occurs as "forests" near Boca Chica and Port Isabel. The hurricane of 1933 completely wiped out this species at Boca Chica.

Boscaje de Palma. Probably the most picturesque and certainly one of the most interesting associations in the Lower Rio Grande Valley is the native palm grove ten miles below Brownsville (pl. XVII). Rio de las Palmas was the first name for the river later known as Rio Bravo del Norte (17), and now called El Rio Grande. This first name is found on an old Spanish map (Cantino, 1502) of North America, perhaps the first one made (31). No doubt the name was suggested by the native palms which grew on its banks. This palm, *Sabal texana, la palma de micharos,* is one of the four arborescent palms occurring in the continental United States outside of Florida. The others are the delta palm, *Sabal Deeringiana,* of the Mississippi delta, the cabbage tree, *Sabal Palmetto,* of the southeastern Atlantic region, and the fan-leaf palm, *Neowashingtonia robusta,* of the California deserts.

Arthur V. Schott, a geologist and surveyor in the Mexican-United States Boundary Survey, collected plants in the Lower Rio Grande Valley, and probably made the first report of any importance regarding these palms. The following is a quotation

FIGURE 1

FIGURE 2

PLATE XVII. Fig. 1. *Sabal texana.* This palm extends over approximately one hundred acres along the Rio Grande below Brownsville. Fig. 2. *Cordia Boissieri.* When land is cleared native trees are sometimes allowed to remain.

from his report (29): "It is also in the lower portion of this belt [coastal plain of Texas] where the palm tribe is represented by Chamaerops Palmetto that the palmetto attains a growth as gorgeous even as that on the lower Mississippi; it extends on the Rio Bravo up to about eighty miles from the Gulf."

Sabal texana in the United States is confined to a limited area in Cameron County near the Rio Grande extending from El Salado ranch ten miles below Brownsville up the river three or four miles, forming a heavy growth. This subtropical forest with its tangle of vines, shrubs, and fallen trees is almost impenetrable. The palms grow to the height of fifty feet on the Rabb ranch where the finest growth occurs. This palm has often been confused with *Sabal mexicana* of southern Mexico. *Arundo Donax* is twenty feet tall here and adds to the tropical appearance of the locality, as does *Malvaviscus Drummondii.* It is difficult to tell what plants rank second or third in dominance, but prominent ones are: *Ulmus crassifolia, Pithecolobium brevifolium, Celtis mississippiensis, Celtis pallida, Fraxinus Berlandieri, Leucaena pulverulenta, Tillandsia usneoides,* and *Arundo Donax.* Below is a list of plants collected from the river's edge into the densest palm growth: *Sabal texana, Arundo Donax, Echinochloa colonum, E. Crusgalli, Eragrostis hypnoides, Oplismenus setarius, Panicum fasciculatum, P. purpurascens, Paspalum conjugatum, Sporobolus Buckleyi, Carex Brittoniana, Cyperus ochraceus, Tillandsia recurvata, T. usneoides, Commelina longicaulis, Smilax renifolia, Celtis mississippiensis, C. pallida, Ulmus crassifolia, Persicaria longistyla, P. mexicana, Rumex Berlandieri, Acanthochiton Wrightii, Amaranthus hybridus, A. spinosus, Rivina humilis, Clematis Drummondii, Roripa Nasturtium, Rubus trivialis, Erythrina herbacea, Mimosa Berlandieri, Leucaena pulverulenta, Pithecolobium brevifolium, Ionoxalis* sp., *Xanthoxylum insulare, X. Pterota, Malphigia glabra, Chamaesyce hypericifolia, Poinsettia heterohpylla, Tragia nepetaefolia, Cardiospermum corindum, C. Halicacabum, Zizyphus obtusifolia, Ampelopsis arborea, Abutilon Jacquinii, Malachra urens, Malvastrum spicatum, Malvaviscus Drummondii, Wissadula amplissima, Gaura parviflora, Passiflora lutea, Plumbago scandens, Bumelia angustifolia, Diospyros texana, Forestiera angustifolia, Fraxinus Berlandieri, Metastelma barbigerum, Cuscuta arvensis, Phacelia patuliflora, Lantana horrida, Lippia alba, Verbena* (hybrid), *Salvia Greggii, Solanum nigrum, Melothria pendula, Ammannia coccinea, Centaurea americana, Eclipta alba, Erigeron tenuis, Eupatorium odoratum, Parthenium Hysterophorus, Senecio glabellus, Verbesina virginica.*

Succession in Cultivated Areas

Much of the land below Peñitas has been cleared for several miles back from the river and is under cultivation. Irrigation projects have been responsible for much of this clearing. Some of this land has been abandoned. Primary succession in an unirrigated area near Peñitas is characterized largely by the following species: *Panicum firmulum, P. Hallii, Paspalum Langei, Chamaesyce cordifolia, Croton leucophyllus, Solanum elaeagnifolium, Verbena Halei, Ambrosia elatior, Parthenium Hysterophorus,* and *Verbesina encelioides.* This is usually followed by *Celtis pallida, Zizyphus obtusifolia, Prosopis juliflora* var. *glandulosa,* and *Opuntia Lindheimeri.* Near the river *Clematis Drummondii, Amaranthus hybridus, Cuscuta arvensis, Cardiospermum Halicacabum, Solanum triquetrum,* and *Parthenium Hysterophorus* are some of the first plants to invade an abandoned clearing. In the irrigated section *Cenchrus pauciflorus, Cynodon Dactylon, Holcus halepensis, Setaria macrostachya, Amaranthus,* and *Parthenium Hysterophorus* are most important during primary succession.

In many places native trees have been permitted to stand in clearings; and when the land is abandoned, seeds from these trees start new colonies of the former vegetation. Some of these favored species are: *Cordia Boissieri, Siderocarpos flexicaulis, Diospyros texana,* and *Prosopis juliflora* var. *glandulosa.*

Relations of Edaphic Factors and Geological Formations to Plant Distribution

A comparison of the geological map (text fig. 1) and the vegetation map (text fig. 3) shows that in many instances there is a close correlation between the geologic formations and plant distribution in the Lower Rio Grande Valley.

The *zacatal* or prairie grass region conforms almost exactly to the wind-blown sands and beach deposits.

In general, the *mesquital-zacatal* in Zapata County (which is included in the Aguilares Plain) conforms to the Fayette Sandstone formation. In places the surface materials are clay and sand with gravel from the Reynosa formation and consequently areas of chaparral appear in places throughout the *mesquital-zacatal.*

The Reynosa formation covering much of Starr County and a strip along the west side of Hidalgo County is largely *mesquital* divided into the same three phases which continue toward the coast. However, there is a difference in the appearance of the brush. The growth here tends to be smaller and sparser with fewer mesquites present.

The Bordas Scarp begins at Rio Grande City and continues through Starr County to Cuevitas. It extends northward into Jim Hogg County and cuts the northeast corner of Zapata County. The vegetation along this escarpment consists of a sparse growth of *chaparral* with more species of cacti than are found on either side of this elevation.

Terrace deposits in general produce a growth of large mesquites. This is well shown at San Ignacio and Sam Fordyce.

There is little difference in the vegetation on Beaumont clay and the so-called "Fluviatile" deposits except toward the coast. The *chaparral* here shows a more luxuriant growth than that of the Reynosa.

There is no doubt that moisture is an important limiting factor. The vegetation along the river in the lower part of this region is composed of species which require more moisture than those in the upper valley. Some species which grow well near the coast are hardly recognizable for their diminutive size in dry gravel areas.

Salt depressions have characteristic beach and coastal prairie vegetation at their margins, although a few yards distant the inland type of plant growth is dominant. Poorly drained soil has become so impregnated with alkali salts as to become practically useless for farming. This condition naturally limits all vegetation to alkali resistant plants such as the salt grasses, and *Suaeda, Varilla texana, Salicornia,* and *Lycium carolinianum.*

Hechtia texensis seems to prefer soil of the type found in the Cockfield formation. This formation was deposited in salt and brackish marshes and must still be at least slightly saline since *Varilla texana* (a halophyte) is always associated with it. Dry gravel hills are covered with *Acacia amentacea* often accompanied by *Acacia Berlandieri, Leucophyllum frutescens, Mortonia Greggii* and *Cordia Boissieri,* species which ordinarily prefer limestone soil. More species of cacti are found in this Lissie Gravel than in any other formation. This may be either because they are better adapted to this soil, or because there is a sparse growth of brush, thus permitting them to have better light conditions.

The most luxuriant vegetation is in the alluvial soil along the Rio Grande below Peñitas. As moisture increases toward the coast the vegetation increases in size and number of species. Plants with tropical affinities are more abundant in the region of Brownsville probably because of better moisture conditions and slightly higher temperature. The soil is more favorable for growth, allowing chance seeds to germinate.

Effect of Changes in Physiography

The changing course of the Rio Grande causes changes in vegetation. Alluvial soil is deposited in places and carried away in others. Floods fill up *resacas,* killing some plants and permitting the growth of others. Gulf storms destroy vegetation by wind-action and by blowing salt water inland. The filling of estuaries causes very unstable conditions for plant development. Arroyos dig deeper and wider with each succeeding storm, influencing the vegetation along the banks. Water-holes are formed in the beds of arroyos allowing such trees as *Acacia Farnesiana* and *Parkinsonia aculeata* to become established on the banks.

ACKNOWLEDGMENTS

I wish to express appreciation to Dr. E. J. Alexander, Assistant Curator at the New York Botanical Gardens, for determining and checking much of the material; to Dr. S. F. Blake, National Herbarium, Smithsonian Institution, who determined most of the Compositae; to Dr. Hugh O'Neill, Catholic University, Washington, D. C., who determined the Cyperaceae; and to Dr. William C. Steere who determined the Hepaticae and Musci. The late Dr. A. S. Hitchcock, Department of Agriculture, Bureau of Plant Industry, determined the Gramineae. I am much indebted to Professor H. H. Bartlett and to Dr. J. H. Ehlers for their helpful advice in the study of the problem and the preparation of this paper, and to the Department of Botany and the Botanical Gardens of the University of Michigan for financial assistance in the field survey.

SPECIES COLLECTED IN THE LOWER RIO GRANDE VALLEY[3]

RICCIACEAE

OXYMITRA ANDROGYNA Howe. Dry, red, sandy soil, Rio Grande City.

RICCIA sp. On sandy-loam soil, mesquite woods, Rio Hondo.

LEJEUNEACEAE

FRULLANIA SQUARROSA (R., Bl. & N.) Dumort. On living branches of *Castela Nicholsonii*, Raymondville.

FRULLANIA EBORACENSIS Gottsche. Mesquite woods, Rio Hondo.

POTTIACEAE

PTERYGONEURUM CAVIFOLIUM (Ehrh.) Jur. On dry, sandy loam, Rio Grande City.

TRICHOSTOMUM BRACHYDONTIUM Bruch. On dry, sandy-clay soil, Zapata.

WEISIA ANDREWSII Bartr. On limestone rock in full sunlight, La Joya.

FUNARIACEAE

PYRAMIDULA TETRAGONA (Brid.) Brid. On sandy soil in mesquite woods, Raymondville.

PHYSCOMITRIUM TURBINATUM (Michx.) Brid. On damp alluvial soil, roadside, Barreda.

PHYSCOMITRIUM IMMERSUM Sulliv. In deep cracks made by mud drying after flood, Peñitas.

BRYACEAE

BRYUM ARGENTEUM Hedw. var. LANOSUM Bryol. eur. Dry sandy soil, in low brush, Raymondville.

ERPODIACEAE

ERPODIUM DOMINGENSE (Brid.) C. Müll. In shade, on decaying wood, Rio Hondo.

THUIDIACEAE

HAPLOCLADIUM MICROPHYLLUM (Hedw.) Broth. On decaying log in moist woods, Palm Grove, Brownsville.

[3] Numbers in parentheses refer to collections by the author.

Plagiotheciaceae

Stereophyllum Wrightii (Sulliv.) Ren. & Card. On decaying log in moist woods, Alamo.

Marsileaceae

Marsilea macropoda Engelm. Progresso (18).
Marsilea vestita Hook. & Grev. Mission (115).

Filicineae

Notholaena dealbata (Pursh) Kunze. Roma (791).

Pinaceae

Taxodium mucronatum Tenore. Havana (1123).

Gnetaceae

Ephedra antisiphilitica Meyer. Edinburg (1593).
Ephedra pedunculata Engelm. Barrocetes Ranch, San Ignacio (1584).

Potamogetonaceae

Zosterella dubia (Jacq.) Small. La Joya Lake (640).

Typhaceae

Typha latifolia L. Chihuahua (214).

Naiadaceae

Naias guadalupensis (Spreng.) Morong. Alamo (894).

Alismaceae

Echinodorus cordifolius (L.) Griseb. Alamo (639).
Sagittaria variabilis Engelm. Alamo (265).

Gramineae

Andropogon barbinodis Lag. Laredo (1278).
Andropogon glomeratus (Walt.) B. S. P. Weslaco (462).
Andropogon littoralis Nash. Padre Island (1633).
Andropogon saccharoides Swartz. Edinburg (440).
Aristida purpurea Nutt. Peñitas (575).
Arundo Donax L. Palm Grove, Brownsville (959).
Bouteloua barbata Lag. Alamo (8).
Bouteloua hirsuta Lag. San Ignacio (1586).
Bouteloua trifida Thurb. Salineño (1406).
Brachiaria ciliatissima (Buckl.) Chase. Monte Cristo (927).
Cenchrus incertus M. A. Curtis. San Juan (305).
Cenchrus pauciflorus Benth. La Joya (586).
Chloris andropogonoides Fourn. Mission (162).
Chloris cucullata Bisch. Tabasco (91).
Chloris Gayana Kunth. Donna (625).
Chloris Petraea Swartz. Clark Island (704A).
Cynodon Dactylon (L.) Pers. Alamo (433).
Dactyloctenium Aegyptium (L.) Richt. San Juan (107).
Digitaria sanguinalis (L.) Scop. Harlingen (1211).
Distichlis spicata (L.) Greene. Boca Chica (383).
Echinochloa colonum (L.) Link. Chihuahua (985).
Echinochloa Crusgalli (L.) Beauv. Palm Grove, Brownsville (1518).
Echinochloa Crusgalli zelayensis (H. B. K.) Hitchc. Alamo (289).
Eleusine indica (L.) Gaertn. Alamo (1350).
Eragrostis Barrelieri Daveau. San Juan (451).

Eragrostis Beyrichii J. G. Smith. Cuevitas (1095).
Eragrostis curtipedicellata Buckl. La Joya Lake (43).
Eragrostis hypnoides (Lam.) B. S. P. Palm Grove, Brownsville (950).
Eragrostis lugens Nees. Kingsville (837).
Eragrostis secundiflora Presl. Boca Chica (720).
Eragrostis sessilispica Buckl. Clark Island (740).
Eragrostis reptans (Michx.) Nees. Alamo (432).
Eragrostis spicata Vasey. Alamo (297).
Eriochloa punctata (L.) Desv. Brownsville (1650).
Heteropogon contortus (L.) Beauv. Linn (847).
Holcus halepensis L. Alamo (149).
Leptoloma cognatum (Schult.) Chase. Boca Chica (727).
Leptochloa dubia (H. B. K.) Nees. Alamo (1481).
Leptochloa filiformis (Lam.) Beauv. San Juan (559).
Leptochloa Nealleyi Vasey. Rio Hondo (1580).
Leptochloa uninervia (Presl) Hitchc. & Chase. Alamo (918).
Monanthochloë littoralis Engelm. Clark Island (759).
Oplismenus setarius (Lam.) Roem. & Schult. Palm Grove, Brownsville (1508).
Panicum fasciculatum Swartz. Palm Grove (956).
Panicum firmulum Hitchc. & Chase. La Joya (580).
Panicum Hallii Vasey. La Joya (557).
Panicum hians Ell. Encino (836).
Panicum nodatum Hitchc. & Chase. Encino (834).
Panicum purpurascens Raddi. Palm Grove, Brownsville (1511).
Panicum sphaerocarpon Ell. Encino (858).
Panicum texanum Buckl. Alamo (1347).
Pappophorum bicolor Fourn. Arroyo el Tigre (697).
Pappophorum mucronulatum Nees. San Manuel Ranch (851).
Paspalum conjugatum Berg. Palm Grove, Brownsville (1507).
Paspalum dilatatum Poir. Alamo (1349).
Paspalum distichum L. Boca Chica (365).
Paspalum Langei (Fourn.) Nash. Tabasco (781).
Paspalum lividum Trin. Alamo (1115).
Paspalum stramineum Nash. Encino (860).
Paspalum Urvillei Steud. Donna (1014).
Phalaris caroliniana Walt. Encino (832).
Phragmites communis Trin. Mercedes (630).
Polypogon monspeliensis (L.) Desf. Clark Island (758).
Setaria macrostachya H. B. K. Rio Hondo (613).
Setaria Scheelei (Steud.) Hitchc. Alamo (1453).
Setaria setosa (Swartz) Beauv. Alamo (1453A).
Setaria geniculata (Lam.) Beauv. Encino (839).
Spartina Spartinae (Trin.) Merr. Boca Chica (729).
Sporobolus argutus (Nees) Kunth. Clark Island (1256).
Sporobolus Buckleyi Vasey. Palm Grove, Brownsville (1560).
Sporobolus cryptandrus (Torr.) Gray. Harlingen (1213).
Sporobolus Wrightii (Munro) Scribn. Boca Chica (402).
Trichachne californica (Benth.) Chase. Mission (1993).
Trichachne saccharata (Buckl.) Nash. Mission (174).
Trichloris mendocina (Phil.) Kurtz. Arroyo Veleño (1290).
Trichloris pluriflora Fourn. Weslaco (628).
Tricholaena rosea Nees. Donna (466).
Trichoneura elegans Swallen. San Ignacio (1582).
Triodia albescens Vasey. Harlingen (1025).
Triodia mutica (Torr.) Scribn. Salineño (1405).
Triodia pilosa (Buckl.) Merr. Arroyo el Tigre.
Uniola paniculata L. Boca Chica (386).
Vaseyochloa multinervosa (Vasey) Hitchc. Clark Island (1719).

Cyperaceae

Carex Brittoniana Bailey. Progresso (18).
Cyperus acuminatus Torr. & Hook. Chihuahua (598).
Cyperus articulatus L. Alamo (1119).
Cyperus cylindricus (Ell.) Britton. Ojo de Agua (995B).
Cyperus elegans L. Rio Hondo (1020).
Cyperus erythrorrhizos Muhl. Palm Grove, Brownsville (1529).
Cyperus ferax L. C. Rich. Progresso (15).
Cyperus globosus Aubl. Monte Cristo (929).
Cyperus ochraceus Vahl. Palm Grove, Brownsville (1981).
Cyperus oxycarioides Britton. Alamo (995).
Cyperus strigosus L. Alamo (898).
Cyperus uniflorus Torr. & Hook. Alamo (150).
Cyperus virens Michx. Rio Hondo (1030).
Eleocharis albida Torr. Clark Island (747B).
Eleocharis palustris (L.) Roem. & Schult. Rio Hondo (1012).
Fimbristylis castanea (Michx.) Vahl. Boca Chica (771).
Scirpus americanus Pers. Boca Chica (701).
Scirpus californicus Britton. Brownsville (973).
Scirpus Hallii Gray. Alamo (887).
Scirpus validus Vahl. La Feria (633).

Palmae

Sabal texana (O. F. Cook) Small. Brownsville (1504).

Lemnaceae

Lemna minor L. Rio Hondo.
Wolffia columbiana Karsten. Rio Hondo.

Bromeliaceae

Hechtia texensis Wats. Roma (523).
Tillandsia Baileyi Rose. Alamo (1422).
Tillandsia recurvata L. La Joya (69).
Tillandsia usneoides L. Tabasco (226).

Commelinaceae

Commelina crispa Wooton. Roma (161).
Commelina longicaulis Jacq. Alamo (1422).
Sitreavsia pulcherrima Bartlett. Port Isabel (974).

Pontederiaceae

Heteranthera limosa (Swartz) Willd. Rio Hondo (1038).
Eichornia crassipes Mart. Brownsville (361).

Juncaceae

Juncus aristulatus Michx. Raymondville (833).

Liliaceae

Allium arenicola Small. Arroyo el Tigre (1797).
Allium scaposum Benth. Boca Chica (1709).
Smilax renifolia Small. Tabasco (227).
Yucca rupicola Scheele. San Manuel Ranch (820).
Yucca tenuistyla Trel. San Ignacio (505).
Yucca Treculeana Carr. Boca Chica (989).
Yucca sp. Peñitas (135).

Amaryllidaceae

Agave melliflua Trel. El Conchito Ranch, Zapata (1295).
Agave Lechuguilla Torr. Roma (477).
Agave sp. Trel. Rio Grande City (284).

Atamosco texana (Herb.) Greene. Alamo (1421).
Cooperia Drummondii Herb. San Juan (4).
Manfreda maculosa (Hook.) Rose. La Joya (62).
Manfreda variegata (Jacobi) Rose. Alamo (12).
Runyonia longiflora Rose. Rio Grande City (483).

Iridaceae

Sisyrinchium amoenum Bicknell. Padre Island (1640).
Sisyrinchium furcatum Bicknell. San Manuel Ranch (808).
Sisyrinchium longipedunculatum Bicknell. Boca Chica (707).

Zingiberaceae

Croftia parvifolia (Torr.) Small. Edinburg (1587).

Salicaceae

Salix longifolia Muhl. Alamo (261).

Batidaceae

Batis maritima L. Clark Island (764).

Fagaceae

Quercus virginiana Mill. N. Willacy County (638).

Ulmaceae

Celtis mississippiensis Bosc. Palm Grove (457).
Celtis pallida Torr. La Joya (75).
Ulmus crassifolia Nutt. Tabasco (224).

Urticaceae

Parietaria obtusa Rydb. Alamo (1780).
Urtica chamaedryoides Pursh. Alamo (1863).

Loranthaceae

Phoradendron flavescens Nutt. Rio Grande City (525).

Aristolochiaceae

Aristolochia longiflora Engelm. & Gray. Arroyo el Tigre (751).

Polygonaceae

Eriogonum multiflorum Benth. Boca Chica (1913).
Persicaria longistyla Small. Palm Grove, Brownsville (1514).
Persicaria mexicana Small. Palm Grove, Brownsville (1455).
Persicaria pennsylvanica (L.) Small. Alamo (903).
Rumex Berlandieri Meisn. Palm Grove, Brownsville (1530).
Rumex crispus L. Weslaco (608).
Rumex mexicanus Meisn. Tabasco (166).
Rumex spiralis Small. Havana (1127).

Chenopodiaceae

Atriplex acanthocarpa (Torr.) S. Wats. Roma (1090).
Atriplex arenaria Nutt. Port Isabel (1263).
Atriplex canescens (Pursh) Nutt. El Jaral Ranch, Zapata Co. (1581).
Atriplex matamorensis Nels. Boca Chica (374).
Chenopodium album L. Boca Chica (1710).
Chenopodium viride L. San Benito (1929).
Dondia conferta Small. Boca Chica (354)
Dondia linearis (Ell.) Millsp. Port Isabel (1262).
Dondia multiflora (Torr.) Heller. Boca Chica (377).
Dondia sp. Clark Island (329). Possibly a new species.
Salicornia ambigua Michx. Clark Island (767).

Suaeda in text!

Salicornia Bigelovii Torr. Boca Chica (359).
Salicornia herbacea L. Clark Island (766).

Amarantaceae

Acanthochiton Wrightii Torr. Palm Grove, Brownsville (1535).
Achyranthes repens L. Boca Chica (395).
Amaranthus Berlandieri (Moq.) Uline & Bray. San Juan (444).
Amaranthus hybridus L. Alamo (1342).
Amaranthus spinosus L. Palm Grove, Brownsville (1534).
Celosia paniculata L. Salino Station, Hidalgo Co. (1609).
Cladothrix lanuginosa Nutt. Boca Chica (357).
Froelichia campestris Small. Rio Grande City (1939).
Froelichia Drummondii Moq. N. Hidalgo Co. (855).
Philoxerus vermicularis (L.) R. Br. Padre Island (380).

Nyctaginaceae

Acleisanthes Greggii Standley. San Juan (464).
Acleisanthes obtusa (Choisy) Standl. Roma (1386).
Allionia nyctaginea Michx. Clark Island (1715).
Anredera vesicaria (Lam.) Gaertn. (1919).
Boerhaavia erecta L. San Juan (302).
Boerhaavia viscosa Lag. & Rohr. Rio Grande City (1312).
Nyctaginia capitata Choisy. Rio Grande City (187).
Wedeliella incarnata (L.) Cockerell. Zapata (1358).

Phytolaccaceae

Phaulothamnus spinescens Gray. Rio Hondo (1034).
Rivina humilis L. Alamo (13).

Aizoaceae

Mollugo verticillata L. Harlingen (1201).
Sesuvium verrucosum Raf. Boca Chica (1713).

Cactaceae

Acanthocereus pentagonus (L.) Britt. & Rose. Rio Hondo (1872).
Ancistrocactus brevihamatus (Engelm.) Britt. & Rose. La Joya.
Ancistrocactus Scheeri Salm-Dyck. La Joya (1887).
Astrophytum asterias (Zucc.) Lemaire. Rio Grande City (1867).
Coryphantha Pirtleana I. Wright. Rio Grande City (15273, Gard. No.)
Coryphantha Runyonii Britt. & Rose. Rio Grande City (1875).
Dolicothele sphaerica (Dietrich) Britt. & Rose. Salineño (1876).
Echinocereus angusticeps Clover. Linn (1870). (Type.)
Echinocereus Blanckii (Poselger) Palmer. Alamo (1878).
Echinocereus enneacanthus Engelm. La Joya (1874).
Echinocereus Fitchii Britt. & Rose. Rio Grande City (1871).
Echinocereus papillosus Linke. Rucio (1869).
Echinocereus pentalophus (DC.) Rumpler. La Joya (1890).
Escobaria Runyonii Britt. & Rose. Tabasco (1886).
Ferocactus hamatacanthus (Muhlenpfordt) Britt. & Rose. Zapata (1873).
Hamatocactus setispinus Engelm. La Joya (1876).
Homalocephala texensis (Hopffer) Britt. & Rose. La Joya (1868).
Lophophora Williamsii (Lemaire) Coulter. Rio Grande City (187).
Neomammillaria applanata (Engelm.) Britt. & Rose. La Joya (1889).
Neomammillaria hemisphaerica (Engelm.) Britt. & Rose. La Joya (1885).
Neomammillaria Heyderi (Muhlenpfordt) Britt. & Rose. La Joya (1891).
Neomammillaria multiceps (Salm-Dyck.) Britt. & Rose. Raymondville (1865).

OPUNTIA ALLAIREI Griffiths. Boca Chica.
OPUNTIA ENGELMANNII Salm-Dyck. Zapata.
OPUNTIA LEPTOCAULIS DC. Peñitas (29).
OPUNTIA LINDHEIMERI Engelm. Peñitas (35).
OPUNTIA SCHOTTII Engelm. Rio Grande City (1884).
THELOCACTUS BICOLOR (Galeotti) Britt. & Rose. Rio Grande City (1880).
WILCOXIA POSELGERI (Lemaire) Coulter. La Joya (1877).

PORTULACACEAE

PORTULACA OLERACEA L. Boca Chica (352).
TALINUM ANGUSTISSIMUM (Gray) Wooton & Standl. McAllen (1001).
TALINUM REFLEXUM Cav. Tabasco (79).
TALINOPSIS FRUTESCENS Gray. Rio Grande City (481).

CARYOPHYLLACEAE

ALSINE BALDWINII Small. San Benito (617).

NYMPHAEACEAE

CASTALIA ELEGANS Greene. Alamo (944).

RANUNCULACEAE

CLEMATIS DRUMMONDII Torr. & Gray. San Juan (1).

MENISPERMACEAE

COCCULUS DIVERSIFOLIUS DC. Santa Maria (1215).

PAPAVERACEAE

ARGEMONE ALBA Lestib. Mercedes (467).
ARGEMONE MEXICANA L. Alamo (192).
ARGEMONE PLATYCERAS Link & Otto. Chihuahua (601).

CRUCIFERAE

CAKILE AMERICANA Nutt. Boca Chica (353).
LEPIDIUM AUSTRINUM (Millsp.) Small. La Joya (1876).
LEPIDIUM VIRGINICUM L. Clark Island (749).
LESQUERELLA AURICULATA (Engelm. & Gray) S. Wats. Barreda (1648).
LESQUERELLA DENSIFLORA (Gray) S. Wats. Zapata (1794).
LESQUERELLA LASIOCARPA (Hook.) S. Wats. Donna (624).
NERISYRENIA CAMPORUM (Gray) Greene. San Ignacio (684).
RADICULA WALTERI (Ell.) Small. Chihuahua (597).
RORIPA NASTURTIUM (L.) Rusby. Palm Grove, Brownsville (1795).
SELENIA sp. Alamo (1424). Possibly a new species.
SYNTHLIPSIS BERLANDIERI Gray. Zapata (1795).

CAPPARIDACEAE

CRISTATELLA EROSA Nutt. Monte Cristo (931).
POLANISIA TRACHYSPERMA Torr. & Gray. Rio Grande City (474).

CRASSULACEAE

LENOPHYLLUM TEXANUM (J. G. Smith) Rose. Tabasco.

ROSACEAE

RUBUS TRIVIALIS Michx. Brownsville (1711).

LEGUMINOSAE

ACACIA AMENTACEA DC. Rio Grande City (472).
ACACIA BERLANDIERI Benth. Alamo (1337).

Acacia Farnesiana (L.) Willd. Alamo (293).
Acacia Greggii Gray. San Juan (3).
Acacia Roemeriana Schlect. Monte Cristo (935).
Desmanthus depressa (Willd.) Kuntze. San Juan (303).
Calliandra eriophylla (Benth.) Britt. Rio Grande City (1677).
Baptisia leucophaea Nutt. Clark Island (769).
Cassia bauhinioides Gray. Rio Grande City (1311).
Cassia Medsgeri Shafer. Edinburg (1588).
Cassia pumilio Gray. Zapata (679).
Cercidium floridum Benth. La Joya (65).
Cercidium texanum Gray. (1321).
Chamaecrista cinerea (Cham. & Schlecht.) Pollard. Starr Co. (1102).
Chamaecrista littoralis Pollard. Padre Island (1638).
Cologania sp. Clark Island (746). Possibly a new species.
Coursetia axillaris Coult. & Rose. La Lomita (Mission) (1060).
Tephrosia Lindheimeri (Gray) Kuntze. Raymondville (1198).
Daubentonia Cavinillesii (S. Wats.) Standl. Boca Chica (388).
Rhynchosia americana (Mill.) Vail. Clark Island (814).
Rhynchosia minima (L.) Medic. Weslaco (459).
Erythrina herbacea L. Palm Grove, Brownsville (1925).
Eysenhardtia texana Scheele. La Joya (72).
Hamosa Nuttalliana (DC.) Rydb. (754).
Hoffmanseggia caudata Gray. (1275).
Hoffmanseggia densiflora Benth. Boca Chica (360).
Indigofera leptosepala Nutt. Boca Chica (704).
Leucaena pulverulenta (Schlecht.) Benth. Alamo (455).
Lupinus texensis Hook. La Joya (104).
Mimosa Berlandieri Gray. Boca Chica (393).
Mimosa strigillosa Torr. & Gray. Boca Chica (712).
Parkinsonia aculeata L. Alamo (105).
Parosela aurea (Nutt.) Britton. N. Starr Co. (1106).
Parosela humilis (Mill.) Rydb. Boca Chica (1242).
Parosela nana (Torr.) Heller. Arroyo el Tigre (694).
Parosela pogonathera (Gray) Vail. Havana (646).
Petalostemon emarginatus Torr. & Gray. Boca Chica (703).
Pithecolobium brevifolium Benth. La Lomita (Mission) (1072).
Prosopis juliflora var. glandulosa Torr. San Juan (2).
Siderocarpos flexicaulis (Benth.) Small. San Juan (7).
Sophora secundiflora Lag. San Benito (1743).
Sophora tomentosa L. Boca Chica (768).
Strombocarpa cinerescens Gray. Los Fresnos (969).
Vicia texana (Torr. & Gray) Small. Rio Hondo (611).

Geraniaceae

Geranium carolinianum L. Alamo (1779).

Oxalidaceae

Ionoxalis violacea (L.) Small. Alamo (1425).
Ionoxalis sp. Palm Grove, Brownsville (1512).
Monoxalis dichondraefolia (Gray) Small. Rio Grande City (1046).
Oxalis corniculata L. Alamo (1423).

Linaceae

Cathartolinum alatum Small. Boca Chica (316).
Cathartolinum multicaule (Hook.) Small. N. Starr Co. (1097).

Zygophyllaceae

Covillea tridentata (DC.) Vail. San Ignacio (1938).
Guaiacum sanctum L. Peñitas (89A).
Kallstroemia parviflora Norton. Clark Island (1308).

PORLIERIA ANGUSTIFOLIA Engelm. Tabasco (89).
TRIBULUS TERRESTRIS L. San Juan (299).

RUTACEAE

AMYRIS PARVIFOLIA Gray. Rio Hondo (242).
ESENBECKIA RUNYONII Morton. Santa Maria.
HELIETTA PARVIFOLIA Benth. & Hook. Rio Grande City (1317).
THAMNOSMA TEXANA (Gray) Torr. Tabasco (581).
XANTHOXYLUM INSULARE Rose. Rio Hondo (1035).
XANTHOXYLUM PTEROTA H. B. K. Rio Hondo (239).

SIMARUBACEAE

CASTELA NICHOLSONII Hook. Rio Hondo (241).
CASTELARIA TEXANA (Torr. & Gray) Small. Alamo (1501).

MALPIGHIACEAE

COELOSTYLIS TEXANA Torr. & Gray. Alamo (881).
MALPIGHIA GLABRA L. Alamo (553).

POLYGALACEAE

POLYGALA ALBA Nutt. Boca Chica (706).
POLYGALA BOYKINII Nutt. Clark Island (745).
POLYGALA MACRADENIA Gray. Rio Grande City (488).

EUPHORBIACEAE

ACALYPHA HEDERACEA Torr. La Joya (183).
ADELIA VASEYI (Coulter) Pax & Hoff. Mission (1077).
BERNARDIA MYRICAEFOLIA (Scheele) Gray. Rio Hondo (1036).
CHAMAESYCE CORDIFOLIA (Ell.) Small. Mission (356).
CHAMAESYCE HYPERICIFOLIA (L.) Small. Alamo (356A).
CHAMAESYCE LAREDANA (Millsp.) Small. Rio Grande City (1363).
CHAMAESYCE SERPENS (H. B. K.) Small. Rio Grande City (1364).
CROTON CILIATO-GLANDULOSUS Ort. Roma (1392).
CROTON CORTESIANUS Kunth. Raymondville (190).
CROTON ENGELMANNII Ferguson. Raymondville (1216).
CROTON FRUTICULOSUS Engelm. Alamo (1483).
CROTON LEUCOPHYLLUS Muell. Arg. Ojo de Agua (999).
CROTON NEOMEXICANUS Muell. Arg. Edinburg (1596).
CROTON PUNCTATUS Jacq. Padre Island (1635).
CROTON TORREYANUS Muell. Arg. Rio Grande City (1330).
CROTON sp. Alamo (1776). Possibly a new species.
DITAXIS HUMILIS Engelm. & Gray. Arroyo Veleño (1786).
GALARHOEUS ARKANSANUS (Engelm. & Gray) Small. Alamo (872).
GALARHOEUS sp. Alamo (889). Possibly a new species.
JATROPHA BERLANDIERI Torr. Rio Grande City (478).
JATROPHA SPATHULATA Muell. La Joya (39).
JATROPHA STIMULOSA Michx. Santa Elena Ranch (1844).
POINSETTIA HETEROPHYLLA L. San Juan (109).
STILLINGIA TORREYANA Wats. Zapata (498).
TRAGIA NEPETAEFOLIA Cav. Palm Grove, Brownsville (1562).
TRAGIA URTICAEFOLIA Michx. Camp Perry (1758).

CELASTRACEAE

MAYTENUS PHYLLANTHOIDES Benth. Brownsville (417).
MORTONIA GREGGII Gray. La Joya (1791).
SCHAEFFERIA CUNEIFOLIA Gray. La Joya (73).
CARDIOSPERMUM CORINDUM L. Palm Grove, Brownsville (1558).
CARDIOSPERMUM HALICACABUM L. Tabasco (205).
SAPINDUS DRUMMONDII Hook. & Arn. Alamo (779).
SERJANIA BRACHYCARPA Gray. Alamo (1468).

Rhamnaceae

Colubrina texensis Gray. Zapata (1033).
Condalia obovata Hook. Havana (1129).
Condalia obtusifolia (Hook.) Weberbauer. Rio Grande City (1371).
Karwinskia Humboldtiana Zucc. Alamo (11).
Microrhamnus ericoides Gray. Rio Grande City (470).
Zizyphus obtusifolia (Hook.) Gray. Palm Grove, Brownsville (1087).

Vitaceae

Amelopsis arborea (L.) Rusby. Tabasco (209).
Amelopsis mexicana Rose. Barreda (1702).
Cissus incisa Desmoul. Zapata (1272).

Malvaceae

Abutilon americanum (L.) Sweet. Rio Grande City (185).
Abutilon incanum (Link.) Sweet. Boca Chica (1238).
Abutilon Jacquinii Don. Palm Grove, Brownsville (1505).
Abutilon texensis Torr. & Gray. Alamo (1454).
Abutilon triquetrum (L.) Presl. Alamo (1446).
Abutilon Wrightii Gray. Rio Grande City (489).
Callirrhoë digitata Nutt. San Ignacio (685).
Cienfuegosia sulphurea (St. Hil.) Garcke. Alamo (1259).
Gayoides crispum (L.) Small. Roma (1391).
Hibiscus cardiophyllus Gray. La Joya (38).
Kosteletzkya hastata Presl. Edinburg (1608).
Malachra urens Poit. Palm Grove, Brownsville (1526).
Malvastrum coromandelianum Garcke. Boca Chica (407).
Malvastrum spicatum (L.) Gray. Boca Chica (406).
Malvaviscus Drummondii Torr. & Gray. Palm Grove, Brownsville (1845).
Sida diffusa H. B. K. Alamo (1498).
Sida filipes Gray. Roma (1408).
Sida hastata St. Hil. Las Comitas (1314).
Sida paniculata L. Rio Hondo (1014).
Sida spinosa L. Mission (112).
Wissadula amplissima (L.) R. E. Fries. Palm Grove (1564).

Violaceae

Calceolaria verticillaria (Ortega) Kuntze. Clark Island (723).

Bombacaceae

Waltheria americana L. San Isidro Ranch (1840).

Sterculiaceae

Melochia pyramidata L. Olmito (1261).

Cochlospermaceae

Amoreuxia Wrightii Gray. Rio Grande City (486).

Koeberliniaceae

Koeberlinia spinosa Zucc. La Joya (64).

Flacourtiaceae

Xylosma celastrinum (H. B. K.) Kuntze. Combes (1641).

Turneraceae

Turnera aphrodisiaca Ward. Zapata (1686).
Passiflora foetida L. Mission (191).
Passiflora lutea L. Palm Grove, Brownsville (1603).

Loasaceae

Cevallia sinuata Lag. Zapata (1409).

Onagraceae

Galpinsia Hartwegii (Benth.) Britton. Arroyo el Tigre (695).
Galpinsia tubicula (Gray) Small. Clark Island (719).
Gaura Drummondii Torr. & Gray. Weslaco (623).
Gaura villosa Torr. Las Viboras Ranch (1100).
Hartmannia speciosa (Nutt.) Small. Peñitas (1846).
Jussiaea diffusa Forskal. Rio Hondo (1040).
Kneiffia arenicola Small. Mission (169).
Oenothera Drummondii Hook. Boca Chica (351).

Umbelliferae

Ammoselinum Popei Torr. & Gray. Chihuahua (573).
Apium Ammi (L.) Urban. La Joya (1895).
Eryngium compactum Small. Alamo (874).
Eurytaenia texana (Torr. & Gray) Small. Santa Elena Ranch (1107).
Hydrocotyle umbellata L. Alamo (787).

Primulaceae

Samodia ebracteata (H. B. K.) Baudo. Boca Chica (318).
Samolus cuneatus Small. Boca Chica (1248).
Samolus floribundus H. B. K. Rio Hondo (1026).

Plumbaginaceae

Limonium Nashii Small. Boca Chica (355).
Plumbago scandens L. Alamo (785).

Sapotaceae

Bumelia angustifolia Nutt. Edinburg (1328).
Bumelia lycioides Pers. La Joya (1328A).

Ebenaceae

Diospyros texana Scheele. Alamo (784).

Oleaceae

Forestiera angustifolia Torr. Rio Hondo (1597).
Fraxinus Berlandieri DC. Palm Grove, Brownsville (1924).
Menodora heterophylla Moric. Mission (1063).

Gentianaceae

Eustoma Russellianum (Hook.) Griseb. Chihuahua (199).
Sabbatia campestris Nutt. N. Hidalgo Co. (831).
Sabbatia carnosa Small. Boca Chica (702).

Asclepiadaceae

Metastelma barbigerum Scheele. Palm Grove, Brownsville (1547).
Podostemma longicornu (Benth.) Greene. San Juan (1906).
Podostemma sp. Boca Chica (320). Possibly a new species.
Vincetoxicum brevicoronatum (Rob.) Vail. E. Starr Co. (663).
Vincetoxicum reticulatum (Engelm.) Heller. Barreda (1624).

Convolvulaceae

Convolvulus incanus Vahl. Linn (1612).
Cuscuta arvensis Beyrich. Rio Hondo (230).
Cuscuta indecora Choisy. Boca Chica (390).
Evolvulus alsinoides L. Tabasco (40).
Ipomoea carnosa Britton. Boca Chica (314).
Ipomoea dissecta (Jacq.) Pursh. Alamo (1457).
Ipomoea fistulosa Mart. Alamo (294).
Ipomoea Pes-Caprae Sweet. Boca Chica (323).

Ipomoea sinuata Ort. Raymondville (1196).
Ipomoea trifida (H. B. K.) G. Don. Tabasco (206).

Polemoniaceae

Gilia incisa Benth. Rio Hondo (1905).
Phlox pilosa L. var. detonsa Gray. N. Hidalgo Co. (822).

Hydrophyllaceae

Marilaunidium hispidum (Gray) Kuntze. Chihuahua (585).
Marilaunidium jamaicense (L.) Kuntze. Chihuahua (592).
Marilaunidium macranthum (Choisy) Kuntze. Alamo (909).
Phacelia parviflora Pursh. Combes (1760).
Phacelia patuliflora (Engelm. & Gray) Gray. Mercedes (618).

Boraginaceae

Coldenia canescens DC. Zapata (1847).
Cordia Boissieri A. DC. Alamo (9).
Ehretia elliptica DC. Alamo (896).
Heliotropium confertifolium Torr. Zapata (682).
Heliotropium curassavicum L. Boca Chica (396).
Heliotropium indicum L. Boca Chica (202).
Heliotropium inundatum Swartz. Alamo (902).
Heliotropium parviflorum L. E. Starr Co. (659).
Lithospermum matamorense DC. Tabasco (676).
Tournefortia volubilis L. Camp Perry (1756).

Verbenaceae

Avicennia nitida Jacq. Clark Island (1251).
Citharexylum Berlandieri Robinson. Boca Chica (1694).
Goniostachyum citrosum Small. Rio Hondo (1566).
Helleranthus quadrangulatus (Heller) Small. Chihuahua (596).
Lantana horrida H. B. K. Peñitas (1426).
Lantana macropoda Torr. Rio Grande City (1681).
Lippia alba (Mill.) N. E. Brown. Palm Grove (962).
Lippia Berlandieri Schauer. Tabasco (1676).
Lippia ligustrina (Lag.) Small. Tabasco (10).
Lippia macrostachya (Torr.) Moldenke. Rio Grande City (1268).
Phyla nodiflora (L.) Greene. Mission (119).
Verbena bipinnatifida Nutt. Tabasco (106).
Verbena ciliata Benth. Alamo (1450).
Verbena Halei Small. Clark Island (736).
Verbena officinalis L. Barreda (1695).
Verbena xutha Lehm. Rio Grande City (1618).
Verbena (hybrid?). Palm Grove, Brownsville (1519).

Labiatae

Melosmon cubense (L.) Small. Mission (171).
Micromeria pilosiuscula (Benth.) Small. Camp Perry (1903).
Monarda dispersa Small. San Juan (5).
Monarda punctata L. Alamo (1046).
Monarda sp. N. Hidalgo Co. (807). Possibly a new species.
Salvia ballotaeflora Benth. La Joya (1333).
Salvia coccinea L. Raymondville (606).
Salvia Greggii Gray. Brownsville.
Scutellaria Drummondii Benth. Mission (591).
Stachys agraria Cham. & Schlecht. Rio Hondo (1051).
Stachys Drummondii Benth. Chihuahua (602).
Zornia bracteata (Walt.) Gmel. N. Starr Co. (1841).

Solanaceae

Capsicum baccatum L. Alamo (1113).
Chamaesaracha conioides (Moric.) Britt. Barreda (1714).
Datura innoxia Safford. Roma (502).
Lycium Berlandieri Dunal. Rio Grande City (490).
Lycium carolinianum Walt. Olmito (1654).
Lycium Chateaui Standl. La Joya (74). nomen
Lycium Torreyi Gray. Zapata (1301).
Lycopersicon cerasiforme Dunal. Alamo (1052).
Nicotiana glauca Graham. La Joya (184).
Nicotiana repanda Willd. Roma (1396).
Petunia parviflora Juss. Chihuahua (505).
Physalis Carpenteri Riddell. Roma (1383).
Physalis mollis Nutt. Clark Island (1926).
Physalis viscosa L. Los Fresnos (1631).
Physalis viscosa L. var. spathulaefolia Gray. Clark Island (728).
Quincula lobata (Torr.) Raf. Tabasco (598).
Solanum carolinense L. Alamo (1122).
Solanum elaeagnifolium Cav. Alamo (264).
Solanum nigrum L. Alamo (917).
Solanum rostratum Dunal. Roma (503).
Solanum triquetrum Cav. San Benito (616).

Scrophulariaceae

Gerardia heterophylla Nutt. Boca Chica (1252).
Leucophyllum frutescens (Berlandier) Johnston. (81).
Leucophyllum frutescens f. albiflorum Clover. A *L. frutescens* differt floribus albis haud purpureo-rosaceis. Legit ad Romam, Starr Co., Texas, *Clover 492*, in Herb. Mich.
Leucophyllum minus Gray. San Benito (1746).
Linaria canadensis (L.) Dumont subsp. texana (Scheele) Pennell. Mission (1787).
Stemodia lanata Ruiz & Pavon. Clark Island (747).

Martyniaceae

Martynia fragrans Lindl. Roma (120).

Lentibulariaceae

Utricularia subulata L. Rio Hondo (1748).

Acanthaceae

Justicia Runyonii Small. Brownsville (1233).
Carlowrightia glabrata Fernald. Mission (1066).
Ruellia intermedia Leonard. La Joya (118).
Ruellia noctiflora (Nees) Gray. Roma (1389).
Ruellia tuberosa L. Tabasco (92).
Siphonoglossa dipteracantha (Nees) Heller. (1911).
Tubiflora acuminata Small. E. Starr Co. (652).

Plantaginaceae

Plantago lanatifolia (Coult. & Fish.) Small. Zapata (1922).
Plantago rhodosperma Decne. Clark Island (1921).
Plantago virginica L. var. longifolia Gray. Tabasco (675).

Rubiaceae

Galium aparine L. Palm Grove, Brownsville (1703).
Macrosiphonia Macrosiphon (Torr.) Heller. La Joya (554).
Randia aculeata L. Mission (1065).
Richardia braziliensis (Moq.) Gomez. Santa Elena Ranch (1109).

Cucurbitaceae

Cucumis Anguria L. La Joya (1897).
Cucurbita foetidissima H. B. K. Tabasco (1505).
Ibervillea Lindheimeri (Gray) Greene. Alamo (1919).
Melothria pendula L. Alamo (1417).

Campanulaceae

Lobelia brachypoda A. DC. Rio Grande City (908).
Lobelia Cliffortiana L. Rio Hondo (615).
Lobelia Feayana Gray. Los Fresnos (1729).

Lythraceae

Ammannia coccinea Rottb. Palm Grove, Brownsville (1523).
Heimia salicifolia Link. Havana (1126).
Lythrum alatum Pursh. Mercedes (287).

Compositae

Actinea linearifolia (Hook.) Greene. Zapata (692).
Actinea odorata (DC.) Kuntze. Zapata (1693).
Amblyolepis setigera DC. Rio Grande City (1832).
Ambrosia elatior L. Mission (167).
Ambrosia psilostachya DC. Mission (160).
Aphanostephus ramosissimus DC. Raymondville (1210).
Aphanostephus skirrobasis (DC.) Trel. Clark Island (765).
Aphanostephus skirrobasis var. Hallii (Gray) Blake. Linn (810).
Aplopappus Drummondii (Torr. & Gray) Blake. Los Fresnos (1732).
Aplopappus phyllocephalus DC. Boca Chica (714).
Arctium Lappa L. Roma (1940).
Aster exilis Ell. San Juan (441).
Aster Palmeri Gray. Rio Grande City (1380).
Aster spinosus Benth. Pharr (789).
Baccharis glutinosa Pers. Boca Chica (399).
Baccharis texana (Torr. & Gray) Gray. Clark Island (1726).
Bahia absinthifolia Benth. Rio Grande City (1359).
Borrichia frutescens (L.) DC. Clark Island (330).
Calyptrocarpus vialis Less. Mission (170).
Centaurea americana Nutt. Palm Grove, Brownsville (951).
Cirsium undulatum Nutt. ? San Benito (627).
Clappia suaedaefolia Gray. Mercedes (619).
Conyza Coulteri Gray. Camp Perry (1757).
Coreopsis cardaminifolia (DC.) Torr. & Gray. Clark Island (571).
Dyssodia Berlandieri (DC.) Blake. Zapata (1827).
Dyssodia tephroleuca Blake. Rio Grande City (1825). Type.
Eclipta alba (L.) Hassk. Alamo (873).
Erigeron canadensis L. Havana (1131).
Erigeron repens Gray. Boca Chica (713).
Erigeron tenuis Torr. & Gray. Palm Grove (1834).
Eupatorium ageratifolium DC. Barreda (1647).
Eupatorium azureum DC. Barreda (1740).
Eupatorium odoratum L. Palm Grove, Brownsville (1835).
Evax multicaulis DC. E. Zapata Co. (1864).
Florestina tripteris DC. San Juan (468).
Franseria confertiflora (DC.) Rydb. Zapata (690).
Gaillardia pulchella Foug. Chihuahua (193).
Gnaphalium spathulatum Lam. Rio Hondo (1044).
Gochnatia hypoleuca (DC.) Gray. San Ignacio (934).
Grindelia colepsis Blake. Brownsville.
Gutierrezia eriocarpa Gray. Boca Chica (389).
Helenium linifolium Rydb. Raymondville (1769).
Helenium microcephalum DC. Mission (163).
Helenium quadridentatum Labill. Alamo (906).

HELIANTHUS ANNUUS L. Zapata (1828).
HELIANTHUS CUCUMERIFOLIUS Torr. & Gray. Raymondville (1200).
HETEROTHECA SUBAXILLARIS (Lam.) Britt. & Rusby. Combes (1765).
IVA ANGUSTIFOLIA Nutt. Boca Chica (328).
IVA CILIATA Willd. Tabasco (213).
LEPACHYS COLUMNARIS (Sims) Torr. & Gray var. PULCHERRIMA (D. Don) Torr. & Gray. Mission (110).
LYGODESMIA TEXANA (Torr. & Gray) Greene. N. Hidalgo Co. (824).
MELAMPODIUM CINEREUM DC. E. Starr Co. (653).
OTHAKE ROBUSTUM Rydb. Clark Island (733).
OTHAKE TEXANUM (Hook.) Bush. Tabasco (93).
PARTHENIUM HYSTEROPHORUS L. Mission (114).
PEREZIA RUNCINATA Lag. Barreda (1622).
PERITYLE MICROGLOSSA Benth. Rio Hondo (1742).
PLUCHEA CAMPHORATA (L.) DC. Boca Chica (367).
PSILOSTROPHE GNAPHALODES DC. San Ignacio (1689).
RUDBECKIA BICOLOR Nutt. San Manuel Ranch (809).
SELLOA GLUTINOSA Spreng. Los Fresnos (1731B).
SENECIO AMPULLACEUS Hook. Palm Grove, Brownsville (1833).
SENECIO GLABELLUS Poir. Brownsville (1644).
SIMSIA CALVA (Gray & Engelm.) Gray. Rio Grande City (1355).
PYRRHOPAPPUS GRANDIFLORA (DC.) Greene. San Benito (1928).
PYRRHOPAPPUS MULTICAULIS (DC.) Greene. Port Isabel (1649).
SONCHUS OLERACEUS L. San Juan (445).
TRICHOCORONIS WRIGHTII (Torr. & Gray) Gray. Alamo (876).
TRIXIS RADIALIS (L.) Kuntze. Alamo (1428).
VARILLA TEXANA Gray. Roma (1351).
VIGUIERA STENOLOBA Blake. Mission (173).
XANTHIUM SPECIOSUM Kearney. Roma (500).
VERBESINA ENCELIOIDES (Cov.) Benth. & Hook. Tabasco (172).
VERBESINA VIRGINICA L. Olmito (1645).
ZEXMENIA BREVIFOLIA Gray. Tabasco (90).
ZEXMENIA HISPIDA (H. B. K.) Gray. Rio Grande City (1673).
ZINNIA PUMILA Gray. Rio Grande City (479).

University of Michigan,
Ann Arbor, January 1, 1936.

LITERATURE CITED

1. BAILEY, VERNON. Biological survey of Texas. U. S. Dept. Agric., Biol. Surv., N. Am. Fauna No. 25. 1905.
2. BARTLETT, H. H. A method of procedure for field work in tropical American phytogeography based upon a botanical reconnaissance in parts of British Honduras and the Petén forest of Guatemala. Carnegie Inst. Washington, Publ. No. 461: 1–25. 1935.
3. BECK, M. W., and B. H. HENDRICKSON. Soil survey of Cameron County, Texas. U. S. Dept. Agric., Bur. of Chem. and Soils, No. 17, series 1923.
4. BERLANDIER, L. Espedicion scientifica del general Terán á Tejas. Boletin de la Sociedad Mexicana de Geografía y Estadística 5: 125–133. 1857.
5. BRAY, WM. L. The ecological relations of the vegetation of western Texas. Bot. Gaz. 32: 99–123, 195–217, 262–291. 1901.
6. ————. The mistletoe pest in the southwest. U. S. Dept. Agric., Bur. Plant Industry, Bull. No. 166. 1910.
7. BRITTON, N. L., and J. N. ROSE. The Cactaceae. Carnegie Inst. of Washington, Publ. No. 248. 1919–1923.
8. CLEMENTS, F. L. Plant succession—an analysis of the development of vegetation. Carnegie Inst. of Washington, Publ. No. 242. 1916.
9. CLOVER, E. U. Astrophytum asterias in the United States. Rhodora 37: 227–228. 1932.
10. ————. Echinocereus angusticeps, a new species from the Lower Rio Grande Valley, Texas. Rhodora 37: 77–80. 1935.

11. Cook, O. F. Change of vegetation on the south Texas prairies. U. S. Dept. Agric., Bur. Plant Industry, Circ. No. 14. 1908.
12. Cooper, W. S. The broad-sclerophyll vegetation of California. An ecological study of the chaparral and its related communities. Carnegie Inst. of Washington, Publ. No. 319. 1923.
13. Coulter, J. M. Upon a collection of plants made by Mr. G. C. Nealley, in the region of the Rio Grande, in Texas, from Brazos Santiago to El Paso County. Contr. U. S. Nat. Herb. 1: 29–61. 1890.
14. ————. Botany of western Texas. Contr. U. S. Nat. Herb. 2: 1–588. 1891–1894.
15. Cowles, H. C. Review of "Plant Succession" by F. E. Clements. Bot. Gaz. 68: 477–478. 1919.
16. Drude, O. Handbuch der Pflanzengeographie. Stuttgart. 1890.
17. Emory, W. H. Report on the United States and Mexican Boundary Survey 1(1): xvi + 258. 1857.
18. Engelmann, G., and A. Gray. Plantae Lindheimerianae. Boston Jour. Nat. Hist. 5: 210–264. 1845.
19. Engelmann, G. Cactaceae of the Boundary. In Emory, Wm. H., Report on the United States and Mexican Boundary Survey 2(1): 1–78, pls. 1–75. 1858.
20. Engler, A. Die Pflanzengeographische Gliederung Nord-Amerikas. Abdruck, aus dem Notizblatt des Königl. Bot. Gart. Berlin, Appendix IX. 1902.
21. Foscue, E. J. Physiography of the Lower Rio Grande Valley. Pan-American Geologist 57: 263–267. 1932.
22. Gray, A. Plantae Lindheimerianae. Boston Jour. Nat. Hist. 6: 141–240. 1850.
23. Harshberger, J. W. Phytogeographic survey of North America. In Engler und Drude, Die Vegetation der Erde 13: vi + 789. 1911.
24. Havard, V. The Mezquit. Am. Nat. 18: 451–459. 1884.
25. ————. Report on the flora of western and southern Texas. Proc. U. S. Nat. Mus. 8: 449–533. 1885.
26. Hooker, W. J. Notice concerning Mr. Drummond's collections made chiefly in the southern and western parts of the United States. Companion to Bot. Mag. 1: 39–49, 95–101, 170–177. 1835; 2: 60–64. 1836.
27. Lundell, C. L. Preliminary sketch of the phytogeography of the Yucatan Peninsula. Carnegie Inst. of Washington, Publ. No. 436. 1934.
28. Merriam, C. H. Life zones and crop zones of the United States. U. S. Dept. Agric., Biol. Surv., Bull. No. 10. 1898.
29. Schott, A. V., and C. C. Parry. In Emory, Wm. H., Report on the United States and Mexican Boundary Survey 1(2): viii + 174. 1857.
30. Schulz, E. D., and R. Runyon. Texas cacti; a popular and scientific account of the cacti native of Texas. Trans. Texas Acad. Sci. including Proc. 14: 1–181. 1930.
31. Small, J. K. The palmetto-palm, Sabal texana. Jour. N. Y. Bot. Gard. 28: 132–143. 1927.
32. Spaulding, M. V. Biological relations of certain desert shrubs. Bot. Gaz. 38: 122–138. 1904.
33. Tharp, B. C. Structure of Texas vegetation east of the 98th meridian. Univ. Texas Bull. No. 2602. 1926.
34. Torrey, J. Botany of the Boundary. In Emory, Wm. H., Report on the United States and Mexican Boundary Survey 2(1): 27–270, pls. 1–61. 1858.
35. Trowbridge, A. C. Tertiary and quaternary geology of the Lower Rio Grande Valley region, Texas. U. S. Geol. Surv. Bull. No. 837. 1932.
36. Warming, E. U. G. Oecology of plants. Oxford, Clarendon Press. 1909.
37. Weaver, J. E., and F. R. Clements. Plant ecology. New York. 1929.
38. Winkler, C. H. The botany of Texas: an account of the botanical investigations in Texas and adjoining territory. Univ. Texas Bull. No. 18. 1915.

NOTES AND NEWS

On June 30, 1937, Dr. Willis Linn Jepson, Professor of Botany, University of California, retires from active service. An alumnus of the institution, he joined the faculty in 1894 and has since devoted most of his attention to the study of the California flora. Among his many well known publications on this subject the following may be mentioned: "The Silva of California," 1911; "The Trees of California," 1909; "A Flora of California," 1909–1937 (Volumes 1 and 2 completed); "A Manual of Flowering Plants of California," 1925. Dr. Jepson directed the organization of the California Botanical Society in 1913 and was for many years its president. He founded "Madroño" in 1916 and acted as editor of the journal until 1934.

Dr. Lincoln Constance has recently been appointed Assistant Professor of Botany and Assistant Curator of the Herbarium at the University of California, Berkeley. Since 1933 he has held a similar position at Washington State College, Pullman. A graduate of the University of Oregon, Dr. Constance entered the University of California as teaching assistant in botany, and in 1933 received from that institution the degree of Doctor of Phliosophy.

The publications listed below are of special interest to botanists of western North America.

Recent issues of the University of California Publications in Botany: "A systematic study of the genus Eriophyllum," by Lincoln Constance (Univ. Calif. Publ. Bot. 18: 69–136, pls. 3–8, text figs. 16, 1937. $.50); "An unusual ascomycete in the shells of marine animals [Didymella conchae Bonar]," by Lee Bonar (Univ. Calif. Publ. Bot. 19: 187–194, pl. 22, text fig. 1, 1936. $.25); "Iridophycus, with special reference to the South American species," by William Albert Setchell and Nathaniel Lyon Gardner (Univ. Calif. Publ. Bot. 19: 195–244, pls. 23–29, 1937. $.50).

"Moisture relations in the chaparral of the Santa Monica Mountains, California," by Harry Lloyd Bauer (Ecological Monographs 6: 409–454, July, 1936).

Publications on the Templeton Crocker expedition of the California Academy of Sciences, 1932: No. 31, "A preliminary report on the algae," by William Albert Setchell (Proc. Cal. Acad. Sci. ser. 4, 22: 65–98, pls. 3–25, text fig. 1, 1937); No. 32, "The plant genus Coldenia in the Galapagos Islands" by John Thomas Howell (Proc. Calif. Acad. Sci. ser. 4, vol. 22: 99–110, pls. 26, 27, 1937).

"A key to the grasses of Montana based upon vegetative characters," by C. Leo Hitchcock (Published by the author, University of Montana, Missoula, Montana, pp. 1–28, pls. 1–8, 1936. $.50).

This key, of convenient size and based upon characters observable at any time during the growing season, requires as aids only a millimeter rule and a lens of ten power magnification. It should thus be of great service in field identification of grasses. The plates comprise 190 excellent figures illustrating for the most part ligule characters of nearly as many species of grasses.

California Forest and Range Experiment Station: Staff Publications, January 1, 1916, to April 30, 1937. This bibliography includes publications of forty-three authors and lists approximately two hundred titles of important papers on forestry and related subjects (Berkeley, California: compiled by A. M. Avakian, Librarian. Mimeographed).

"Leaflets of Western Botany," owned and published by Alice Eastwood and John Thomas Howell of the California Academy of Sciences, San Francisco, has completed its first volume. The volume contains twenty numbers issued from January 16, 1932 to November 12, 1936, and consists of over one hundred articles on various phases of western botany.

Volume I of "Contributions from the Dudley Herbarium," 1927–1936, closed with number 7, "A resurrection and revision of the genus Iliamna Greene" [Malvaceae] by Ira L. Wiggins (Stanford University Press, pp. 213–229, pl. 20). With this number appears also the volume index and title-page. The volume consists of twelve articles on the taxonomy and distribution of western plants by the following authors: L. R. Abrams, Elmer Applegate, Rimo Bacigalupi, Roxana S. Ferris, Howard E. McMinn, and Ira L. Wiggins.

On July 14, 1937, Mr. Bayne Beauchamp of Honolulu, Mr. Charles Belshaw of Oakland, student at the University of California, and Mr. Ole Olson of Tri-State University, Indiana, sailed on the Japanese liner *Heiyo Maru* for South America with the objective of making botanical collections for their respective institutions. Their first objective is the Inter-Andean Valley of Peru in which region they will collect for some weeks. In September Mr. Beauchamp will return to Berkeley while Mr. Belshaw will continue collecting for several months southward along the Andes. Mr. Olson will cross the cordilleras into the rain forest of the upper Andes and will then travel by boat down the Amazon to the Atlantic Coast. He will return to Tri-State University by way of Rio de Janeiro or Para. The collectors are carrying equipment for taking color photographs.

Dr. C. Leo Hitchcock of the Department of Botany of the University of Montana at Missoula has accepted a position as Assistant Professor of Botany at the University of Washington, Seattle.

During June, 1937, Dr. Theodor Just of the Department of Botany, University of Notre Dame, Indiana, visited botanical institutions of the San Francisco Bay region in the interests of the "American Midland Naturalist" of which he is editor.

Dr. Ira L. Wiggins of the Department of Botany, Stanford University, California, is spending a part of this summer at the Royal Botanic Gardens at Kew, consulting type specimens in connection with his researches on the flora of the Sonoran Desert of northern Mexico.

"Wild Flowers of Southern California" by Carl Thurston is described on the title page as "an easy key to the names of flowers, ferns, and trees, with 547 illustrations from photographs taken by the author." By attempting to cover only a limited geographic area, this book is more complete than the usual popular handbook. It is designed on an original plan as a field index, the purpose of which is to supply quickly the names of plants with technical terms, keys, and descriptions reduced to a minimum. Two hundred and fifty-two tables comprise the bulk of the volume. These are supplemented by a short list of definitions of botanical terms, a list of families and genera, and an index of the scientific and common names (Esto Publishing Company, Pasadena. 412 pp. 1936. $4.00).

PROCEEDINGS OF THE CALIFORNIA BOTANICAL SOCIETY

Thursday, April 1, 1937. A meeting was held at 8:00 p. m. in Room 2093, Life Sciences Building, University of California, Berkeley. Lecture: "Farthest South America" by Mrs. Ynes Mexia. Mrs. Mexia recounted her experiences during a recent botanical collecting trip to Tierra del Fuego.

Thursday, April 22, 1937. A meeting was held at 8:00 p. m. in Room 460, Physiology Building, Stanford University. Lecture: "In Africa and Australia after Insectivorous Plants" by Francis E. Lloyd, Professor of Botany, Emeritus, McGill University. The lecture was illustrated by slides showing photographs of habitats of *Utricularia* and other insectivorous plants and microphotographs, drawings, and charts of the insect trapping mechanisms.

At a business meeting of the recently organized Santa Barbara Branch of the California Botanical Society on April 14, 1937, the following offiecers were elected: President, Mr. Maunsell Van Rensselaer; Vice-President, Mrs. Hugh Dearing; Secretary-Treasurer, Miss Ruth Hartwell. On the evening of March 10, 1937, at the Santa Barbara Museum of Natural History, Professor H. E. McMinn of Mills College, California, addressed the Branch on "The evolution of trees as represented by the trees of Santa

Barbara." On Sunday, May 2, 1937, a field trip was taken to Figueroa Mountain. About fifty persons attended. Leaders were: Hugh Dearing, Ruth Hartwell, Irma Cooke, Father Seraphin Muller, and M. Van Rensselaer. The Santa Barbara Branch of the Society now numbers sixty-five members: Mrs. Dorothy Crofton Atkins, Mrs. Alexander Baring, Mr. Antonio Beatrice, Mrs. Robert Woods Bliss, Mr. William Body, Miss Ellen Chamberlain, Mrs. Philip S. Chancellor, Miss Pearl Chase, Miss Helen Clarke, Dr. Frederic E. Clements, Mrs. George Clyde, Mrs. Olivia L. Converse, Mrs. E. A. Danielson, Mrs. Hugh Dearing, Mr. William R. Dickinson, Mrs. Malcolm Douglas, Mr. William North Duane, Mr. Frank E. Dunne, Mrs. George S. Edwards, Mrs. Muriel Edwards, Mrs. G. Hillyer Garvin, Mrs. E. Palmer Gavit, Dr. Adele Lewis Grant, Mrs. Clifford Greene, Mrs. Clinton B. Hale, Mrs. Girard van B. Hale, Mrs. William Hart, Miss Caroline Hazard, Mr. Bernard Hoffman, Mrs. Frank Holtzbauer (Chairman, Native Daughters of the Golden West), Mr. W. M. James, Mrs. Kirk B. Johnson, Mr. Bert Kallman, Mr. Frederick B. Kellam, Mrs. W. F. Kelly, Mrs. Lora J. Knight, General William Lassiter, Miss Lorraine Lawton (Secretary, San Foca Garden Guild), Mrs. J. D. Lewis, Mrs. Francis V. Lloyd, Dr. Frances Long, Mrs. August C. Magnus, Mr. Emmett Martin, Mrs. Henry P. Moseley, Father Seraphin Muller, Mrs. Charles Nelson, Mrs. William P. Nelson, Mrs. George M. Newell, Dr. Asbjorn P. Ousdal, Mrs. DeWitt Parshall, Mr. Reginald C. Robbins, Mr. C. S. Robinson, Mr. E. D. Rowe, Mr. Hobart O. Skofield, Mrs. Otis S. Southworth, Mr. George L. Stebbins, Mrs. George F. Steedman, Mrs. Anne Stow-Fithian, Mr. M. Van Rensselaer, Mr. L. D. Waller, Margaret Ely Webb, Dr. Harrington Wells, Mrs. George G. Whitelaw, Mr. Harry S. Wilson, Mr. W. H. Yule.

The Santa Barbara Branch of the California Botanical Society is governed by a council made up of a representative from each of the following organizations or institutions: Blaksley Botanic Garden, Santa Barbara Museum of Natural History, Garden Club of Santa Barbara and Montecito, Little Garden Club of Santa Barbara, Santa Barbara County Horticultural Society, The Santa Barbara Gardener, Flower Seed Industry of Santa Barbara County, United States Forest Service, Santa Barbara County Forest Department, Santa Barbara City School System, Santa Barbara County School System, Santa Barbara State College, Santa Barbara School of Nature Study, St. Anthony's College, Plans and Planting Committee, Community Arts Association of Santa Barbara, Carnegie Institution of Washington.

A meeting of the Santa Barbara Branch was held at the Santa Barbara Museum of Natural History, Friday, June 18th, at 8:00 p. m. Mr. H. M. Butterfield of the College of Agriculture, University of California, Berkeley, spoke on "Early Introductions of Ornamental Plants to Santa Barbara and California."

VOLUME IV NUMBER 4

MADROÑO

A WEST AMERICAN JOURNAL OF BOTANY

Contents

Published at Lime and Green Streets, Lancaster, Pennsylvania

October, 1937

MADROÑO

A WEST AMERICAN JOURNAL OF BOTANY

Business Manager—Dr. David D. Keck
Lime and Green Sts., Lancaster, Pennsylvania
or
Carnegie Institution of Washington
Stanford University, California

Entered as second-class matter October 1, 1935, at the post office at Lancaster, Pa., under the act of March 3, 1879.

Established 1916. Published quarterly. Subscription Price $2.50 per year. Volume I, Numbers 1 to 17, complete, $5.00. Volume II, Numbers 1 to 17, complete, $5.00. Volume III, Numbers 1 to 8, complete, $5.00. Single numbers $0.75.

Papers up to 15 or 20 pages are acceptable. Longer contributions may be accepted if the excess costs of printing and illustration are borne by the contributor. Articles may be submitted to any member of the editorial board. Manuscripts may be included in the forthcoming issue provided that the contributor pay the cost of the pages added to the issue to accommodate his article. Reprints of any article are furnished at a cost of 4 pages, 50 copies $3.70; 100 copies $4.10; additional 100's .75¢; 8 pages, 50 copies $5.40; 100 copies $6.00, additional 100's $1.20. Covers, 50 for $2.50; additional covers at $1.50 per hundred. Reprints should be ordered when page proofs are returned.

Published at Lime and Green Streets, Lancaster,
Pennsylvania, for the

CALIFORNIA BOTANICAL SOCIETY

President: Dr. F. W. Foxworthy, Berkeley, California. First Vice-President: Dr. Ira L. Wiggins, Department of Botany, Stanford University. Second Vice-President: Dr. Philip A. Munz, Department of Botany, Pomona College, Claremont, California. Treasurer: Dr. David D. Keck, Carnegie Institution of Washington, Stanford University. Secretary: Miss Ethel Crum, 4004 Life Sciences Building, University of California, Berkeley.

Annual membership dues of the California Botanical Society are $2.00, $1.50 of which is for a year's subscription to Madroño. Dues should be remitted to the Treasurer. General correspondence and applications for membership should be addressed to the Secretary.

THE VEGETATION OF THE CAPE REGION OF BAJA CALIFORNIA

Forrest Shreve

The southern end of the peninsula of Baja California is virtually an island from the biological standpoint on account of its effective isolation from the nearest areas of similar climate. It is separated from the Mexican mainland by the Gulf of California, with an average width of 150 kilometers (93 miles), and from the mesic highlands of northern Baja California by an arid stretch of 550 kilometers (342 miles).

The groundwork of the vegetation of the peninsula is desert. In the north there are two large mountain ranges, the Sierra Juarez and the Sierra San Pedro Martir, with summits clothed by coniferous forest. Between them and the Pacific lies an area of chaparral, desert-chaparral transition and some grassland. Between the mountains and the Gulf of California is the narrow band of desert which connects the continental and peninsular parts of the Sonoran Desert. In the extreme south is another series of mountains, the Sierra Giganta, Sierra Laguna and Sierra Victoria, which reach altitudes of 1800 to 2400 meters (5900 to 7875 feet) and have an area of about 830 square kilometers (300 square miles) above an elevation of 1000 meters (3280 feet). Outside the Viscaiño Desert and the Magdalena Plain the entire surface of the peninsula is rugged or mountainous, and there are a few scattered ranges with small areas above 1000 meters (see map, fig. 1).

The northern mountains and the chaparral region are very regularly visited by winter rains. The southern mountains usually have copious summer rains. In the intervening area, latitude 26° to 30° N., the rainfall is low and sometimes there is none for three or four consecutive years.

The botanist who traverses the peninsula from north to south is impressed by the steady loss of familar plants and the constant appearance of new species throughout the entire distance of 1300 kilometers (800 miles). South of latitude 30° N., in the desert part of the peninsula, there is little change in the physiognomy of the vegetation in spite of the gradual changes in the flora. South of Comondú, at latitude 26° N., the types of vegetation gradually become more numerous and the communities found in different situations and habitats become more unlike each other than is the case in the central region. With the enriched vegetation comes a more rapid change in the flora.

The distinctive character of the fauna and flora of the "Cape Region," or "Cape District," has been shown by Bryant (1), Brandegee (4), Nelson (6), Grinnell (5) and others. Nelson

Madroño, Vol. 4, pp. 105–136, October 4, 1937.

has mapped the life zones of Baja California (6, pl. 32), extending the arid tropical zone northward from the cape to latitude 27° 30′ N., and comprising in the lower sonoran zone the northern part of the central desert region and also the higher elevations of the southern mountains. Grinnell has studied the distribution of the birds of Baja California and has demonstrated strong differentiation centers in the high mountains of the north and of the Cape Region south of La Paz, as well as weaker centers at latitude 27° N. and on the Pacific islands. Brandegee, working over forty-five years ago, made the most thorough botanical exploration of the Cape Region that has yet been carried out and published three papers (2, 3, 4) which must long serve as the foundation for further work in southern Baja California.

During a visit to the southern part of the peninsula in the spring of 1935 I was interested in locating the southern limit of desert plants and desert types of plant communities, in determining the character of the vegetation of the Cape Region, and in comparing the southern edge of the desert with its termination in southern Sonora (7).

South of La Paz the topography of the peninsula is dominated by the Sierra Laguna and Sierra Victoria, which together form a narrow range with seven sharp peaks, steep sides, and outwash slopes which fall at sharp gradients. These mountains are wholly granitic, and the coarse angular character of their eroded material is responsible for the steepness of their detrital slopes and for the broad sandy streamways which pitch down to the sea.

Northward from La Paz the topographic pattern of Baja California is relatively simple for about 250 kilometers (155 miles). In this stretch lies the Sierra Giganta, which hugs the Gulf coast with an unbroken ridge from 500 to 1000 meters (1640 to 3280 feet) in altitude and culminates in a rounded peak of 1766 meters (5775 feet) at latitude 26° 7′ N. The eastern face of the Sierra Giganta is very precipitous, while the western slope falls gradually to the Magdalena Plain. The escarpment which faces the Gulf is genetically related to the similar ones found on the eastern side of the Sierra Nevada, San Jacinto, Cuyamaca, Juarez and San Pedro Martir ranges. With rapidly falling elevation the escarpment crosses the peninsula west of La Paz and runs into the Pacific coast a short distance north of Todos Santos. The numerous drainageways on the west slopes of the Sierra Giganta are responsible for the building of the Magdalena Plain. At present, in a stretch of 200 kilometers there are only five large canyons which discharge their flood waters to the Pacific or the coastal lagoons. The plain is covered with thousands of small playas or dry lakes, which testify to the lack of established drainage. The rock material of the Sierra Giganta is very largely volcanic. Also there are

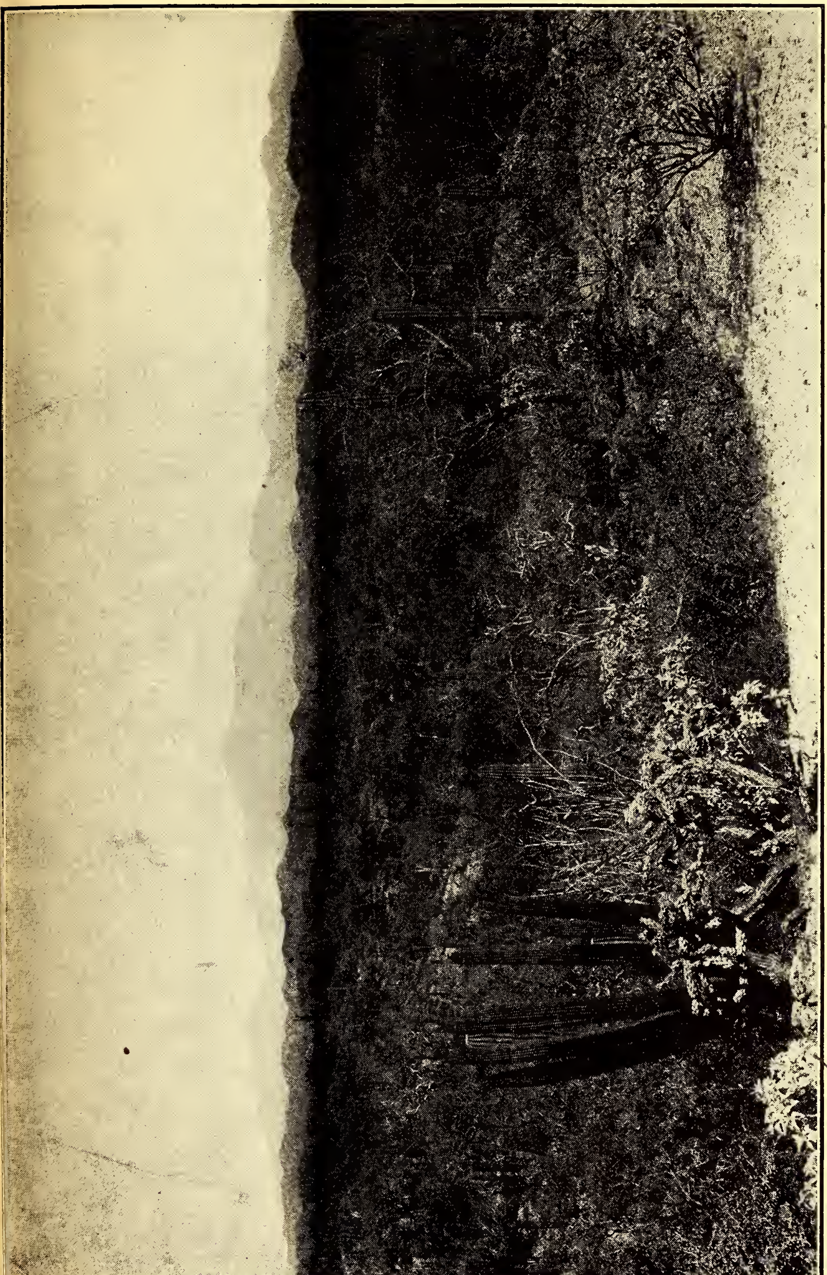


PLATE XVIII. Looking southeast from a locality 15 kilometers north of Todos Santos toward Victoria. Open forest of *Bursera microphylla*, *Cyrtocarpa edulis*, *Cassia atomaria*, *Pachycereus pecten-aboriginum*, *Gochnatia arborescens*, and numerous shrubs. In foreground *Lemaireocereus Thurberi*, *Opuntia cholla*, *Jatropha spathulata* and *Encelia farinosa*.

volcanic hills immediately east of La Paz and in an irregular series running southward along the Gulf coast, broken between Bahia de las Palmas and Punta Arena del Sur, and terminating in a large area in and around the Sierra de la Trinidad, northeast of San Jose del Cabo.

Southern Baja California, in contradiction to the northern section, receives more rain on the east coast than on the west. There is occasional winter rain west of the mountains, but the summer rains which visit the east coast and the mountains are much more copious and certain. Summer rain also occurs in the Sierra Giganta, in the Sierra de Zacatecas, west of Concepcion Bay, and extends sporadically northward to the mountains of California.

The Cape Region not only has a higher rainfall than the central section of the peninsula but receives it in the most favorable season. To these facts must be attributed the termination or localization of desert and the existence in the Cape Region of vegetation with a higher water requirement. The plant life of the region has developed under conditions of both geographic and climatic isolation. The available geological evidence indicates that these isolating features have undergone little change during most of the period in which the angiosperms have dominated the vegetation of the earth. It would, therefore, be a matter of considerable interest to compare the flora and vegetation of this ancient area with the region of summer rainfall in Sonora and Sinaloa, with the long stretch of desert which it terminates, and with the nearest mesic areas in Baja California. Such a discussion of the relationships of the flora will have to await a much more thorough exploration and study of the areas involved.

Brandegee (4) tabulated by families the flora of the Cape Region as known at that time, finding a total of 732 flowering plants and ferns, of which number 146 are confined to the high mountains and 586 to the lowlands. He found that 362 species are common to central and northern Baja California and 494 common to the mainland of Mexico. Out of 390 genera there are 230 which are represented by a single species, indicating a ratio of genera to species similar to that found in island floras. There were four genera and 72 species which appeared to be endemic to the Cape Region as far as known in 1892. An important phase of the floral relationships which Brandegee was not able to touch concerns the number of species on the nearest analagous part of the Mexican mainland which are absent from the Cape District. It is probable that this number is more than twice the total given by Brandegee for the Cape flora.

Owing to the character of the topography there are no extensive areas in the Cape Region with a relatively uniform set of physical conditions. The largest are the plain of La Paz, which lies between that town and the Sierra Laguna, the rolling

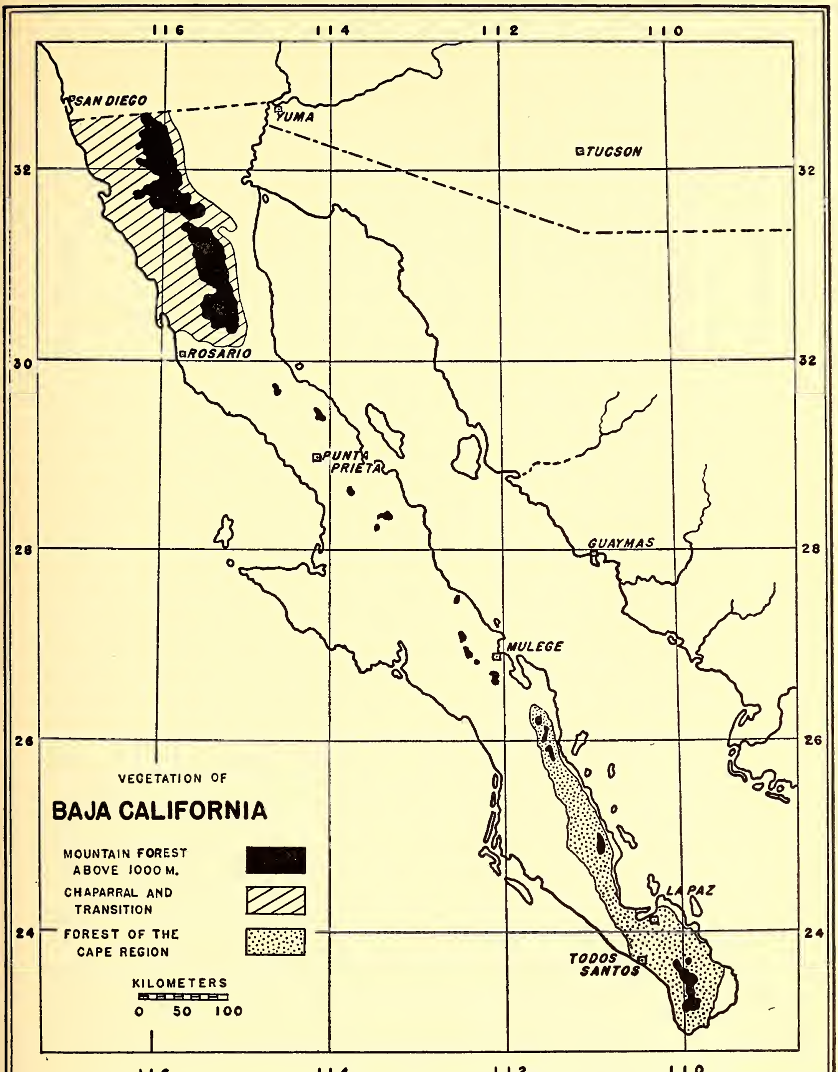


Fig. 1. Vegetation of Baja California.

limestone ridges west of the plain of La Paz, and part of the outwash slope which falls from the eastern base of the Sierra Victoria down to the Bahia de las Palmas. These three areas are representative of the lowland vegetation of the Cape Region. On the Pacific coast south of Todos Santos the vegetation is of a much more xeric stamp. Above 1000 meters the vegetation of the mountains is of a more mesic character.

The bajadas and plains of the Cape Region are either purely granitic or else of purely volcanic material, the former predominating. The granite soil is a light gray loam which is largely covered by sand in the plain of La Paz and is coarser and more homogeneous on the bajadas immediately east and west of the mountains. There is a poor development of small drainage-ways, due to the porosity of the soil and the high mobility of the surface. The streams originating high in the mountains have cut deep and abrupt channels midway in their course across the bajadas, and their floods move over a bed with very coarse white sand and remarkably few stones and boulders. The gradient of these arroyos is commonly as great as 1 : 10, and their courses are very direct, free of meanders, islands and relicts of former levels.

The volcanic areas south of La Paz are irregular in their topography and mainly covered by shallow clay soils. Their vegetation below 500 meters is desert and between 500 and 1000 meters is different only in a scattering representation of species from the Cape forest and in a slightly greater density of stand.

The Cape forest below 1000 meters is distinctly xeric. Its height ranges from 6 to 14 meters (19 to 45 feet), and it varies greatly in density, composition and the growth forms which are represented. Certain areas are dominated by slender leguminous trees and others by stout-stemmed trees with low spreading branches. The canopy of the forest is usually open and always extremely irregular. It is rarely that a single species of tree forms as much as 30 per cent of the stand, except in the case of *Jatropha cinerea.* The low interlacing branches of this tree are an obstacle to progress through the forest. In fact an open floor is found only in glades along arroyos where *Lysiloma candida, L. microphylla* and *Cercidium peninsulare* are dominant. Cacti are almost omnipresent, *Pachycereus pecten-aboriginum* being most abundant where the trees are thickest, and *Lemaireocereus Thurberi, Machaerocereus gummosus* and *Opuntia cholla* most common in the open situations. Shrubs are almost invariably abundant and in slightly moist situations contribute to the formation of impenetrable thickets. One of the commonest shrubs is *Tecoma stans,* which has height and stoutness of stem which almost give it the rank of a tree. Several composite shrubs equal the trees in height and their flowers may be seen projecting from the tallest limbs. The commonest of these are *Viguiera tomentosa, V. deltoidea, Alvordia fruticosa* and *Eupatorium sagittatum.* The polygonaceous vine *Antigonon leptopus* is abundant in all but the driest situations and its clusters of brilliant crimson flowers do much to give vivid color to a floral display in which yellow is predominant.

The relatively rich composition of the Cape forest, the close mingling of trees of different height and branching habit, the occurrence of erect compact shrubs, broad poorly branched ones and semi-scandent ones, of cacti, yuccas and vines, gives much of the Cape Region the air of an impoverished tropical jungle.

The vegetation of the Cape Region bears some resemblance to the thorn-forest of Sinaloa (8) in height, density, and many of the growth forms which are to be found. Nowhere is the Cape forest dominated by the thorny acacia type of tree, as is the case in Sinaloa, and it is scarcely appropriate to designate it as "thorn-forest."

The leaves of the trees are mainly compound with small leaflets, but in many of them the leaflets are more than one square centimeter in area. The number of trees with large simple leaves is very small. The seasonal habits of foliage differ widely in some of the common trees. A few of them are evergreen (*Cassia atomaria, Gochnatia arborescens, Sebastiania bilocularis*), a small number are winter deciduous (*Prosopis glandulosa, P. Palmeri*), and a large number are drought deciduous (*Jatropha cinerea, Bursera laxiflora, B. microphylla, Cyrtocarpa edulis, Cercidum sonorae*). Many others are partly deciduous in the dry spring months, the extent of defoliation doubtless depending on the severity of the dryness at that season.

The most common trees and other tall plants in the Cape forest below 1000 meters (3280 feet) are the following:

Lysiloma microphylla	Esenbeckia flava
Jatropha cinerea	Albizzia occidentalis
Cyrtocarpa edulis	Gochnatia arborescens
Bursera laxiflora	Haematoxylon brasiletto
Lysiloma candida	Lemaireocereus Thurberi
Cercidium peninsulare	Sebastiania bilocularis
Leucaena microcarpa	Bursera microphylla
Cassia atomaria	Pithecolobium tortum
Pachycereus pecten-aboriginum	Plumeria acutifolia
Cercidium sonorae	Bursera odorata
Prosopis Palmeri	Yucca sp.

Small trees with soft wood and large shrubs from 2 to 5 meters in height are abundant and very important in contributing to the physiognomy of the vegetation. The most prominent species, including cacti, are the following:

Tecoma stans	Lippia formosa
Viguiera tomentosa	Viguiera deltoidea
Karwinskia Humboldtiana	Opuntia cholla
Melochia tomentosa	Turnera diffusa
Mimosa Brandegei	Mimosa Xanti
Euphorbia Xanti	Hypis tephrodes
Bourreria sonorae	Alvordia fructicosa
Colubrina glabra	Acacia flexicaulis
Ruellia californica	Calliandra californica
Pithecolobium confine	Fouquieria peninsularis
Gossypium Davidsonii	Machaerocereus gummosus
Randia Thurberi	Opuntia fuliginosa
Celosia floribunda	Randia armata
Citharexylum flabellifolium	

The approximate distribution of the forest of the Cape region is shown on the accompanying map (fig. 1). On the Pacific coast it extends from sea-level to the borders of the mountain type of forest, found above 1000 meters. A short distance north of Todos Santos it gives way to the low desert scrub which characterizes the outer edge of the Magdalena Plain. On the Gulf Coast it covers all of the granitic outwash and certain favorably located areas of volcanic outwash but is not found on the volcanic hills near the coast south of La Paz. In the Sierra Giganta it occupies the slopes of the mountain on the west and the upper slopes on the arid eastern side. At the northern tip of the Cape forest its occurrence at lower elevations is limited to canyons and broad structural depressions in the lava fields.

The Magdalena Plain and the eastern coastal fringe south of latitude 26° N. are desert in both vegetation and flora. South of La Paz the character of the underlying rock and the derived soils is closely correlated with the distribution of forest and desert. Trustworthy inhabitants state that the east coast receives less rain than the interior as far north as Concepcion Bay, a circumstance which adds to the aridity of the volcanic areas. The Magdalena Plain is like the central region of the peninsula in having little rain at any season. There is some morning fog in April and May, and a narrow coastal strip is visited by strong ocean wind varying in relative humidity from 55 to 65 per cent. The region is distinctly unfavorable to the northward spread of the Cape forest.

The number of plants which are common in the Cape Region but absent from the desert of Baja California is large. The infiltration of the Cape vegetation by desert plants is considerable as to the number of species but only locally important with respect to their role in the vegetation. *Larrea* reaches the top of the southern end of the escarpment but does not descend into the plain of La Paz. *Pachycereus, Lemaireocereus, Cercidium, Bursera* and other genera prominent in the desert are also frequent in the Cape vegetation. Many of the common plants of the desert are abundant on the volcanic areas in the Cape Region but only sparingly represented in the Cape forest. On the volcanic areas the height, spacing, types of plants and other physiognomic features are identical with those of the desert areas far to the north, and the composition of the vegetation is very similar.

Following is a list of the principal desert plants found in dry and open habitats in the Cape forest. A few of these occur in the desert only south of latitude 29° N. The remainder are found nearly throughout the desert of Baja California and some of them occur in southwestern Arizona also. The extent of the northern range is indicated after each species.

Pachycereus Pringlei	B.C.	Brickellia Coulteri	Ariz.
Bursera microphylla	Ariz.	Beloperone californica	Ariz.
Lemaireocereus Thurberi	Ariz.	Opuntia cholla	29° N.

Encelia farinosa	Ariz.	Machaerocereus gummosus	B.C.
Fouquieria peninsularis	29° N.	Calliandra californica	B.C.
Solanum Hindsianum	Ariz.	Franseria magdalenae	29° N.
Trixis californica	Ariz.	Colubrina glabra	29° N.
Franseria ambrosioides	Ariz.	Condalia spathulata	Ariz.
Bursera rhoifolia	B.C.	Simmondsia californica	Ariz.
Pedilanthus macrocarpus	29° N.	Euphorbia tomentulosa	B.C.
Jatropha cinerea	B.C.	Jatropha spathulata	Ariz.

On the level plains of Sonora the desert merges gradually into thorn-forest between latitude 27° and 28° N. In Baja California there is uninterrupted desert as far south as latitude 26° N.; it covers more than half of the peninsula thence south to latitude 24° N., and small areas of it are found almost to the extreme tip. The transition from desert to Cape forest is not a matter of gradual change over many miles so much as the interdigitation of the two over rugged and varied country.

Differences of flora and of vegetation are not of the same kind and are therefore difficult to compare. From a general standpoint, nevertheless, it may be said that the Cape Region and the adjacent mainland differ in vegetation fully as much as in flora. The southern limit of desert is about three degrees further south in Baja California than it is on the mainland. The relationships of the flora of the Cape Region, as far as known, are somewhat closer to Sonora than to Sinaloa. The flora of the mainland, over a comparable area, is much richer than that of the Cape Region, but the vegetation of the lowlands of the Cape is very much more diversified than that of the lowlands of Sinaloa and southern Sonora. In the latter region a single tree is everywhere strongly dominant, and its commonest associates are few as compared with the great variety of arborescent forms in the Cape forest.

Desert Laboratory,
Carnegie Institution of Washington,
Tucson, Arizona, July, 1937.

Bibliography

1. Bryant, W. E. The Cape Region of Baja California. Zoe, 2: 185–201. 1891.
2. Brandegee, T. S. A Collection of Plants from Baja California, 1889. Proc. Cal. Acad. Sci. Ser. 2, 2: 117–232. 1889.
3. ————. Flora of the Cape Region of Baja California. Proc. Cal. Acad. Sci. Ser. 2, 3: 108–182. 1891.
4. ————. The Distribution of the Flora of the Cape Region of Baja California. Zoe, 3: 223–231. 1892.
5. Grinnell, Joseph. A Distributional Summation of the Ornithology of Lower California. Univ. Cal. Publ. Zool. 32: 1–300. 1928.
6. Nelson, Edward W. Lower California and its Natural Resources. Mem. Nat. Acad. Sci. 16. 1921.
7. Shreve, Forrest. Vegetation of the Northwestern Coast of Mexico. Bull. Torr. Bot. Club, 61: 373–380. 1934.
8. ————. Lowland Vegetation of Sinaloa. Bull. Torr. Bot. Club, in press.

A NEW THALICTRUM FROM MOUNT RAINIER, WASHINGTON

Harold St. John

Thalictrum rainierense sp. nov. Perennial, producing a slender offset at base; stem 30–48 cm. tall, glabrous, with 9–11 angles, the base short decumbent, clothed with brown marcescent leaf sheaths; basal or sub-basal leaves usually 1 at anthesis, the petiolar sheath 15–25 mm. long, membranous, brown, strongly

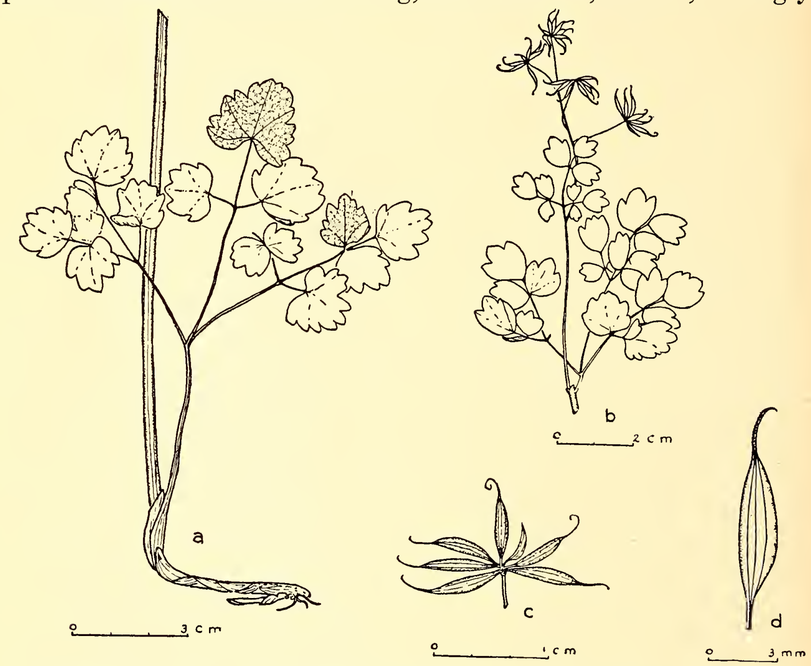


Fig. 1. *a,* stem and basal leaf; *b,* tip of stem and pistillate inflorescence; *c,* fruit; *d,* achene.

ribbed, auricled at tip; petiole 4–5 cm. long, glabrous; blades biternate, the petiolules 1–8 mm. long; leaflets 8–16 mm. long, thin chartaceous, above dark green and glabrous, beneath pale and glaucous and minutely capitate glandular puberulous, in outline suborbicular to broadly rhombic, the basal half entire, the apex 1–2-times lobed with broad ovate or rounded lobes; cauline leaves 3–4, the upper gradually reduced and shorter petioled; staminate plants not seen; pistillate plants with the inflorescence 25–45 mm. long, loosely cymose, 3–5-flowered, glabrous; bracts minute, suborbicular; pedicels 8–15 mm. long; calyx deciduous, not seen; the 5–12 achenes stipitate at base the outer ones on a stipe 0.2–1 mm. long, the inner on a stipe 1–1.8 mm. long, the body 5.5–6 mm. long, 1.2–1.7 mm. wide, obliquely slender fusiform, with about 9 prominent, longitudinal ribs; stigma 0.4–3 mm. long. (Fig. 1.)

Perenne 30–48 cm. altum, caule glabro angulato, foliis biternatis, foliolis 8–16 mm. longis tenuiter chartaceis suborbicularibus vel late rhomboideis subtus glanduloso-puberulis apicibus lobatis, inflorescentibus foemineis cymosis 3–5-floriferis; acheniis fusiformibus stipitatis.

Washington: in meadows, altitude 6000 feet, Mount Rainier, August, 1895, *C. V. Piper 2022* (type in State College of Washington Herbarium, Pullman).

No similar species is known in the region. The closest relative seems to be *T. stipitatum* Rydb. (not *T. stipitatum* Rose, 1903), a native of the mountains of Colorado. It has the herbage glabrous, and the achenes about 6 mm. long, and 2.5–3 mm. broad. *T. rainierense* has the leaflets capitate glandular puberulous beneath, and the achenes 5.5–6 mm. long, and 1.2–1.7 mm. wide.

University of Hawaii, Honolulu,
February 7, 1937.

SEEDLINGS FROM POLYEMBRYONIC SEEDS OF EUGENIA HOOKERI

Arthur M. Johnson

In a previous paper[1] the writer described an unusual polyembryonic condition found in the seeds of *Eugenia Hookeri,* a common ornamental tree in the Los Angeles area. The question naturally followed as to whether or not seedlings would develop from these embryos and what form the seedlings would take. The present paper deals with the results obtained from seeds that were allowed to germinate in the soil under the parent tree. The species produces an abundant crop of fruit annually in this locality, and if the fallen fruits are allowed to remain on the ground a good crop of seedlings will usually spring up.

The seedlings herein described were dug up on May 26, 1934. The parent tree stands within a few feet of the north side of a dwelling, where, except during the midsummer season, no direct sunlight falls upon the ground beneath it. The soil is clayey and is always moist, and frequently wet, especially on days when the adjacent lawn is watered.

At the time these seedlings were collected numerous other seedlings were growing in the ground beneath the parent tree. Many more seedlings were examined than the ones here described and figured. Seedlings have appeared annually in varying numbers since these were collected, though at the present

[1] Johnson, A. M. Polyembryony in *Eugenia Hookeri.* Amer. Journ. Bot. 23: 83–88. 1936.

writing there are relatively few, owing perhaps to the recent long cold spell.

One peculiarity of these seedlings is that they have never developed further than to a height of about a decimeter. The past summer (1936) a number of seedlings, all less than a decimeter in height, were transplanted to a more favorable location, in drier soil, where they would be exposed to direct sunlight for the greater part of the day. Up to the present they have made no growth, although they are all as green and healthy looking as when planted. It remains to be seen whether they will resume growth after the advent of the warm season.

The thirteen seedlings illustrated (Pl. XIX) were selected from a representative lot of twenty-eight, which were growing in scattered clusters in the shade beneath the parent tree. The tallest specimen (Pl. XIX, fig. A) was 7.5 centimeters in height, measured from the cotyledonary node to the uppermost visible node. The most vigorous specimen (Pl. XIX, fig. C,—drawn on a larger scale for the sake of a clearer presentation of certain details) measured 7 centimeters in height. Seedlings from the

---

Explanation of the Figures. Plate XIX

A. Normal seedling from a medium-sized embryo with unequal cotyledons. Shoot 7.5 cm. in height.

B. Twin seedlings from a 3-cotyledonous embryo. Seedlings connate at the cotyledonary node. Cotyledons very unequal; *t*, testa; *a, b, c*, cotyledons.

C. Vigorous seedling from the largest embryo of a seed. Shoot forking at second epicotylary node. Twin primary roots.

D. Seedling from a large embryo. Twin primary roots.

E. Interlocked seedlings (*x, y*) from two embryos of the same seed; *x*, two unequal shoots from the epicotyl of the smaller embryo, the cotyledons of which are *a, b, c*, and the primary root, *r*; *y*, well developed shoot from the larger embryo, the cotyledons of which are *d, e, f*, and the primary root, *s*.

F. The smaller seedling of Fig. E, showing the two shoots, *x*, springing from the epicotyl, the three unequal cotyledons, *d, e, f* (corresponding to *d, e, f* in fig. E), and the forking primary root, *r*.

G. Opposite side of the seedling shown in fig. F, with the cotyledons correspondingly labeled.

H. Part of the larger seedling, *y*, of fig. E, showing the three unequal cotyledons (labeled correspondingly).

I. Normally developed seedling from one of the larger embryos of a seed, with unequal polyhedral cotyledons.

J. Seedling from one of the smaller embryos, with twin primary roots. Cotyledons unequal and polyhedral.

K. Seedling from a large embryo, with two unequal and arrested primary roots.

L. Young normal seedling from a large embryo. Cotyledons nearly equal in size but of irregular shape.

M. Part of a large seedling from a large embryo. Closely appressed against its cotyledons is a small seedling from a minute embryo of the same seed; *a*, epicotyl; *r*, part of the primary root; *c*, the cotyledons of the larger embryo, closely appressed against each other on one side of the seedling; *s*, cotyledons of the smaller embryo.

Plate XIX. Seedlings of Eugenia Hookeri.

smallest embryos were but a few millimeters in height; one such specimen, 12 millimeters in height, is shown (Pl. XIX, fig. J).

Of these twenty-eight seedlings, six had large cotyledons of unequal size. In five others the cotyledons were small, and in the remaining seventeen seedlings the cotyledons were of intermediate size. The size of the cotyledons, however, did not appear to have had any bearing on the size of the seedlings. It should be remarked in passing that the cotyledons are hypogeal, and that the extreme differences in size and shape is due to their close packing in the seed. Cotyledons of equal size in the same embryo are not uncommon, although more frequent in smaller embryos than in larger ones. Tricotyledonous embryos are also not infrequent, and some seedlings from such embryos are herein figured and described.

The primary root was in general well developed,—to the length of the shoot or longer (Pl. XIX, figs. A, B, C). But in some instances it was remarkably short, as if arrested early in its development. In one small seedling in particular two such primary roots were present, but were very unequal in length (Pl. XIX, fig. K). There were several seedlings with twin primary roots of considerable length, more or less equally developed. (Pl. XIX, figs. C, D, J.) In these cases only a single shoot had developed from the epicotyl. In one instance, a small tricotyledonous seedling interlocked with a larger one, twin shoots arose from the epicotyl, and the primary root forked into two approximately equal branches a short distance from the tip of the hypocotyl. The three cotyledons and the twin shoots suggest a condition of connate embryos (Pl. XIX, figs. E, F, G). But a clearer case of twin seedlings, each with its distinct primary root, was found, in which the twins were connate at the cotyledonary node only, and in this case there were also three cotyledons present (Pl. XIX, fig. B). Interlocked seedlings, as might be expected under the circumstances, were not uncommon, and most of them were difficult to separate in order to determine to what extent, if any, they were connate. It was especially difficult in the case of seedlings from the small embryos. In the vigorous seedling already mentioned (Pl. XIX, fig. C) the shoot forked at the second node above the cotyledonary node, the branches being equally well developed.

Seedlings which showed none of the pecularities above described were frequent. These may be said to be normal, except that the cotyledons were frequently very unequal in shape and size (Pl. XIX, fig. A, I, L). In every seedling examined the lower leaves were minute scale-like organs.

University of California at Los Angeles,
March, 1937.

THE MARITIME FRANSERIA OF THE PACIFIC COAST

IRA L. WIGGINS AND PALMER STOCKWELL

Since Nuttall described *Franseria bipinnatifida* in 1841 it has been accepted generally as being distinct from *F. Chamissonis* Less. In 1907 Dr. Harvey M. Hall suggested that *F. bipinnatifida* was probably not specifically separable from *F. Chamissonis.*[1] However, Dr. Hall and other botanists of the Pacific Coast continued to accord it specific rank, the segregation based primarily on the twice or thrice pinnatifid leaves.

At the suggestion of Dr. L. R. Abrams of Stanford University experimental work was done to test the hypothesis that the races mentioned are variants of one ecospecies.

Through the courtesy of the staff the plants were grown and the cytological work was done at the laboratory of the Carnegie Institution of Washington on the Stanford University campus. Professor James McMurphy of Stanford University very kindly furnished greenhouse space and care for some of the cultures.

Seventeen crosses were made. Five were *F. Chamissonis* on *F. bipinnatifida,* five reciprocal, four *F. bipinnatifida* on *F. bipinnatifida,* and three *F. Chamissonis* on *F. Chamissonis.* In all cases there was some variation in the F_1 progeny. When *F. Chamissonis* and *F. bipinnatifida* were crossed the F_1 hybrids showed as much variation in the small numbers raised as would be expected in F_2 hybrids. One cross was carried on to the F_2 generation. The male parent, *F. Chamissonis,* from Half Moon Bay was collected by Wm. Hiesey; the female parent, *F. bipinnatifida,* was collected by D. D. Keck (no. 2197) five miles north of Cambria. The chromosome number of each was $2N = 36$. Two hybrid offspring, intermediate in leaf character, were chosen; one was used as the male and the other as the female parent. The chromosome number of each was $2N = 36$ and $N = 18$. Further, M_1 and M_{11} were normal and regular. On October 5, 1935, 104 seeds were planted in a flat from which 79 plants were harvested and pressed about June 20, 1936. Of these, 11 had leaves entire, or nearly so; 36 had coarsely cut leaves; and 32 had finely cut leaves.

These tests, as well as field observations, indicate that in most places the maritime *Franseria* is heterozygous and unstable. The leaf form with associated characters is dependent on genetic constitution, and this, of course, is dependent on chance. Maintaining these forms as species does not seem to be justified as they cross freely; one form swamping out the other at times, but both being found from British Columbia to southern California. They have the same chromosome number, both mitosis and meiosis are normal, and cytologically they are indistinguishable. Therefore, the following taxonomic treatment of these subspecies is proposed.

[1] Hall, Harvey M. Univ. Calif. Publ. Bot. 3: 121. 1907.

1. Franseria Chamissonis subsp. **typica** nom. nov. *Franseria Chamissonis* Less. Linnaea 6: 507. 1831. *Franseria Chamissonis* var. *malvaefolia* Less. Linnaea 6: 507. 1831. *Franseria cuneifolia* Nutt. Trans. Am. Phil. Soc. ser. 2, 7: 345. 1840. *Franseria Chamissonis* var. *cuneifolia* Torr. & Gray, Fl. N. Am. 2: 293. 1842. *Gaertneria Chamissonis* Kuntze, Rev. Gen. 339. 1891. *Ambrosia Chamissonis* Greene, Man. Bay Reg. Bot. 188. 1894.

Leaves serrate to the cuneate base; bur channeled above.

Sandy coastal regions, San Clemente and San Miguel Islands, and from middle California to Washington.

2. Franseria Chamissonis subsp. **bipinnatisecta** comb. nov. *Franseria Chamissonis* var. *bipinnatisecta* Less. Linnaea 6: 507. 1831. *Franseria bipinnatifida* Nutt. Trans. Am. Phil. Soc. II. 7: 344. 1840. *Franseria Lessingii* Meyen & Walp.; Walp. Nova Acta Acad. Leop. Carol. 19: Suppl. 268. 1843. *Gaertneria bipinnatifida* Kuntze, Rev. Gen. 339. 1891. *Ambrosia bipinnatifida* Greene, Man. Bay Reg. Bot. 187. 1894. *Franseria bipinnatifida dubia* Eastw. Proc. Calif. Acad. ser. 3, 1: 117. 1898. *Gaertneria bipinnatifida dubia* A. Heller, Muhl. 1: 6. 1900. *Franseria bipinnatifida villosa* Eastw.; Rydb. N. Am. Fl. 33: 26. 1922, as synonym. *Franseria villosa* Rydb. N. Am. Fl. 33: 26. 1922.

Leaves once to thrice pinnatifid, bur ovoid but more slender than in *typica* with spines sub-terete and usually only slightly channeled above.

Range: British Columbia to Lower California. The South American form seems to be this subspecies or a variant thereof, and may be an introduction.

Stanford University, California.
February 10, 1937.

ON THE POLLEN OF THE MIMOSOIDEAE AND THE IDENTITY OF THE SUPPOSED ALGA PHYTOMORULA

Herbert F. Copeland

The state of California harbors a few native species of Mimosoideae, together with a large number of introduced species, including about three of *Albizzia* and more than three-score of *Acacia*. It may not be inappropriate to summarize what is known about the remarkable clusters of pollen grains produced by some of the members of the group. The existence of these clusters is no new discovery: it is noted in several of the standard reference works (1, 8, 10, 11); it has been reported for Californian material by Rowe (7); it has been known for more than a hundred years.

I have not been able to confirm a reference to the writings of Köhlreuter. The oldest paper which I have seen that describes these clusters is by von Mohl (4), who distinguished a variety of types of clusters almost exactly as they are known up to the present.

Rosanoff (6) added examples to the types already distinguished by von Mohl, and studied the development; his account of the process in the majority of the species may be transcribed into modern terms as follows. In each microsporanguim, all of the archesporial cells except two become sterile. The two fertile cells divide once, twice, or three times, forming clusters of two, four, or eight microspore mother cells. Each of the latter forms a tetrad of microspores. The outcome is the production, by each anther, of eight clusters of pollen grains, each cluster consisting of eight, sixteen, or thirty-two grains. (It is evident that by homology each unit of the cluster is a pollen grain. We should not regard the whole cluster as a single grain, though some authors have done so.) As an anomalous exception, Rosanoff found in a few species clusters of twelve pollen grains; these, it is evident, represent clusters of three pollen mother cells derived from single fertile archesporial cells.

Wodehouse (11) brought to the description of these clusters an extensive knowledge of the systems of grooves on the surfaces of pollen grains. He interprets the quadrate markings found on the exposed surfaces of the grains of *Acacia* as representing his dodecacolpate (12-grooved) system. In the species commonly known as *Acacia Farnesiana,* he finds the grains hexacolpate (6-grooved); this seems sufficient justification for his excluding it from *Acacia,* under the old name *Vachellia Farnesiana* Wight & Arnold.

What remains to be accomplished is a correlation of the characters of the clusters and grains with the classification of the group. Rosanoff remarked of the variety of types of clusters that it "dient noch einmal als Bestätigung des alten Satzes von Köhlreuter, dass die Aehnlichkeit der Pollenkörner nicht immer mit dem Umgrenzung der Verwandtschaftskreise zusammenfällt." This in effect gave the taxonomists license to pay no attention to the pollen grains; and they seem to have taken advantage of it. But Rosanoff wrote at a time when the limits of the most familiar genera, *Mimosa, Acacia,* and *Albizzia,* were not understood; and I have encountered a number of facts which suggest that when all of the genera are well understood the type of pollen will be found uniform in each. Thus as noted above, when Wodehouse found the Farnesian species to differ from *Acacia* in a character of the pollen, he found also that it had long before been excluded from *Acacia* on the basis of other characters. Again, Merrill removed the rain tree (a common ornamental in the tropics) from *Pithecolobium,* and placed it in another genus as *Samanea Saman;* its pollen grains are in clusters of thirty-two, instead of sixteen as in the only species of *Pithecolobium* I have examined. Most species of *Inga* seem uniform in type of cluster; but von Mohl, dealing with *I. anomala,* and

Rosanoff, dealing with *I. tergemina,* found in these species a quite distinct type. I have myself found this type in *Calliandra grandiflora;* and I cannot but suspect that the peculiar species of *Inga* might better be placed in *Calliandra.* But the re-shuffling of the group cannot be attempted at this time. More than thirty genera are recognized in the Mimosoideae; we know by observation in California how numerous in species *Acacia* is; and a glance at the literature shows that *Inga, Pithecolobium, Enterolobium,* and *Calliandra* are comparably numerous.

The following outline of the pollen types is based primarily on my own observations; the examples which I have seen are marked with exclamation points. All the observations were made on herbarium material. The pollen is most easily seen by dissecting out and crushing the anthers of buds which are just in the act of opening. From among the many examples offered by the older authors I have cited but few, because I do not trust the generic names they used.

I. THE GRAINS OR CLUSTERS NUMEROUS IN EACH ANTHER

Grains solitary: *Leucaena glauca! Desmanthus* spp. and *Entada* spp., *fide* von Mohl, Rosanoff, and Wodehouse; all species of *Prosopis, fide* Wodehouse; some species of *Mimosa, fide* Rosanoff.

Grains in tetrads: *Mimosa pudica* and other species, also *Schrankia unciniata, fide* Rosanoff.

Grains in octets: *Schrankia* sp., *fide* Rosanoff.

II. THE GRAINS IN CLUSTERS; CLUSTERS EIGHT IN EACH ANTHER

The tetrads tetrahedral, so that the grains lie in more than one plane.

1. The grains interpretable as dodecacolpate, each having a quadrate marking (sometimes seen as circular) on the exposed surface.
   a. Grains in octets: *Acacia armata! A. tenuifolia* (Pl. XX, fig. 1)! and various other species, *fide* von Mohl and Rosanoff.
   b. Grains in clusters of twelve: *Acacia rutaefolia, A. pentadenia,* and *A. pulchella, fide* Rosanoff.
   c. Grains in clusters of sixteen, the greatest dimension of the cluster 30–50 microns. Throughout the family, clusters of sixteen or more grains are always of a lenticular form, half of the grains forming a circumferential belt, while the rest are in two clusters, one on each of the broad surfaces. The limits of the tetrads are obvious, each consisting of two adjacent circumferential cells and one cell from each of the superficial groups. *Acacia Baileyana* (Pl. XX, fig. 2)! *A. cultriformis! A. decurrens* var. *dealbata! A. elata! A. longifolia! A. melanoxylon! A. neriifolia! A.*

podalyriaefolia! A. retinoides! A. verticillata! and various other species, *fide* von Mohl and Rosanoff. The only species outside of *Acacia* which is known to me as probably belonging here is *Archidendron Vaillantii;* Taubert's figure (after von Mueller) appears to show the quadrate surface markings.

2. The grains hexacolpate, the exposed surfaces divided into three prominent protuberances; grains in clusters of sixteen: *Vachellia Farnesiana!*
3. The grooves essentially obsolete, so that the grains appear smooth.
   a. Grains in clusters of sixteen, of which the greatest dimension is 75–100 microns: *Albizzia Acle! A. Julibrissin* (Pl. XX, fig. 3) ! *A. Lebbek! A. lophantha! Inga myriantha, fide* Wodehouse; *Pithecolobium dulce!*
   b. Grains in clusters of thirty-two, greatest dimension 90–160 microns: *Inga cordistipula, fide* Taubert after Bentham (actually seven tetrads, not eight, are shown) ; *I. edulis! I. spectabilis, fide* Rosanoff (as an individual variation, some clusters of thirty-six grains) ; *Samanea Saman!* (Pl. XX, fig. 4).

Cells of the tetrad lying in one plane; tetrads always two, so that the cluster is a flat plate of eight. The clusters are exceedingly large, to 250 microns long; the two ends are not alike, so that the outline in surface view is lanceolate. Von Mohl reported a cluster of minute cells, serving as a clinging organ, at the pointed end. Rosanoff could see nothing but the naked point. My own understanding of the situation is as follows. The pointed end is, in the anther, pressed against a large sterile cell. Under some circumstances it may break completely free; under others, it may be found attached to a scrap of cell wall. *Inga anomala, fide* von Mohl; *I. tergemina, fide* Rosanoff; *Calliandra grandiflora!* (Pl. XX, fig. 5).

On the basis of these data, one may point out a few mistakes, of observation or of interpretation, which have been published.

Rowe's figure of pollen of *Acacia* is readily recognizable but is not strictly accurate. It duly shows the quadrate protuberances on the four cells occupying one surface of the cluster. But as to the belt of circumferential cells, it shows protuberances, not on the edges, but on the surfaces toward the observer. Von Mueller's figure for *Archidendron Vaillantii* shows the same feature, and is presumably in error in the same way.

Pope (5), referring to *Acacia mollissima* (the name is a synonym of *A. decurrens*), describes "Grains . . . almost spherical; surface reticulated, reticulations forming large 4-sided facets." It is evident that she has mistaken the cluster of sixteen grains for a single grain.

Some twenty years ago, Kofoid (2) described and illustrated certain sixteen-chambered structures found by him in a reservoir in Berkeley during the month of March (when, according to Rowe, *Acacia* pollen is most abundant). He looked about, naturally, for something with a family resemblance to these structures, and there was nobody to call to his attention the Mimosoideae; he recognized *Coelastrum* as something similar, and described his material as a new alga, *Phytomorula regularis.* More recently, Smith (9) has reported and illustrated an additional collection of *Phytomorula* (at Stanford University, according to a personal communication from Dr. Smith). The two accounts refer to things slightly different in size and shape, but within the range of the size and shape of clusters of *Acacia* pollen, and consisting of units arranged as in *Acacia* pollen. Kofoid's illustration shows on each cell a minute dome-shaped protuberance; Smith's shows a large one; the protuberances as shown do not agree well with each other, nor with the large quadrate protuberances on the pollen grains of *Acacia.* I have not been able to explain these discrepancies; possibly they depend on conditions of exposure. I am confident, however, that *Phytomorula* as published respectively by Kofoid and Smith is the pollen of two different species of *Acacia.*

Sacramento Junior College,
Sacramento, California, March, 1937.

Literature Cited

1. Fitting, H., and others. Eduard Strasburger's Lehrbuch der Botanik . . . 18 Auflage. Jena. 1931 (I have not studied the many editions of this standard text, to determine in which one the clustered pollen grains of the Mimosoideae were first mentioned. It was a later one than the second (1895) but presumably earlier than the one here cited).
2. Kofoid, C. A. Phytomorula regularis, a symmetrical protophyte related to Coelastrum. Univ. Calif. Publ. Bot. 6: 35–40, t. 7. 1914.
3. von Mohl, H. Über den Bau und die Formen von Pollenkörner. Bern. 1834. *non vidi.*
4. ——————. Sur la structure et les formes des graines de pollen [Abstract, in French, of the above, by Leret]. Ann. Sci. Nat. 2e sér. 3: 148–180, 220–236, 304–346, tt. 9–11. 1835.
5. Pope, M. A. Pollen morphology as an index to plant relationship. Part II. Key to the families. Univ. Colorado Studies 15: 171–215. 1926.
6. Rosanoff, S. Zur Kenntniss des Baues und der Entwicklungsgeschichte des Pollens der Mimoseae. Jahrb. wiss. Bot. 4: 441–450, tt. 31, 32. 1865.
7. Rowe, A. H. A study of the atmospheric pollen and botanic flora of the east shore of San Francisco Bay. Journ. Lab. and Clin. Med. 13: 416–439. 1928.
8. Schnarf, K. Vergelichende Embryologie der Angiospermen. Berlin. 1931.
9. Smith, G. M. Fresh-water algae of the United States. New York. 1933.
10. Taubert, P. Leguminosae. In A. Engler and K. Prantl. Die Natürlichen Pflanzenfamilien 3[3]: 70–385. 1894.
11. Wodehouse, R. P. Pollen grains, their structure, identification and significance in science and medicine. New York. 1935.

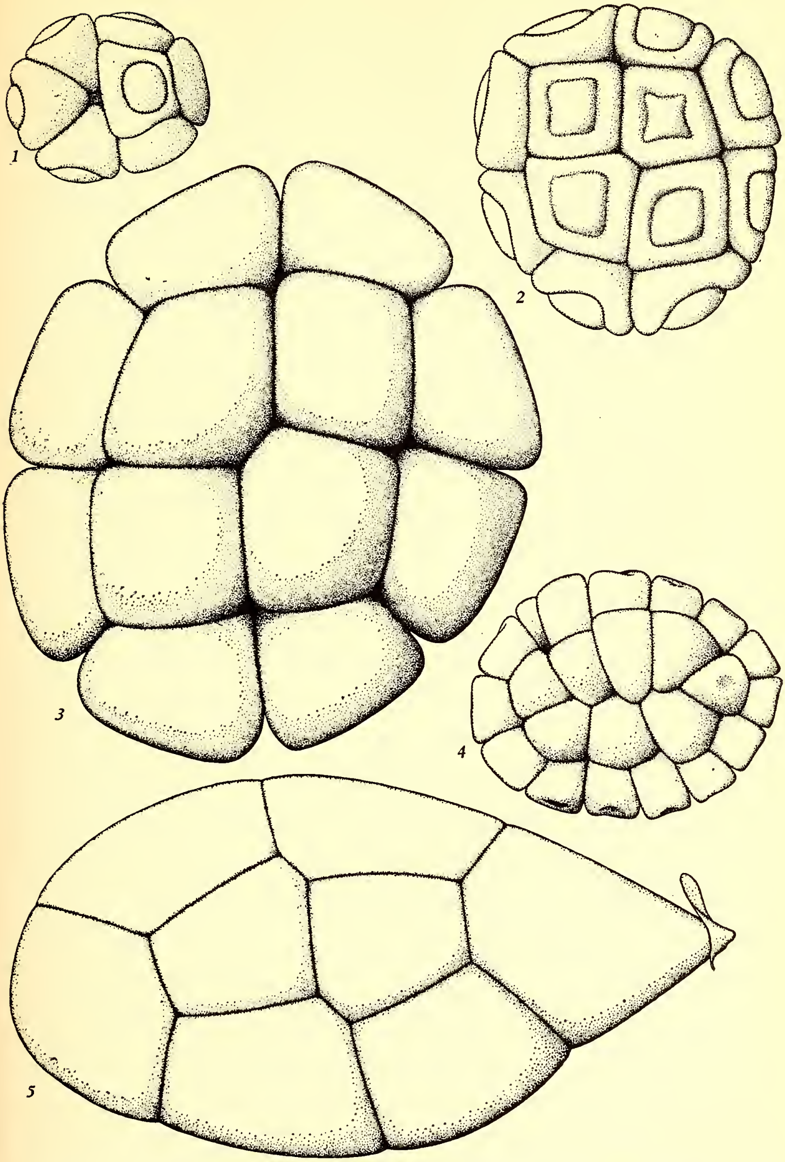


Plate XX. Clusters of pollen grains of certain Mimosoideae. Fig. 1. *Acacia tenuifolia* × 800. Fig. 2. *Acacia Baileyana* × 800. Fig. 3. *Albizzia Julibrissin* × 800. Fig. 4. *Samanea Saman* × 400. Fig. 5. *Calliandra grandiflora* × 400.

NATHANIEL LYON GARDNER

(1864–1937)

There has been removed from our society Nathaniel Lyon Gardner, Professor of Botany, Emeritus, of the University of California. Born in Keokuk, Iowa, on February 26, 1864, he passed away at his home in Berkeley, California, on Sunday, August 15, 1937. His death resulted from a major cerebral hemorrhage after several minor attacks, especially in the optic tract, through a number of years, and which had disabled him and prevented him from carrying on his studies for several months. He was married in 1915 and is survived by his wife, Edith Jordan Gardner, daughter of the late David Starr Jordan, eminent educator and ichthyologist.

The early education of Dr. Gardner was carried on in Iowa, but, after he began to teach school, he removed to Island County, Washington, and continuing his interest in the flora which he had begun in Iowa, sent specimens of various groups of plants to eminent authorities for determination. It was in April, 1897, that while teaching school on Whidbey Island, Washington, he wrote to the writer, asking him as to whether he would be willing to name some specimens of the marine algae of the shores of that island. The request came at a crucial time in the writer's work, when the questions of the algae described from the Puget Sound region and north were becoming critical in his own studies. Nothing had been done in the way of collection or study in this region for about thirty years. It is evident that an enthusiastic and appreciative answer was dispatched and there began a scientific cooperation which has lasted during these past forty years. Through this association much has been done towards making known the rich and peculiar marine flora of the Pacific coasts of North America and work was still actively going on until the afflictions of eye and general bodily health put an end to our mutual effort. In fact, Gardner was carrying on the main work on Pacific Coast algae while the writer pursued more and more studies on the tropical marine floras of the Indo-Pacific region.

In his attempt to prepare himself for better research work, Gardner, soon after the initiation of our correspondence, took up residence at the University of Washington, from which institution he received the degree of bachelor of science in 1900. From 1900 to 1906 he acted as Assistant in Botany at the University of California, advancing to the degree of master of science in 1903 and to that of doctor of philosophy in 1906. Leaving the University of California in the latter year, he became Head of the Department of Biology in the Polytechnic High School of Los Angeles. He returned to the University of California in 1909–1910 as Acting Assistant Professor of Botany, and became regular Assistant Professor in 1913. In 1923 he was appointed Asso-

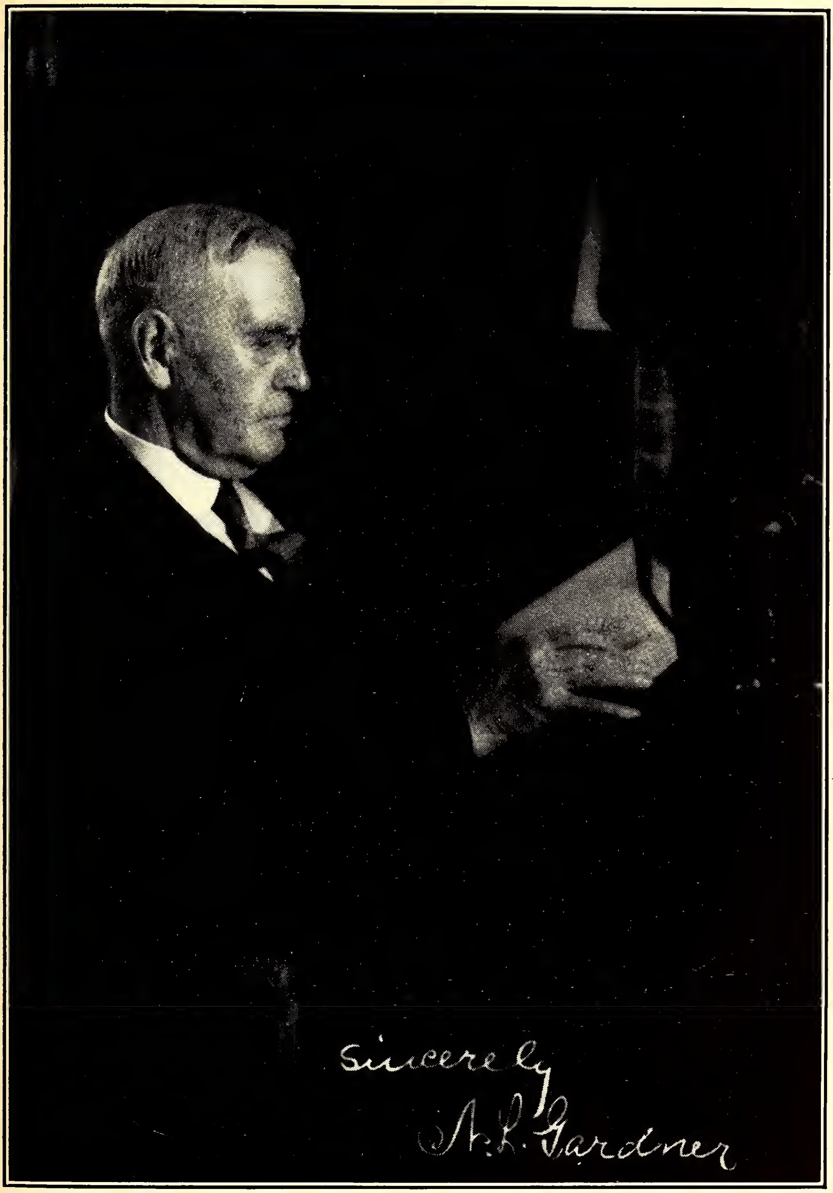


PLATE XXI. NATHANIEL LYON GARDNER.

ciate Professor of Botany, becoming Emeritus in 1934. From 1920 to 1934 he served as Curator of the Herbarium of the University of California; in 1934 he became Curator, Emeritus.

The scientific activities of Dr. Gardner were largely devoted to the algae and he was primarily a phycologist, first, and always exceedingly active in the field, collecting both the marine species and those of the fresh waters. His specimens were selected and prepared with great care and discrimination, as well as in large numbers for each collection. The fresh-water species, particularly those of the blue-green algae, were grown in his laboratory, especial pains being taken to obtain cultures purely or predominatingly of one species and under normal conditions. Many of his cultures of blue-green algae were carried on for years and his experience led him to reject the ideas of even moderate polymorphism among members of this group, an idea so readily assumed by many writers.

From his abundant collections and his careful study of them, his conceptions of species were narrow rather than broad and he could demonstrate from his ample material his precise idea of amplitude of variation and more particularly of its limits. His very last studies were concerned with the Pacific North American species of the genus of red algae, *Iridophycus,* and his extensive field studies were correlated with no less ample studies of their histology and development.

He was a world authority on the blue-green algae and published a series of cytologic and taxonomic studies such as his "Cytological Studies in Cyanophyceae" (1906) and his "New Myxophyceae from Porto Rico" (1927).

His studies on various green algae, particularly marine species, were numerous and thorough and he added much to both our general knowledge and to our more accurate knowledge of the green algae of our Pacific coasts.

Of the brown algae, he made extensive studies of the species of our coasts, detecting, describing, and figuring an incredible number of minute epiphytic forms, all hitherto undescribed. He also studied the large forms of the brown algae in a similar fashion, particularly the Fucales (or rockweeds), collecting abundantly of them from Sitka, Alaska, to Enseñada, Mexico. His "Variations in nuclear extrusion among the Fucaceae" (1910) and his "The genus *Fucus*" (1922) are only two of his outstanding contributions. He also described two new fossil Fucales from the Miocene of California.

Among the red algae, he felt less at home, but nevertheless he made great progress and was becoming more confident in general, while in particular genera he was perfectly equipped.

His work on fungi, while considerable, was only incidental. He published only one paper dealing with them but he was a most successful collector of hypogaeous forms, such as the Tuberales, Hymenogastrales, etc., and contributed much that was novel in his collections.

From 1903, much of his publication was done conjointly with the writer but the greater part of the detailed work was done by him. There are, however, approximately thirty larger and more important papers for which he was willing to assume the sole responsibility.

At his death he was working hard to complete the final volume of "The Marine Algae of the Pacific Coast of North America," a work including the practical monographing of a number of large polymorphous genera of difficult red algae of wide distribution. His thoroughness and patience showed at their best in this work.

As a teacher, he was quiet and meticulous, not so successful with large classes but, with small groups, his pupils received the utmost attention and serious students appreciated his methods.

He was assiduous in exploring and devising methods for the culture of his algae, for their proper preservation for future examination, and for all methods of microtechnique, fixing, staining, sectioning, as well as obtaining the best possible optical demonstration of their habit and structure.

Personally, Dr. Gardner was of a retiring disposition, content to carry on his work and his studies without "fuss or flurry." He was always willing to interrupt his own work to help a worthy beginner or more advanced student and gave freely of his own resources, both material and intellectual. His was not an enthusiastic nature, but rather deliberate, weighing the possible adverse features; but his friendship, once given, was strong and enduring, not of outward demonstration, but of faithful devotion.—W. A. Setchell.

A NEW PENSTEMON FROM THE CHARLESTON MOUNTAINS, NEVADA

Ira W. Clokey

Penstemon Keckii sp. nov. Herba perennis maximam partem glaucescens; rhizoma ramosa; caules erectiusculi diluto-virides vel interdum purpureo-tincti, infra glabri vel minute scabridi, supra usque ad inflorescentem minute sparseque stipitato-glandulosi; folia pallido-viridia integra glabra, margine plus minusve scabrido; folia basalia atque ea surculorum sterilium 2–6 cm. longa oblanceolata, apice obtusa vel rotundata, in petiolum alatum gradatim attenuata; folia caulina lanceolata sessilia; racemus angustus; pedicelli 3–4 mm. longi sparse glanduloso-puberulenti radiati demum sursum curvati; sepala 4–6 mm. longa sparse glanduloso-puberulenta ovata acuta vel obtusa, margine scarioso; corolla 17–23 mm. longa, faucibus 6 mm. latis, infundibuliformis aequibilabiata, extus glandulosa, intus basi labri superiori excepto, eglandulosa, limbo atrocaeruleo, labro inferiore ad medium inciso, pilis albis complanatis faucibus prominente barbatis; stamina didynama, staminibus superioribus corollae faucis excedentibus, inferioribus inclusis; loculis antherarum 1.5 mm. longis late divaricatis fulvis glabris, de apice ad basin dehiscentibus non confluentibus, suturis denticulatis; staminodium staminibus inferioribus paullo brevius, apice dilatum pilis luteis rigidiusculus 0.6 mm. longis dense barbatum; capsula ovata acuta 10–12 mm. longa.

Perennial with branching rootstock; herbage usually glaucescent; stems commonly 8–15 cm. high but up to 25 cm., not strictly erect, light green or sometimes purplish tinged, lower part glabrous or minutely scabridulous, becoming minutely and sparingly stipitate-glandular towards and within the inflorescence; leaves light green, entire, glabrous excepting the more or less scabridulous margin; basal leaves and those of the sterile shoots 2–6 cm. long, oblanceolate, obtuse or rounded at the apex, very gradually reduced to a winged petiole; cauline leaves in two or three pairs, sessile, lanceolate; inflorescence a narrow raceme occupying ½ to ⅔ of stem; pedicels sparingly glandular-puberulent, radiating then curving upwards so that the flowers are erect, 3–4 mm. long; sepals sparingly glandular-puberulent, ovate, acute or obtuse, scarious margined, 4–6 mm. long; corolla deep blue 17–23 mm. long, 6–9 mm. wide at throat, funnel-shaped, the tube exceeding the calyx, glandular externally, glandular within only at base of upper lip; corolla-limb of two equal lips, the lower prominently bearded at junction with throat with flattened white hairs, the lobes cleft about ½ the length of the lips; upper pair of stamens exceeding throat, shorter pair included; anther sacs widely divaricate, buff, 1.5 mm. long, glabrous, dehiscent from the distal apex essentially throughout, not confluent, the suture denticulate; sterile filament reaching orifice, dilated apically, densely bearded dorsally for most of its length with relatively short (0.6 mm. long) stiffish yellow hairs; capsule ovate, acute, 10–12 mm. long.

Deep gravelly, brushy meadow in the bed of Lee Canyon, Charleston Mountains, Clark County, Nevada, altitude 2570 meters, July 3, 1936, *Clokey 7312* (type, Clokey Herbarium, South Pasadena, California; cotypes being distributed in *Exsiccatae Grayanae*). Other collections from the Charleston Mountains which represent *Penstemon Keckii* are: Lee Canyon, August 1, 1935, *Clokey 5579* (topotype), Charleston Peak, altitude 3150 meters, August 8, 1935, *Clokey 5592,* Rainbow Falls, altitude 2670 meters, July 27, 1936, *Clokey 7311.*

This is essentially a subalpine species and is widely but sparingly scattered either on open hillsides or associated with *Pinus aristata* Engelm. It extends, however, some distance below the subalpine zone. At the Lee Canyon station, where it is fairly abundant in an area about 200 yards across, the plants average somewhat larger than those in the subalpine zone; here *Penstemon Keckii* is associated with *Pinus scopulorum* (Engelm.) Lemmon.

Penstemon Keckii belongs to the subgenus *Glabri*. Dr. Keck suggests that this plant "is most closely related to *P. speciosus* Dougl. which, in the broad sense, extends from arid eastern Washington, southward through Oregon and the Sierra Nevada to Mount Piños in California and southern Esmeralda County in Nevada." In addition to being widely separated geographically from *P. speciosus*, *P. Keckii* is smaller and occurs at a higher elevation. The following key may serve to separate the two species:

Inflorescence glandular, corolla glandular without and within, copious beard at base of lower lip, sterile stamen strongly bearded .... *P. Keckii*
Inflorescence and corolla not glandular, the latter sometimes with a sparingly bearded throat and sterile stamen .... *P. speciosus*

In appreciation of the work he is doing with western *Penstemon*, it is a pleasure to name this species for Dr. David D. Keck of the Carnegie Institution of Washington at Stanford University.

South Pasadena, California,
June, 1937.

A NEW CALIFORNIAN SPECIES OF BRODIAEA

Robert F. Hoover

Brodiaea appendiculata sp. nov. Cormo magno, sine propagulis, cum tunica crassa fibrosa circum scapum foliaque extendente; foliis 2–4, angustis; scapo 10–40 cm. alto; perianthio infundibuliforme; tubo perianthii cylindrico, basi rotundo, 8–10 mm. longo, in fructo membranaceo; segmentis rectis, 15–20 mm. longis, exterioribus oblongis, acutis, interioribus latioribus obtusis; staminodiis linearibus, 8–12 mm. longis, obtusis vel retusis, margine involutis undulatis; filamentis 4–5 mm. longis, margine alatis, apice biappendiculatis; appendiculis linearibus, 3–5 mm. longis, undulatis; antheris 7–8 mm. longis; capsula subglobosa, apice acuta; seminibus in quoque loculo circa 5.

Corm large, deep-seated, without offsets, with a heavy coat of brown fibers which extends as a sheath around the subterranean portion of the scape and leaves; leaves 2–4, narrow; scapes stout, 1–3 from a corm, 10–40 cm. tall; umbel 3–10 flowered, the pedicels 3–9 cm. long, widely divaricate in age; perianth funnelform; perianth tube cylindric, rounded at base, green, 8–10 mm. long, in fruit membranaceous, finally brittle; segments straight (that is, not recurved), 15–20 mm. long, purple with dark mid-vein, the outer oblong, acute, the inner broader and obtuse; staminodia purple with white tips, linear, obtuse or retuse, 8–12 mm. long, with involute and undulate margin, approximate around the anthers; stamens shorter than staminodia; filaments 4–5 mm.

long, purple, wing-margined, bearing at apex two appendages which extend along the backs of the anthers; appendages linear, undulate, pale purple or white, 3–5 mm. long, about half as long as the anthers; anthers 7–8 mm. long, deeply notched at both ends; capsule subglobose with acute apex; seeds about five in each cavity.

Type: Warnerville, Stanislaus County, April 29, 1936, *Hoover 1040*.

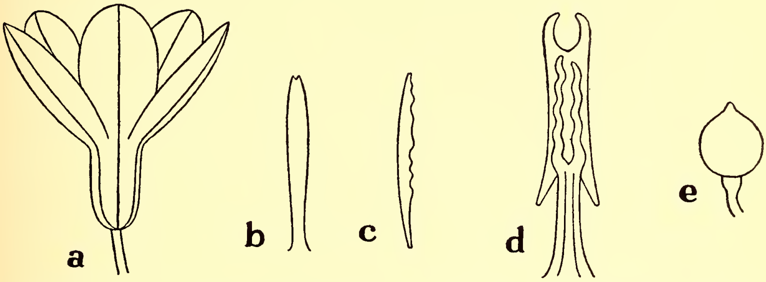


Fig. 1. *Brodiaea appendiculata* Hoover. Outline drawings based on fresh plants: *a*, external view of perianth ×1; *b*, dorsal view of staminodium ×2; *c*, side view of staminodium ×2; *d*, dorsal view of stamen ×3; *e*, mature capsule ×1.

Brodiaea appendiculata is common in the lower Sierra foothills and on the bordering valley plains from Sacramento County to Fresno County. It occurs also, but is apparently rare, in the central Coast Ranges.

Herbaria indicated in the citations below are abbreviated as follows: University of California (UC); California Academy of Sciences (CA); herbarium of W. L. Jepson (J); Dudley Herbarium of Stanford University (S).

Specimens examined. Sacramento County: Sacramento, May, 1919, *Georgia Bentley* (S), *Hoover 1130* (J). Amador County: *Jepson 9957, 9965* (J). Calaveras County: Burson, *Jepson 9954* (J); Jenny Lind, May 14, 1923, *W. P. Steinbeck* (CA). San Joaquin County: Linden, May, 1896, *Gunnison* (UC); Peters, *E. E. Stanford 952* (S); Farmington, *Hoover 1058* (UC). Tuolumne County: Sonora, April 10, 1925, *E. A. Green* (S); open wooded hill slopes near Bear Creek, *Mrs. W. J. Williamson 49* (CA, S). Stanislaus County: Warnerville, April 29, 1936, *Hoover 1040* (type J, isotype UC); Oakdale, *Hoover 1020* (UC); Montpellier, *Hoover 590* (UC). Merced County: Snelling, *Hoover 964* (UC); Merced Falls, *Eastwood 4384* (CA); Merced, *Hoover 1079* (UC); dry rocky soil, edge of foothills, San Joaquin Valley, *J. T. Howell 9* in part (CA). Madera County: Madera, *Hoover 979* (UC). Napa County: Napa Valley, *Jepson 9981* (J). San Mateo County: Cedro field, Stanford University, May 31, 1922, *Bacigalupi* (S).

This species of the subgenus *Hookera* has long been known to the author, but since the characteristic stamen appendages were overlooked, it was thought to be a form of *Brodiaea synandra* (Heller) Jepson. As a distinct species it was first recognized in the field by W. L. Jepson, who made four collections of it in 1923 and at that time noted its distinctive characters. (W. L. Jepson, Field Book, vol. 39: pp. 171, 173, 177, 191, 199, ms.). The presence of appendages on the stamens has been noted previously only in *B. stellaris* Wats., a species occurring locally in the North Coast Ranges, which has broad appendages very different from the slender undulate ones of *B. appendiculata.* The short capsules serve to distinguish *B. appendiculata* from both *B. synandra* and *B. stellaris,* as well as from other species with which it might be confused. The corms are more deeply seated and have heavier sheathing coats than in other species of *Brodiaea.* The horizontally spreading fruiting pedicels also, are distinctive; among other species of the genus they have been observed only in *B. minor* (Benth.) Wats.

University of California, Berkeley,
May 15, 1936.

REVIEW

Flora of southeastern Washington and of adjacent Idaho. By Harold St. John. Students' Book Corporation, Pullman, Washington. 1937. 531 pp. 14 figs. 1 map. Cloth, $3.50; paper, $3.00.

While Thomas Howell was bringing to conclusion his pioneer *Flora of Northwest America,* in 1901, there appeared a modest volume by Charles V. Piper and R. Kent Beattie, *Flora of the Palouse Region,* treating the 663 species and varieties found within a radius of 35 kilometers from Pullman, Washington. The authors expanded this, in 1914, into *A Flora of Southeastern Washington and Adjacent Idaho,* with descriptions of 1,141 species and varieties occurring naturally in the easternmost counties of Washington, from Spokane to Walla Walla, and a narrow strip of neighboring Idaho.

The present work is a lineal descendent of these earlier floras and frankly based upon them, covering the same area as the 1914 work, but it is not, in any sense, a compilation. Every description is original, drawn from the writer's wide field experience, or from personal consultation of specimens in numerous American and European herbaria. The preliminary study and writing has occupied seventeen years and the book affords ample evidence of the pains taken to make it clear, complete and in line with the most recent monographic treatments. A total of 1,473 species and subdivisions of species receives recognition and description.

St. John's flora embraces most of the desirable features to be found in a composite picture of the more recent manuals from the frontispiece map showing life zones in color, through the unusually complete glossary to the useful "Explanation of Authors' Names." The format follows the popular style inaugurated in W. L. Jepson's *Manual of the Flowering Plants of California,* but the genera and species are conveniently placed in strictly alphabetical order. A very clear and concise account of the physiography, the climate and the vegetational features of the area precedes the taxonomic treatment, but one might wish for more information as to the component floristic elements, their affinities and probable origin. C. Hart Merriam's "life zones" are accepted as being the best available indices of major plant environments.

The keys will, I think, evoke chief admiration! There are keys from one end of the book to the other and they approach mechanical perfection. The key to the families is helpfully illustrated with cuts of structures which usually confuse beginning students. *Salix* and *Antennaria* boast keys to the staminate plants and keys to the pistillate; the family Umbelliferae and the genus *Cogswellia* are provided with separate keys to the plants in flowering and in fruiting condition.

Charles Piper Smith is joint author of the treatment of *Lupinus* and J. H. Barnhart assisted with the bibliography of authors. Otherwise, the book is entirely its author's own and reflects his ideas and judgments throughout. It will be noted that more of Wilhelm Suksdorf's work has been taken cognizance of—even to the extent of accepting five of his *Amsinckia* species—than has been usual with American botanists. One recalls that St. John not only knew Suksdorf personally but that he was the man responsible for obtaining his priceless collection for the State College of Washington.

The original plan was to call the flora "Edition II" of Piper and Beattie's later book and the 1914 work is freely cited as "Edition I." However, St. John subsequently decided to omit the earlier authors' names and altered their title slightly, but continued to refer, rather ambiguously, to "Ed. I." Another title would have been preferable for the present work, and the idea was considered and discarded, although the use of such a name as "manual" might have made the similarity in names less confusing.

A tabulation of names reveals the following statistics: new species, 17; plants "doubtless new" but not described, 6; new varieties, 7; new forms, 7; new combinations, 39; new names, 4. The author states, by way of preface, "The writer does not subscribe to the recognition of minute genera and species . . . those minor elements so frequently announced as species by recent American botanists. The writer's concept . . . is not materially different from that of Piper." However, Piper's specific concept was vastly different when he proposed 48 new species of *Allocarya* from that when he wrote *The Flora of Washington;* St. John's treatments show a comparable unevenness. In his treatment of *Rosa,* St. John recognizes 8 species, 3 varieties and 3 "doubtless undescribed" species, and of these 4 species and 1 variety are described as new. George Neville Jones, during a recent study (*Madroño* 3: 120–135, 1935) saw the type collections of all of these but accepted only 9 species and 6 varieties of *Rosa* for the entire state of Washington.

The inclusion of more than forty *formae,* nearly half of them color-forms, is a precedent that few western botanists are likely to follow. That these may have a place in monographs seems defensible, but they seem completely out of place and pedagogically undesirable in a manual. Probably no one will criticize the adoption of the Englerian arrangement but not all will agree with St. John that the Engler and Prantl system "seems the best" arrangement of plant families.

However, the points taken issue with here are largely matters of individual preference and reflect the influence of one taxonomic school. St. John has been highly successful in producing a thoroughly workmanlike, up-to-date and usable flora for southeastern Washington, which will be of value to botanists everywhere but will be an especial boon to those teaching systematic botany within the area covered.—Lincoln Constance.

NOTES AND NEWS

Word has been received from Japan that Dr. William A. Setchell of the Department of Botany, University of California, Berkeley, was elected an honorary member of the Botanical Society of Japan at the general meeting held in Sapporo on July 29, 1937.

Dr. Francis W. Pennell, curator of plants at the Academy of Natural Sciences, Philadelphia, spent the months of June, July, and August collecting Scrophulariaceae principally in Montana, Idaho, Oregon, and Washington. An especial effort was made to follow the trail of Lewis and Clark through Idaho, and so to determine the type locality of *Penstemon fruticosus* (Pursh) Greene.

Miss Sarah C. Dyal, who is studying the Valerianaceae at Cornell University, has been visiting Pacific Coast institutions this summer. She assisted in the University of Wyoming summer school, and plans to spend the winter at Oregon State College, at Corvallis. In the spring, Miss Dyal hopes to gain further field knowledge of the genus *Plectritis* in California and the Northwest.

The Associate Students' store, University of California, Berkeley, reports that the *Manual of the Flowering Plants of California,* by W. L. Jepson, is now out of print. It is to be hoped that a new and revised edition of this valuable work will be soon forthcoming.

Dr. Artemio V. Manza, who received the degree of doctor of philosophy from the University of California in May, 1937, left Berkeley on August 11, 1937, for Canton, China, where he has accepted a position as Assistant Professor of Botany in Lingnan University. Dr. Manza came to this country about ten years ago from the Philippine Islands, first studying plant pathology and then specializing in phycology. He has done considerable work on the jointed corallines, a large group of red algae, recently publishing a revision of the genera in this group.

On September 8, 1937, Mr. and Mrs. Carl W. Sharsmith left Berkeley for Pullman, Washington, where Mr. Sharsmith will take up his duties as instructor in the Department of Botany and Curator of the Herbarium, State College of Washington. For the past two years he has been teaching assistant in systematic botany at the University of California, Berkeley, and for the past year Mrs. Sharsmith has been instructor in biology at Mills College, California.

Mr. Joseph A. Ewan has accepted a position in the Department of Biology, University of Colorado, Boulder. For several years he has been at the University of California, Berkeley, where he assisted Dr. W. L. Jepson with the *Flora of California.*

Mr. F. Raymond Fosberg, recently on the faculty of the University of Hawaii, has received a fellowship at the Morris Arboretum, University of Pennsylvania. Before leaving for the east in August, 1937, Mr. and Mrs. Fosberg spent several days visiting herbaria in Los Angeles and in the San Francisco Bay region.

A survey of the trees of Amador County has recently been completed by Mr. Guy Towsley, principal of schools in Jackson, California. The work was carried on under the guidance of Dr. E. E. Stanford, College of the Pacific, Stockton, California, and is filed in the library of that institution.

Dr. Ruth Harmon has been appointed instructor in bacteriology and botany at Mills College, California. Dr. Harmon, who received the degree of doctor of medicine at Friborg, Germany, will also assist in the Mills College clinic.

Dr. Walter Robyns, Director of the State Botanical Garden, Brussels, Belgium, visited the University of California on September 10, 1937. He is making a study of American and European herbaria and botanic gardens with a view to the reestablishment of the garden and herbarium at Brussels as the growth of that city has made it necessary to find a new location for the garden. Dr. Robyns has been commissioned by the Belgian government to visit our national parks in the interest of further development of the Parc National Albert at Kivu, Belgian Congo. On his trip west, he visited the parks in the northern part of the United States. On September 21 he sailed for the Hawaiian Islands where he will spend about ten days. Upon his return to this country, he will complete his tour of the national parks.

The following recently published monographic treatments are of interest to botanists of western North America:

"The genus Youngia," by Ernest B. Babcock and G. Ledyard Stebbins, Jr. Carnegie Institution of Washington, Publication No. 464, 106 pages, 5 plates, 31 text figures, August 19, 1937. This group of Asiatic composites closely related to *Crepis* has been found on cytological and taxonomic evidence to be distinct from that genus. Twenty-seven species, grouped under six sections are recognized. In the introduction the authors discuss the following subjects: taxonomic history of the genus, criteria of classification, relationships of the genus and of the sections, geographic distribution.

"The North American species of Rumex," by K. H. Rechinger, Jr. Field Museum of Natural History, Publication No. 386, 151 pages, 25 plates, June 24, 1937. Forty-seven species are recognized: these are treated under three subgenera; Acetosella, 2 species; Acetosa, 4 species; Lapathum, 41 species. Under this latter group two new sections are proposed: Axillares, 18 species; Simplices, 23 species. In the introduction Dr. Rechinger discusses the distinctive characters and geographic distribution of section Axillares which has its principal area of distribution in North America. Users of the volume will appreciate the consistently clear statements as to how the author's interpretations of certain specific units differ from those of current floras and manuals.

"The genus Bidens," by Earl Edward Sherff. Field Museum of Natural History, Publication No. 388, 346 pages, 88 plates, August 31, 1937. The introduction comprises a historical survey of the taxonomy of the genus and mention of work done with reference to it in such fields as morphology, histology, ecology and relation to insect pollination. The systematic treatment includes: description of the genus; synopses of the fourteen recognized sections; descriptions of species; citations of specimens and comment. All keys, descriptions and synopses are in Latin. In this cosmopolitan group of composites two hundred thirty-three species are recognized and keyed out; of these, one hundred one are treated systematically in Part I. The major sections of the key are geographic, as follows: Pacific islands; North and Central America and the West Indies; South America; eastern hemisphere exclusive of Africa; Africa, an arrangement which adds greatly to the usefulness of the monograph in any particular region.

VOLUME IV NUMBER 5

MADROÑO

A WEST AMERICAN JOURNAL OF BOTANY

Contents

Published at Lime and Green Streets, Lancaster, Pennsylvania

January, 1938

MADROÑO

A WEST AMERICAN JOURNAL OF BOTANY

Entered as second-class matter October 1, 1935, at the post office at Lancaster, Pa., under the act of March 3, 1879.

Established 1916. Published quarterly. Subscription Price $2.50 per year. Volume I, Numbers 1 to 17, complete, $5.00. Volume II, Numbers 1 to 17, complete, $5.00. Volume III, Numbers 1 to 8, complete, $5.00. Single numbers $0.75.

Papers up to 15 or 20 pages are acceptable. Longer contributions may be accepted if the excess costs of printing and illustration are borne by the contributor. Articles may be submitted to any member of the editorial board. Manuscripts may be included in the forthcoming issue provided that the contributor pay the cost of the pages added to the issue to accommodate his article. Reprints of any article are furnished at a cost of 4 pages, 50 copies $3.70; 100 copies $4.10; additional 100's .75¢; 8 pages, 50 copies $5.40; 100 copies $6.00, additional 100's $1.20. Covers, 50 for $2.50; additional covers at $1.50 per hundred. Reprints should be ordered when page proofs are returned.

Published at Lime and Green Streets, Lancaster, Pennsylvania, for the

CALIFORNIA BOTANICAL SOCIETY

Annual membership dues of the California Botanincal Society are $2.50, $2.00 of which is for a year's subscription to Madroño. Dues should be remitted to the Treasurer. General correspondence and applications for membership should be addressed to the Secretary.

THE STRUCTURE OF ALLOTROPA

Herbert F. Copeland

The monotropoid genus *Allotropa,* with the single species *A. virgata* Torrey and Gray, was described by Gray (9) as "gathered on the Cascade Mountains of northern Oregon, by Dr. Pickering and Mr. Brackenridge, in the South-Sea Exploring Expedition under Commodore Wilkes." The "northern Oregon" of the time of the Wilkes Expedition is of course the present State of Washington. The original publication just cited embraced all the essentials of taxonomic publication, the description of a genus, the name of a species, and the citation of a specimen; but it was brief and in a footnote; and a few years later Gray (10) presented a more extensive and formal account based largely on an adequate collection by Bolander, in the State Geological Survey, "in Mendocino County, between Little Bear Harbor and Noyo, 'generally near *Quercus densiflora.*'" The plant is now known to range from southern British Columbia through Washington and Oregon and south in California, in the Coast Range to Sonoma County and in the Sierra Nevada to Kings River. It occurs at altitudes from not far above sea level up to eight or nine thousand feet. The habitat of Bolander's collection caused Gray (11), and hence various European authors, to regard oak forests as the typical habitat of the plant. Actually, our tanbark oak is currently excluded from oaks proper, as *Lithocarpus densiflora;* and while *Allotropa* is often found as an associate of this plant, it is perhaps more often found in coniferous forests.

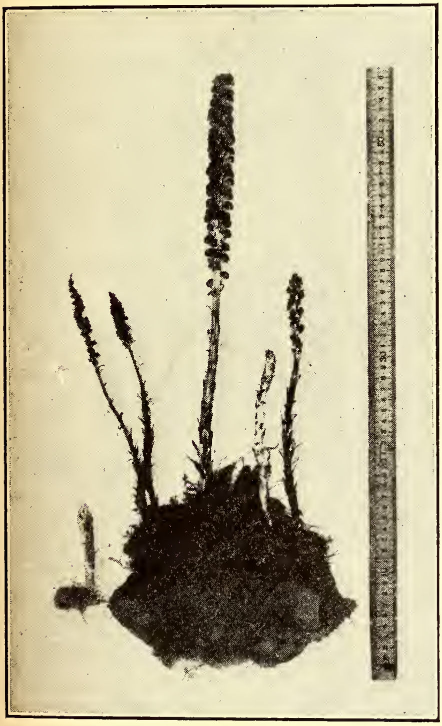


Fig. 1. *Allotropa virgata.* Plants collected on Mount Shasta, California, by William Bridge Cooke, September 8, 1936. Photograph by George C. Kimber.

Madroño, Vol. 4, pp. 137–168, January 11, 1938.

Allotropa invites superficial attention as being infrequent and at the same time conspicuous by its coloration in carmine and white. More fundamentally, it invites attention by certain peculiarities and uncertainties in its structure: authors have mentioned and again denied the presence of bractlets on the pedicel; there is a single whorl of perianth segments, interpreted sometimes as petals, sometimes as sepals (Gray adopted the former interpretation in his first mention of the plant, and the latter in his second); the anthers turn a half-somersault as the bud develops into the flower, agreeing in this feature with those of *Clethra* and *Pyrola* and differing from those of the other saprophytic Ericales; the flower has been described as lacking a disk. Interpretation of the characters affects, of course, opinion as to relationship. Gray associated the plant first with *Monotropa,* then with *Pyrola* and *Schweinitzia,* then with *Pterospora.* The more recent authorities, Drude (8), Andres (1), Domin (7), Small (14), and Jepson (13), have tended to separate it sharply from the other monotropoid plants, either implicitly by listing it first among the genera of the group, or explicitly by assigning it to a separate group of subtribal rank.

Materials and Methods

The anatomical part of the present study is based upon two collections. Mr. Milo S. Baker of the Department of Botany, Santa Rosa Junior College, California, was so kind as to send a fresh specimen, collected about May 15, 1936, by Mr. McMillan of Annapolis, Sonoma County. It consisted of a single shoot without roots, in full anthesis. This collection is the basis of my understanding of the flower. Later in the same year, I had the good fortune to make the acquaintance of Mr. William Bridge Cooke, who was botanizing on Mount Shasta during the summer vacation. He kindly sent most abundant and excellent fresh material collected on September 8. It included abundant roots and nearly ripe fruits. My colleague, Mr. George C. Kimber, had the kindness to photograph this collection (text fig. 1).

After preliminary study, the material as received was fixed in Bouin's fluid. It was imbedded and sectioned in standard fashion. The staining combination generally used has been safranin and light green; this makes conspicuous the xylem and other tissue with lignified walls, and also cells containing stainable material which I take to be tannin. In studying ovules and seeds, in which lignified and tanniniferous cells are not of primary interest, a combination of acetocarmine and aniline blue was found useful. With the help and advice of Dr. A. S. Crafts and Dr. Katherine Esau, both of the College of Agriculture, University of California, Davis, a method of seeing the phloem clearly was worked out. The microtome sections are passed through xylol and the alcohols down to water; exposed for some five minutes to 5 per cent H_2SO_4; flooded alternately with 0.1 per cent aniline blue and Crafts' (6) killing solution (KI, 0.75 g.; I, 0.5 g.; H_2O, 100 cc.), several changes of each, each for several minutes; and mounted and examined in Crafts' mounting solution (glycerine, 30 cc.; H_2O, 60 cc.; $ZnCl_2$, 2 g.; KI, trace; I, 0.2 g.). Such preparations are not permanent in the sense that they can be stored away and studied in subsequent years; but they will last for months, and even improve, at first, with age.

The Root System

As in other monotropoid plants, the root system is the permanent member of the plant, the shoots being temporary reproductive structures. The collection studied was from sandy soil and the roots were found fifteen to thirty centimeters below the surface. Roots are of all sizes from less than one millimeter to about four millimeters in diameter (pl. XXII, fig. 2). The smallest roots bear two rows of branches; the larger ones bear four rows. I have been unable to follow any of the larger roots to the tip; presumably they taper but little. In the microtome sections, only one tip of a small root was studied. A cap is present; as seen, it is minute, consisting of shrivelled cells whose remains are scattered along the sides of the root for a few millimeters back of the tip (pl. XXII, fig. 3). There is a definite dermatogen. There are no root hairs, and no mycorrhiza was detected. Spiral tracheids are formed to within a fraction of a millimeter of the tip; but the plerome cannot be said to reach to the dermatogen. The endodermis is not differentiated from the cortical parenchyma; accordingly, the boundary between the broad pericycle and the cortex cannot be recognized until considerable development has taken place. The oldest part of a root has a diarch primary xylem lying in a plane parallel to the axis of the parent root. Branch roots originate in the pericycle opposite the edges of the strand of xylem and grow out through the cortex; the boundary between stele and cortex is first evident by the level at which branch roots originate (pl. XXII, figs. 4, 5). The xylem of the branch root becomes connected to the primary xylem of the parent root. Apparently smaller roots remain diarch; larger ones, diarch at first, begin to develop a tetrarch xylem after forming their first branches, and subsequently form branches in four rows. A cambium forms secondary xylem, most abundantly in the angles between the four flanges of the primary xylem (pl. XXII, fig. 6). The primary xylem consists chiefly of scalariform elements opening into each other through scalariform or reticulate cross walls; with these are mixed many parenchymatous cells with non-lignified walls. The secondary xylem is of similar conducting elements and includes vascular rays in some of which the cells are tanniniferous. As the secondary wood appears, the line between stele and cortex becomes perceptible by an indefinable difference between the cells inside and outside a cylindrical boundary along which the walls of adjacent cells become more or less stainable with safranin. At this level, and in the planes where branch roots have already developed, adventitious buds appear.

I am not clear as to the timing of the development of which stages were seen. I suppose that growth in length and formation of branch roots takes place in early summer; that formation of secondary wood takes place next, and the development of buds in late summer; and that the shoots appear above ground, flower, and fruit, in the summer after their origin. Presumably each root bears only one crop of secondary roots, and only one crop of shoots, and then dies, leaving the space to the branch roots which it has produced.

These roots, in contrast to those of *Sarcodes* and *Pleuricospora* are perfectly normal; there is no question here of a procaulon. The absence of mycorrhiza may be associated with the sandy soil from which the material was collected (*cf.* Christoph (2)); and the presence of a root cap and the endogenous origin of the branches may in turn be associated with the absence of mycorrhiza.

Gross Structure of the Shoot

Each stem is unbranched and can be regarded as a peduncle together with the axis of a raceme. All of the foliar organs are essentially of the same nature, although the lower ones may be called leaves and the upper ones bracts in a raceme. When fresh and living they are white and fleshy, acute, usually entire below and more or less fimbriate above. They vary in size and shape in different zones of the shoot. They show small numbers of parallel veins evident as red streaks. They do not long remain fresh and white, but soon shrivel and turn brown or black.

The most conspicuous feature of the plant is the coloration of the stem. It is basically white but marked by a regular network of brilliant red bands (pl. XXIV, fig. 21). The junctions of this network lie at the insertions of the leaves; two lines converging from below join at each node, ascend the stem a short distance as a broad single line, and then diverge, running to the bases of the two leaves next above.

In most of the published accounts the shoots are described as rather short and divisible into a densely scaly lower part, a sparsely scaly middle part, and a bracted raceme. Some plants, however, are quite tall, and it is sometimes possible to distinguish other regions in addition to the ones just mentioned: if the roots are deeply seated, there may be a long slender stalk below the densely scaly portion; and the latter is sometimes divisible into a lower region of short leaves and an upper region of longer ones. There is considerable variation in the relative sizes of these parts. The phyllotaxy is spiral, but it is commonly not an orthodox spiral: the numbers found by counting the files of scales on the same shoot, respectively to right and to left, are often not adjacent numbers of the 2, 3, 5, 8, etc., series; they are often not numbers of this series at all. Tables I and II present some frag-

TABLE I

Lengths in centimeters of various parts of shoots of *Allotropa*

Designation of shoot	Stalk below bulb	Region of compact scales		Peduncle	Inflo-rescence	Total
		Lower	Upper			
A	..	..	5	17	17	35
B	4	5	6	16	20	51
C	2.5	..	14	8.5	9	34
D	2	..	11	6	7	26
E	2.5	..	14	5	5	26.5
F	1.5	..	14	6	5	26.5
G	3	..	6	11	8	28
H	6	..	5	14	9	34
I	..	3	1.5	9.5	16	30
J	1.5	..	16	9	7	33.5
K	10	..	9.5	4.5	5	29

TABLE II

Numbers of parstichies to left (*l*) and right (*r*) in various parts of certain shoots of *Allotropa*

Designation of shoot	Region of compact scales		Peduncle	Inflo-rescence
	Lower	Upper		
A		15 *l* 16 *r*	5 *l* 6 *r*	6 *l* 4 *r*
B	10 *l* 7 *r*	5 *l* 7 *r*	4 *l* 3 *r*	3 *l* 4 *r*
Various other shoots of Cooke's collection		8 *l* 6 *r*		
		4 *l* 5 *r*		
			3 *l* 5 *r*	2 *l* 5 *r*
			5 *l* 5 *r*	3 *l* 5 *r*

mentary notes on these points. In these tables, shoot "A" is the one furnished by Mr. Baker; shoot "B" is the exceptionally tall one of Mr. Cooke's collection, shown in the middle of figure 1; the others are various other shoots of the latter collection.

Anatomy of the Shoot

By sectioning a fresh stem, one finds that the red pigment is confined to the epidermis (in the ovary and stigma it is found also in the next few layers of cells within). It is an indicator, turning blue in ammonia vapor and red again in hydrochloric acid vapor; evidently it is an anthocyanin. It disappears completely during fixation and imbedding.

In microtome sections the epidermis both of stems and of leaves is found to bear a thin cuticle with very fine lengthwise striations; to be without stomata; and to contain tannin in every cell.

The cortex and pith are of parenchyma with many scattered tanniniferous cells.

The vascular cylinder is a typical siphonostele, such as we expect in woody plants rather than in herbs: it is broken by vascular rays (bands of parenchyma, frequently tanniniferous) and by leaf gaps, but not by pith rays. At the very base of the shoot, the vascular cylinder is compressed parallel to the axis of the root which bears it, and is connected to the secondary wood of the root.

The xylem includes little clusters of spiral tracheids, more or less crushed as the stem matures, on the inner border; it consists chiefly of scalariform vessels with scalariform or reticulate cross walls. The phloem includes, beside much parenchyma, little patches of typical sieve tubes and companion cells; there is usually one such cluster between each two vascular rays. There are no more than traces of cambial activity (pl. XXIII, fig. 11).

In young shoots the pericycle outside the phloem is parenchymatous (pl. XXIII, fig. 8). Later, in shoots still underground but well developed and ready for flowering in the following season, one finds a heavy sheath of lignified fibers between the phloem and the cortex (pl. XXIII, fig. 9). In fruiting shoots, several layers of cells of the pith, not directly against the xylem but separated from it by a narrow band of parenchyma, are lignified, and form a sheath on the inner side of the vascular cylinder (pl. XXIII, fig. 10).

Each leaf trace consists of a single bundle leaving a gap in the vascular cylinder. Branch traces vary in character with height in the stem and stage of development; the variations parallel those of the fibrous tissue already mentioned. No branch traces are to be found in association with the lowest leaf traces of the shoot. In older material, from higher in the stem, branch traces exist as pairs of bundles running from the two sides of each leaf trace and ending under abortive axillary buds. A sheath, in the form of a trough-shaped band of fibers, lies against the outer side of the leaf trace, and an inconspicuous little strand of fibers accompanies each bundle of the branch trace (pl. XXIII,

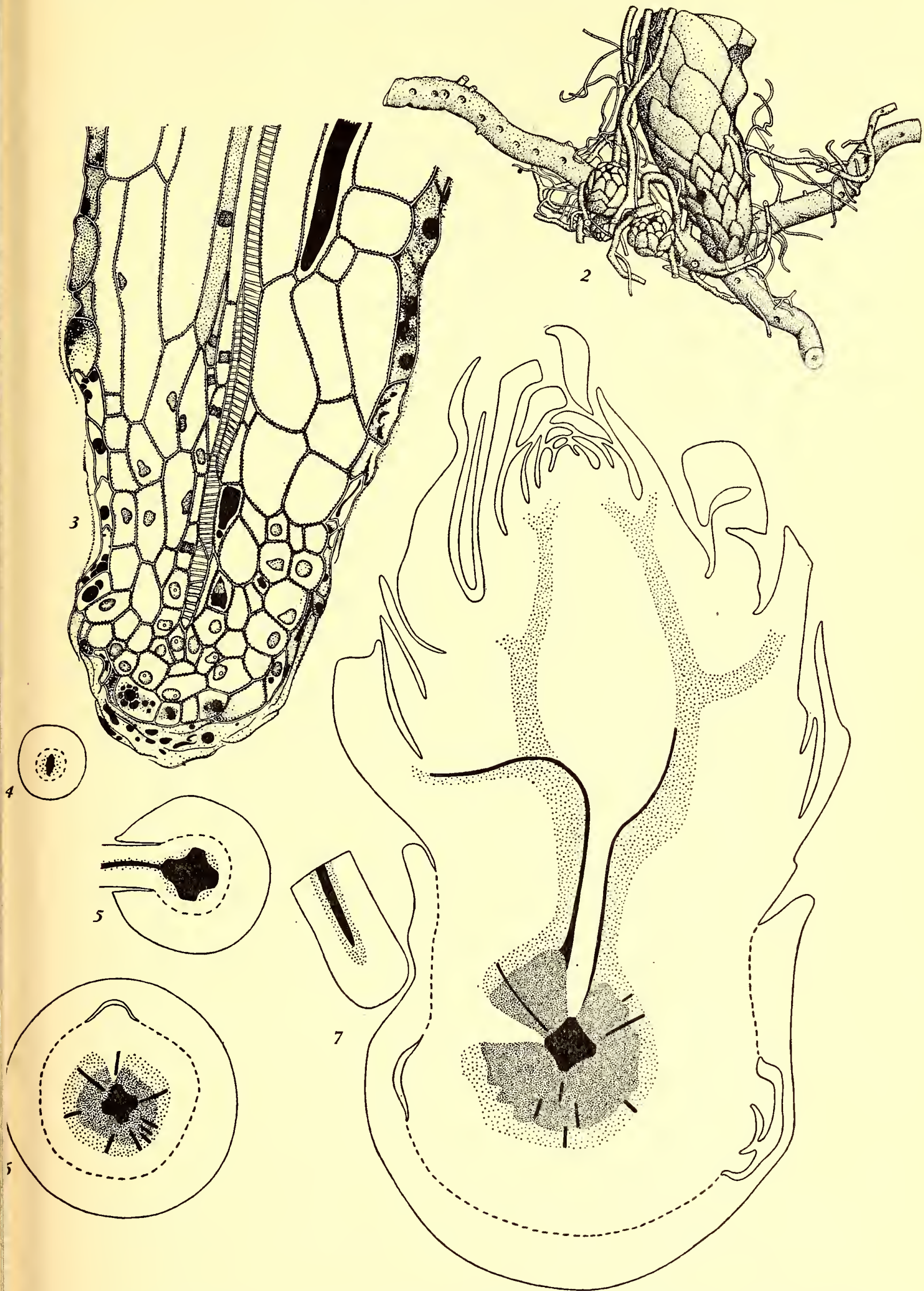


Plate XXII. Allotropa virgata. Fig. 2. Roots and base of shoot × 1.6. Fig. 3. Longitudinal section of root tip × 320. Figs. 4, 5, 6, 7. Cross sections of roots × 16; fig. 4, a small root with diarch primary xylem; fig. 5, a larger root showing tetrarch xylem and attachment of a branch; fig. 6, root showing secondary xylem and origin of a bud; fig. 7, root bearing a well developed bud. Primary xylem and tanniniferous vascular rays black; secondary xylem heavily stippled; phloem and precambial tissue lightly stippled.

fig. 9). In the fruit-bearing rachis, leaf-trace and branch-trace (that is, flower trace) are united into a cylinder of tissue completely enclosed by a sheath of fibers (pl. XXIII, fig. 10). This body extends upward in the cortex through a distance of several centimeters before reaching the level of the bract and flower which it supplies (pl. XXIV, figs. 13–20. Note that in the models the vertical scale is only a quarter of the horizontal scale; these traces are exceedingly long and slender). At the level of the bract, the leaf trace escapes as several small bundles; here, in the inflorescence, the leaf trace appears as a minor appendage of the branch trace. The sheath may fade out at this level, or may continue into the pedicel; it fades out below the receptacle.

The Flower

The pedicel in flower is white, approximately 1 millimeter thick and long. Referring to Bolander's collection, Gray remarked that "two subulate bractlets which were thought to have been detected upon the original specimen of *Allotropa* are not seen in the good specimens now in hand." Drude (8) and Domin (7) both write of these bractlets as definitely present. The fact is that they are present on some specimens, but absent from the majority, at least of specimens collected in California.

The five perianth segments (less commonly four or six) are white, more or less rhombic in outline, fimbriate, commonly a shade under 5 millimeters long and slightly wider.

There are twice as many stamens (pl. XXV, figs. 25–30) as perianth segments. The filaments are glabrous, dark, about as long as the perianth segments. The summit of the young filament is bent outward at a right angle and attached to the base of a dark anther about 2 millimeters long. This juvenile position is approximately the morphologically normal position of the anther; the outer side is the dorsal side. Even in the youngest material available to me, the anthers are dehiscing; each one opens through two lengthwise slits from the lower end half-way up the dorsal side. The slit in each lobe crosses the ends of both microsporangia of the lobe; the wall between them has already broken down in the youngest material I have seen. As the flower matures, the angle at the summit of the filament changes, the end swinging inward through ninety degrees, so that the anther hangs downward with the dorsal side inward and the slits at the top. If the anther is allowed to dry, the slits gape widely and appear as pores. A vascular bundle passes up within the filament, bending as the filament does; makes an additional right angle as it enters the anther; and traverses the middle of it, in the septum between the two lobes and in the plane of the septa between the two microsporangia of each lobe.

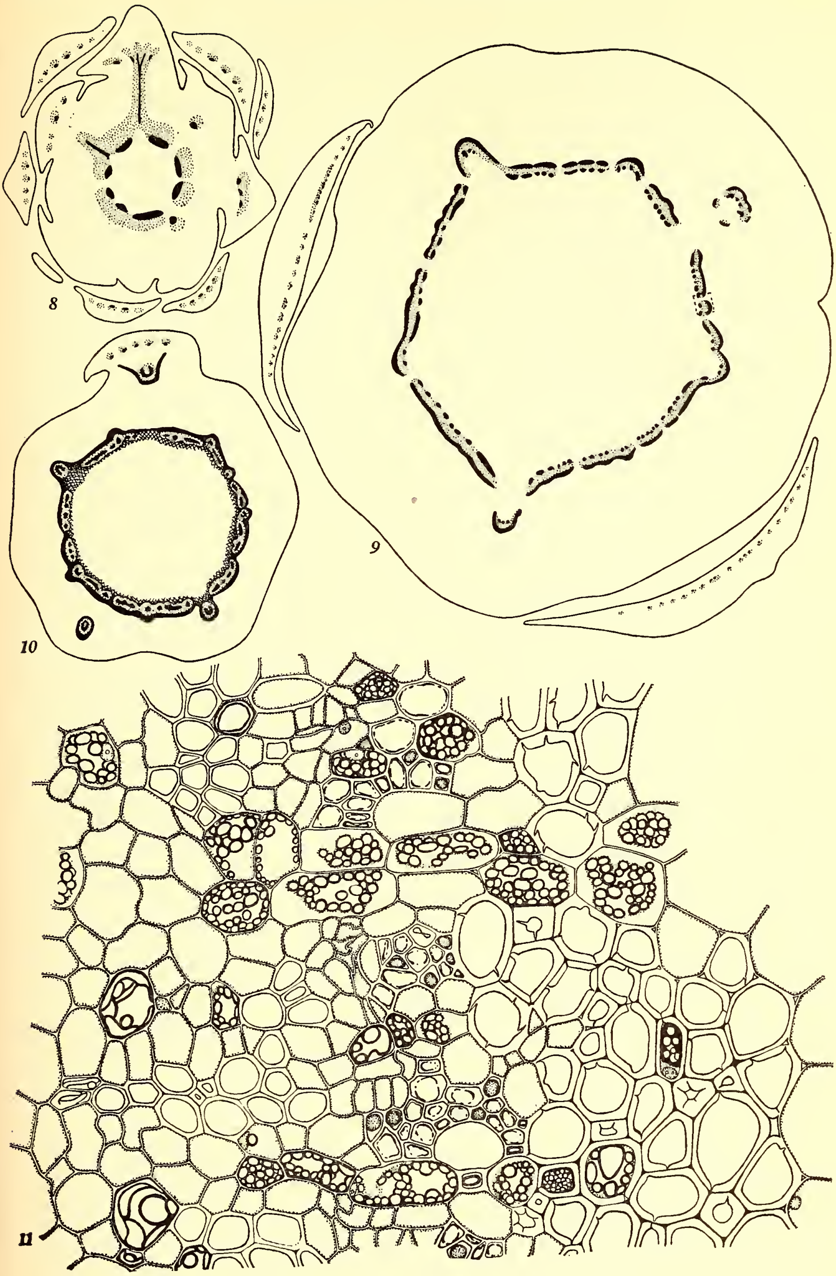


PLATE XXIII. ALLOTROPA VIRGATA. Fig. 8. Cross section of the base of a young shoot ×8. Fig. 9. Cross section of a more highly developed shoot ×8. Fig. 10. Cross section of rachis ×8. Xylem and external sheath black; phloem and small-celled parenchyma within the xylem stippled; internal sheath cross-hatched. Fig. 11. Details of the cross section of the vascular cylinder, from the point indicated by the dotted square in fig. 9, ×320.

The pollen grains are solitary and binucleate, in these respects being typical of the monotropoid group. In the material studied, most of them were found to be 3-grooved (pl. XXV, fig. 35); thus differing from those of *Pterospora* and *Pleuricospora,* which are usually 4-grooved.

The ovary is bright red, subglobular, and usually about 5 millimeters in diameter. It bears at the base a whorl of inconspicuous nectaries projecting between the bases of the filaments. It is impressed at the top, so that there is a groove about the base of the style, which is white, usually about 1 millimeter long and thick. The stigma is red, ordinarily about 1 millimeter high and 3 millimeters in diameter, obscurely 5-lobed (varying to 4- or 6-lobed); grooves, one on top of each lobe, converge at the center of the stigma on the opening leading to the interior of the ovary. In fresh material, the stigmatic surface is covered with a sticky fluid; microtome sections have shown germinating pollen grains imbedded in this.

In internal structure the ovary (pl. XXV, fig. 24) agrees with the other pyroloid and monotropoid plants which are said to show axile placentation: a cross section near the base shows five distinct locules, opposite the perianth segments, with a massive placenta projecting from a central column into each. Higher up, each placenta is split radially into two parts; the clefts between them radiate from a vertical channel continuous with the style channel. In this upper part, then, the placentation is really parietal, with the placentae thrust deeply into a single cavity. (What one calls a placenta in the lower part of the ovary is, as is usual in examples of axile placentation, the two edges of a single carpel; in the upper part, as is usual in examples of parietal placentation, it is the united edges of two adjacent carpels.) These placentae of the upper part, continuations of the septa between the cavities below, continue into the style as ridges projecting into the style channel. The lobes of the stigma stand above the grooves between them; each lobe is the end of one carpel.

The inner surface of the ovary wall is armored with a layer of sclerenchymatous fibers as in *Pterospora, Pyrola,* and *Chimaphila,* but not *Newberrya, Pityopus,* and *Pleuricospora.* The presence of this layer is associated with the dehiscence of a capsule, its absence with the production of a berry.

The stigmatic surface is covered with an epidermis of columnar cells, laterally in contact with one another, with the free ends domed outward. This is apparently a less specialized surface than those of *Sarcodes, Pterospora, Pityopus,* and *Pleuricospora,* in which these cells become spindly needles not in lateral contact with each other. These cells, and also several inner layers, but not the cells farthest from the surface, are tanniniferous.

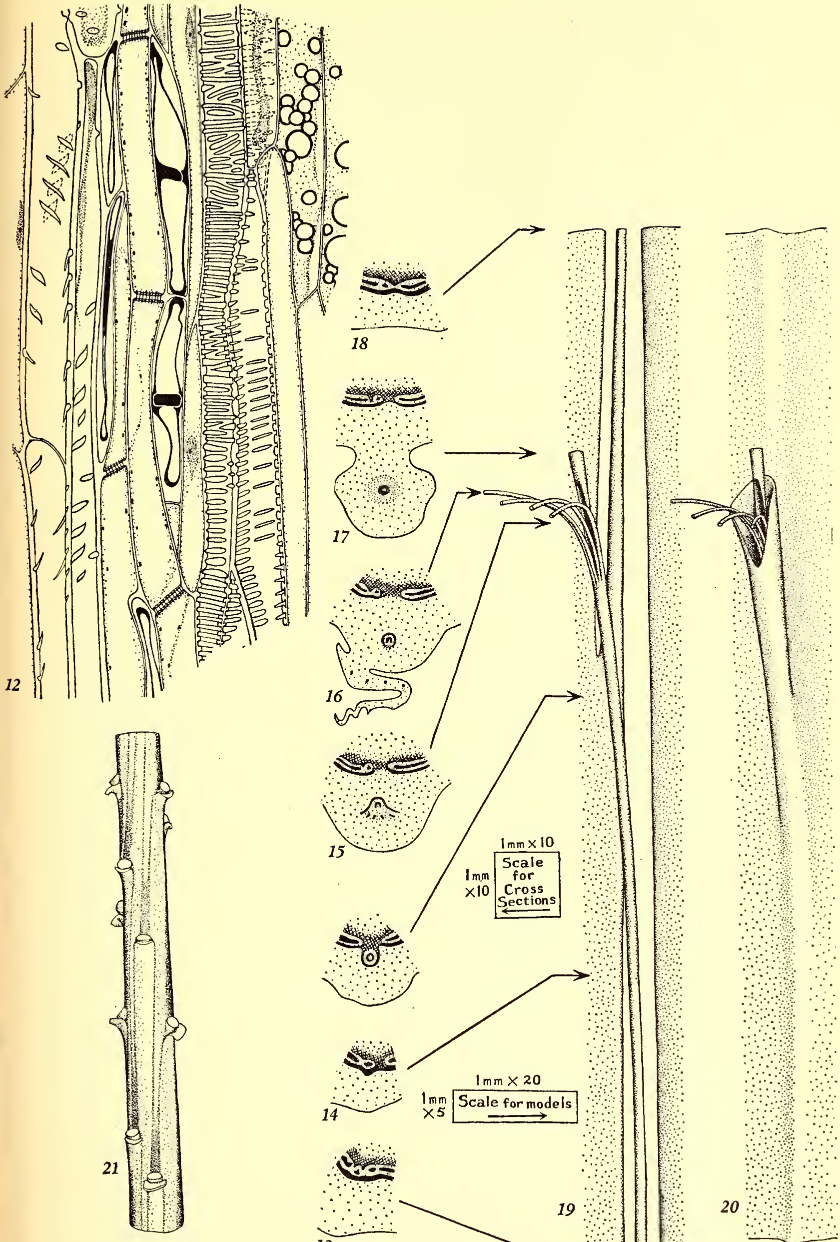


PLATE XXIV. ALLOTROPA VIRGATA. Fig. 12. Longitudinal section of vascular cylinder, from a stem comparable with those represented in figs. 9 and 11, ×320. Figs. 13–18. Portions of cross sections of rachis in succession upward ×8. Fig. 19. Model of a portion of the vascular cylinder of the rachis, based on figs. 13–18, not showing the sheath. Vertical scale ×4; horizontal scale ×16. Fig. 20. Similar model showing the sheath. Fig. 21. External view of the rachis ×1.6.

The vascular cylinder in the pedicel in my material, which is without bractlets, shows no trace of bundles supplying them. The first whorl of five bundles in the receptacle forks periclinally, the lower branch running to a perianth segment, the upper to a stamen. The association of the perianth segment bundles with stamen bundles, and the location of the perianth segments opposite locules of the ovary, are features of petals as distinguished from sepals in the other monotropoid genera, and constitute proof that the perianth segments of *Allotropa* are petals. A second whorl of five bundles, alternating with the first, consists of stamen bundles. The remainder of the vascular supply of the flower breaks up, not without irregularity, into ten bundles. Five of these, lying in the planes of the petals, soon bend sharply outward and ascend the ovary wall; these are carpel dorsals. At the summit of the ovary, they bend down to the base of the style, then continue up the style in the thin places between the internal ridges; they end in the lobes of the stigma. The last whorl of five bundles, being in fact pairs of carpel ventrals, enters the central column of the ovary near the inner edges of the septa. They bend, branch, and break up in furnishing the vascular supply of the placentae. Branches of them may or may not run out through the septa to the ovary wall. In older flowers and in fruits, indefinite small numbers of bundles springing from the bases of the staminal bundles ascend the ovary wall for some distance between and parallel to the carpel dorsals. These correspond to the supernumerary bundles which puzzled me in *Pityopus*. They are evidently of no phylogenetic significance, but are developed in response to need, or by accident, in irregular positions (pl. XXV, fig. 36).

Seed and Fruit

Ovules ready for fertilization, and nearly ripe seeds, have been seen; the stages of development have not.

The ovules are typical of the monotropoid group. An ovule has an integument of two layers of cells; the nucellus is already

Plate XXV. Allotropa virgata and Pterospora. Fig. 22. Bud from an underground shoot which would flower during the following summer × 40. Fig. 23. Flower × 4. Fig. 24. Dissection of a flower × 8. Fig. 25. Two stamens from a bud × 8. Fig. 26. Diagram of the anther of such a stamen to show the course of the bundle supplying it, the locus of the wall between microsporangia of the same anther lobe, and the plane of the section shown in fig. 34. Fig. 27. Similar diagram of a stamen in the mature position. Fig. 28. Mature stamen, lateral view × 8. Fig. 29. Mature stamen, view from within the flower × 8. Fig. 30. Mature stamen after dehiscence × 8. Figs. 31, 32, 33, stamens of *Pterospora* × 8, for comparison: fig. 31, ready for dehiscence; fig. 32, in process of dehiscence, lateral view; fig. 33, in process of dehiscence, view from outside the flower. Fig. 34. Cross section of anther at point of junction with filament × 40. Fig. 35. Pollen grain × 800. Fig. 36. Model of the vascular tissue in the receptacle approximately × 40.

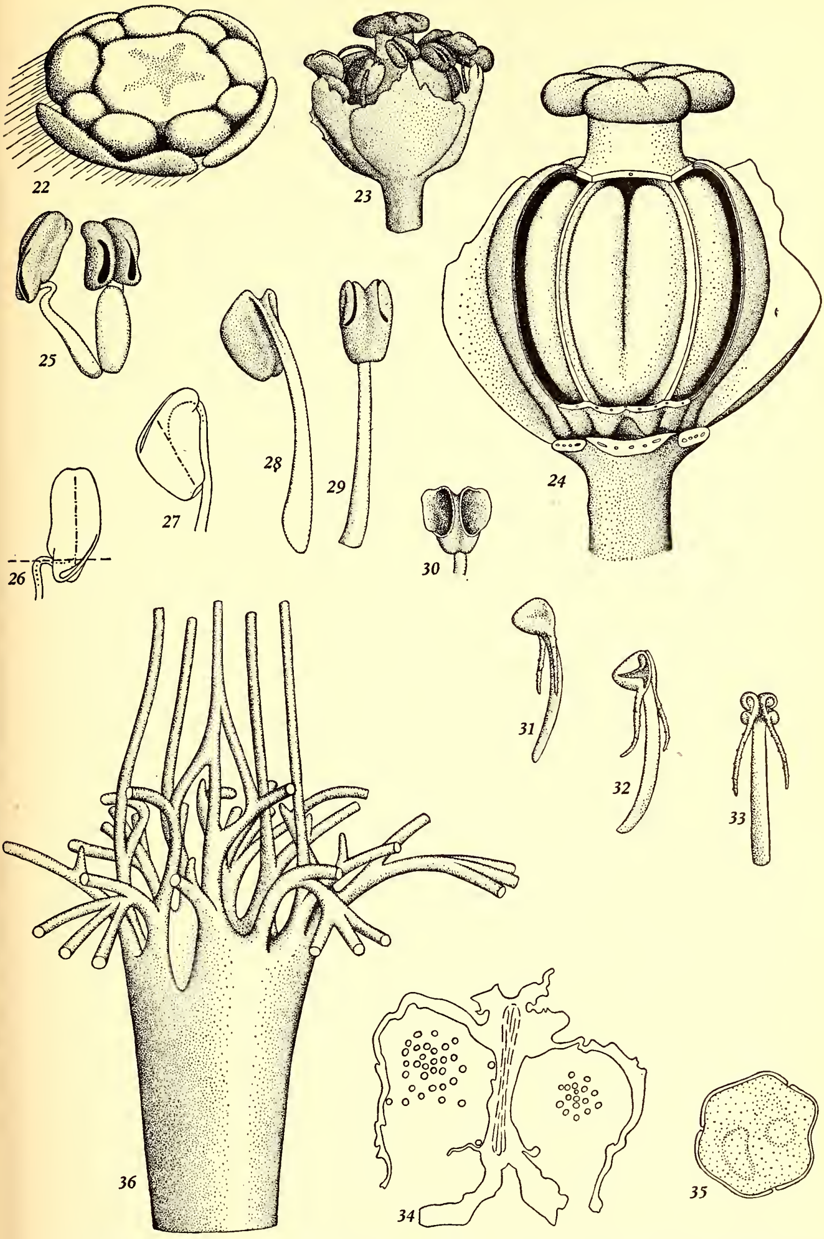


PLATE XXV. ALLOTROPA AND PTEROSPORA. (See explanation of figures on page 148.)

absorbed; the embryo sac consists of the usual egg, two synergids, endosperm mother cell, and three antipodal cells (pl. XXVI, fig. 40). The seed as a whole (pl. XXVI, fig. 42) is about 0.8 millimeter long; it shows a swollen middle part and a tail at each end; it is nearly white. Microtome sections (pl. XXVI, fig. 41) show that the integument, excepting the outmost layer of cells, tends to be absorbed or to collapse; that the endosperm has a haustorium at each end (the exact structure of the haustoria is not clear: they seem to consist of a few empty, very thick-walled cells); the endosperm proper few-celled, the cells well filled with granular material; the embryo, staining in the same fashion as the endosperm, 2- or 3-celled. There is probably a suspensor which is absorbed during development. The few cells of the embryo are separated by oblique walls, as if there were a terminal cell from which the others were successively cut off. I believe my understanding of the embryo of *Pleuricospora* as recently published (5) was incorrect. The embryo of *Pleuricospora* is of the same appearance as that of *Allotropa,* and presumably shows the same manner of growth.

The ovary seems to grow but slightly in developing into a fruit (pl. XXVI, figs. 37, 38). I have, indeed, some quite large fruits, about 1 centimeter in diameter; these are borne on an exceptionally large shoot, and are presumably developed from exceptionally large flowers. I have not observed dehiscence in nature. Fruits dried in the herbarium show two sets of lines of weakness, dehiscence taking place along both. Those of one set lie along the planes of the carpel dorsal bundles, and result in the ordinary dehiscence of a loculicidal capsule, as in *Pyrola, Chimaphila,* and *Pterospora.* The other set forms a circumferential line about the base of the style, as in *Sarcodes.*

Discussion

The indefiniteness of various characters of *Allotropa*—in the relative development of the parts of the shoot; in the phyllotaxy; in the presence or absence of bractlets; and in the numbers of petals, stamens, and carpels—arouses speculation. One is tempted to interpret it in anthropomorphic terms as a resultant of a relaxation of discipline permitted by the dependent manner of nutrition. No scientific explanation of this indefiniteness is forthcoming: one is ignorant of the genetic and physiological mechanisms involved in such behavior, and of the manner of impact of natural selection such that these plants are free to vary much more widely than most.

This indefiniteness of character is itself a character of the whole monotropoid alliance. Variation in the nature of the calyx, discussed by Domin (7), is a phase of it. In perhaps a majority of the genera involved there is a perfectly definite calyx of four

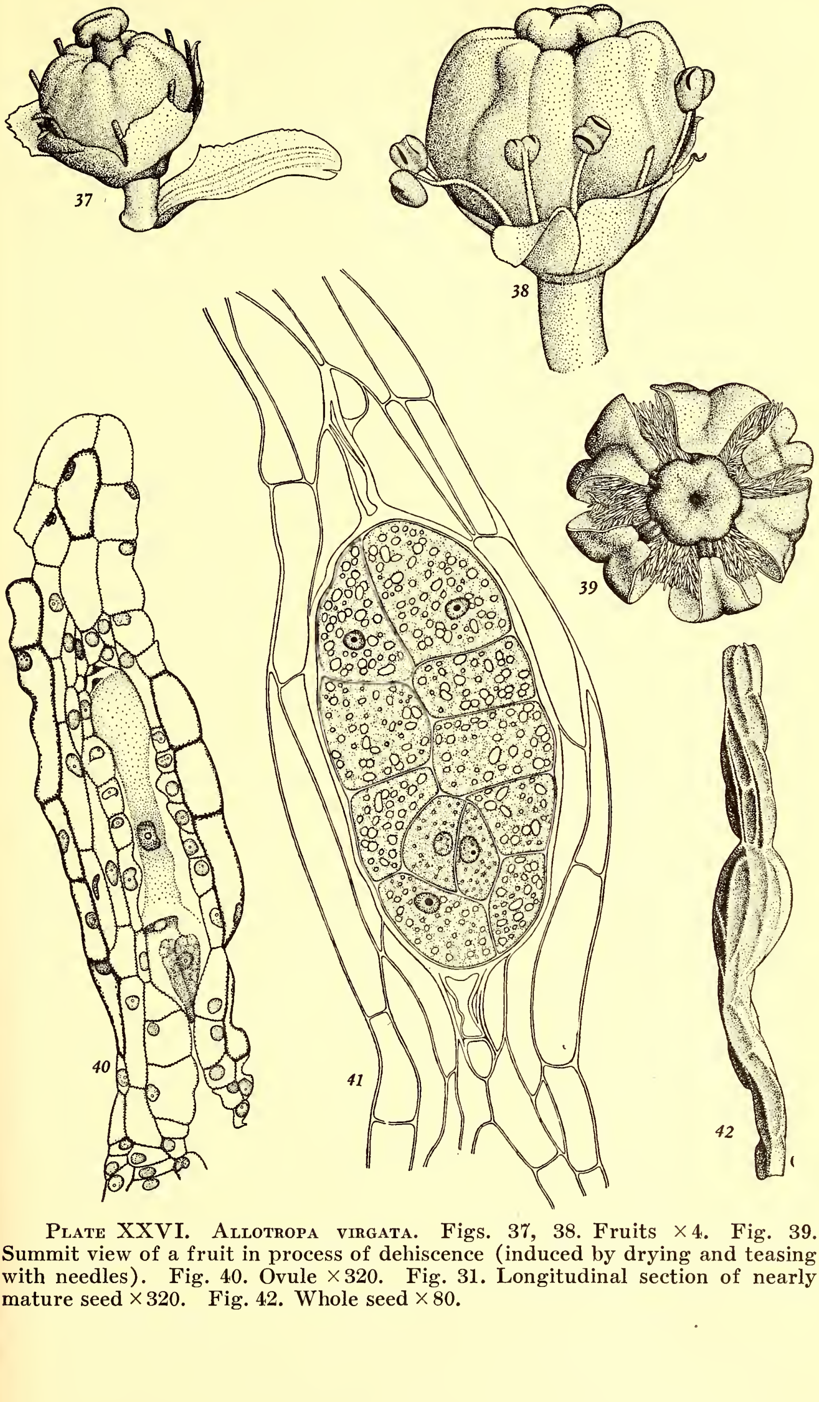


PLATE XXVI. ALLOTROPA VIRGATA. Figs. 37, 38. Fruits ×4. Fig. 39. Summit view of a fruit in process of dehiscence (induced by drying and teasing with needles). Fig. 40. Ovule ×320. Fig. 31. Longitudinal section of nearly mature seed ×320. Fig. 42. Whole seed ×80.

or five sepals alternating with the petals. In other genera, *Monotropa, Hypopitys, Newberrya,* and *Pityopus,* the number of sepals is variable, and the sepals tend to intergrade with leaves, bracts, or bractlets; buds and flowers may appear in the axils of the sepals of *Pityopus,* as of ordinary leaves. In *Allotropa* the calyx is completely suppressed, unless the bractlets, present on a minority of the specimens, are its representatives. As asepalous rather than apetalous, *Allotropa* is much less an anomaly than it has appeared to be. As I understand Domin's thesis, he suggests that the monotropid plants are primitively asepalous, and that a calyx (or pseudocalyx) has gradually been evolved from other foliar organs. I would be inclined to read the series in the reverse direction, and to understand first a loss in definiteness of numbers and sharp distinction of parts, and subsequently a loss of the sepals.

The stamens, and particularly the anthers, of *Allotropa* show resemblances in several directions; most obviously, with those of *Clethra, Pyrola,* and *Chimaphila.* In their mature position, they are the same as anthers of *Arbutus* and *Arctostaphylos;* but they lack the paired tails of the anthers of these genera. Finally, it is clear that anthers of *Pterospora* (pl. XXV, figs. 31–33) are essentially the same, although differing in being fixed in a horizontal position with the dorsal side upward. If *Allotropa* lacks the tails which anthers of *Arbutus* and *Arctostaphylos* possess, *Pterospora* has them. *Pterospora* shows another interesting feature: in addition to the slit along the proximal end of the anther, another is developed at right angles to this, along the plane separating the two microsporangia of each lobe. This gives a hint as to the evolution of the anthers of *Pleuricospora* and *Newberrya,* which open by lengthwise slits in this latter plane.

I have already pointed out resemblances in several directions as shown by the gynoecium. At this point one may offer some strictures on a recent paper by Hunt (12). This author assumes the evolution of carpels eventually from dichotomously branched thalli, and interprets them on this far-fetched basis. He recognizes two types, a more primitive 3-lobed type, exemplified by *Pyrola* (and other examples), and a more advanced 1-lobed type exemplified by *Clethra* (and again by other examples). The suggestion that the carpels of *Pyrola* and *Clethra* are of different types, and that the former is the more primitive is scarcely tenable. To me, it is clear from Hunt's figures that *Clethra* has a pistil comparable with those of other Ericales, but slightly more primitive; a less complete union of carpels is manifest in the fact that the single style passage usual in Ericales branches into three channels in the stigma of *Clethra.* The real difference is that in *Clethra* each lobe of the stigma stands at the end of a single carpel; in *Pyrola,* each lobe is compound, consisting of halves of the ends of two adjacent carpels. This distinction is interesting: *Allotropa* and *Sarcodes* show the more primitive condition as does *Clethra;* the genera with fully parietal placentation, *Pleuricospora* and *Newberrya,* show as does *Pyrola* the derived condition.

The characters of *Allotropa,* as I have come to know them, seem to me to bind together to a surprising extent the genera of the Pyrolaceae of Engler and Prantl (the allies both of *Pyrola* and of *Monotropa*), a group so heterogeneous that their common origin has been questioned. As an asepalous plant, *Allotropa* cannot be recognized as the direct ancestor of the other Monotropoideae; but we can conceive it to be the living genus which has in most features diverged least from the extinct common ancestor of the group. The authors who have listed it first among the Monotropoideae seem fully justified.

Sacramento Junior College,
Sacramento, California, June, 1937.

Literature Cited

1. Andres, H. Piroleen-Studien. Verh. bot. Vereins Prov. Brandenburg 56: 1–76. 1914.
2. Christoph, H. Untersuchungen über die mykotrophen Verhältnisse der "Ericales" und die Keimung der Pyrolaceae. Bot. Centralbl. Beih. 38^1: 115–157, t. 8. 1921.
3. Copeland, H. F. The structure of the flower of Newberrya. Madroño 2: 137–142. 1934.
4. ————. On the genus Pityopus. Madroño 3: 154–168. 1935.
5. ————. The reproductive structures of Pleuricospora. Madroño 4: 1–16. 1937.
6. Crafts, A. S. A technique for demonstrating plasmodesma. Stain technology 6: 127–129. 1931.
7. Domin, K. Vergleichende Studien über den Fichtenspargel. . . . Sitzungsber. kgl. böhm. Gesellsch. d. Wiss., II Cl., I Stück: 1–111. 1915.
8. Drude, O. Pirolaceae. in A. Engler und K. Prantl. Die natürlichen Pflanzenfamilien 4^1: 3–11. 1889.
9. Gray, A., John Torrey, and J. S. Newberry. Exogenous plants. Rep. Expl. Pac. R. R. 6^3: 65–90. 1857.
10. Gray, A. Characters of new plants from California and elsewhere. . . . Proc. Am. Acad. 7: 327–401. 1868.
11. ————. Synoptical Flora of North America, Vol. II, Part I. New York. 1878.
12. Hunt, K. W. A study of the style and stigma, with reference to the nature of the carpel. Amer. Journ. Bot. 24: 288–294. 1937.
13. Jepson, W. L. Manual of the flowering plants of California. Berkeley. 1925.
14. Small, J. K. Monotropaceae. North American Flora 29: 11–18. 1914.

AN ANOMALOUS NEW SPECIES OF LAPSANA FROM CHINA

G. L. Stebbins, Jr.

In going over the unidentified specimens of the Cichorieae in the University of California Herbarium, I found one, collected by Dr. A. N. Steward of the University of Nanking, which was strikingly different from any species known to me in the tribe, and which did not fit in any of the genera listed by Hoffman in Die Natürlichen Pflanzenfamilien. Although the plant strongly resembles the oriental species of *Lapsana,* as well as some species of *Ixeris* (*Lactuca* spp. of auth.), the pappus consists of stout hooks, totally different from any of the numerous types of pappus previously known in the tribe. I sent a few achenes from this specimen to Dr. S. F. Blake of the U. S. Department of Agriculture, and to Dr. A. R. Horwood at Kew, England, both of whom wrote back that they did not recognize them as resembling any Cichoriaceous plant known to them. Dr. Blake noted a resemblance to "one or two genera in other tribes with a similar stiff uncinate pappus, of which the most striking is *Hypericophyllum* of the Tagetinae."

Upon request, Dr. Steward kindly furnished me with additional fragments from the original collection, as well as further information on its habitat, which was the flood plain of the Yangtze River, near Ta T'ung, Anhwei. After careful comparison of this material with specimens of *Lapsana apogonoides* Maxim., with which species Dr. Steward had identified it, I found that the anomalous plant resembled this species not only in habit, but in the character of the involucres, corollas, styles, anthers, etc., as well as in the shape of the achenes. Furthermore, although the achenes of *L. apogonoides* are characteristically epappose, as is typical of the genus, they occasionally bear reduced hooks (pl. XXVII, fig. E). Hence the specimens from Ta T'ung are evidently an anomalous species of *Lapsana,* related to *L. apogonoides.* It may be described as follows:

Lapsana uncinata Stebbins sp. nov. Herba glaberrima patenta; folia basalia runcinato-pinnatifida segmentis deltoideis obtusis remote denticulatis, segmento terminale majore. Caules plures decumbentes; folia caulini reducta vel nulla, lobis saepe acutis. Capitula 5–15 pro inflorescentia; peduncula elongata, erecta. Involucra ad anthesin 5.5 mm., ad fructificationem 6.5 mm. longa, phyllaria exteriora minuta, deltoidea, parce ciliata; phyllaria interiora 5–6, ad fructificationem elliptica, apice obtusa; floscula 10–12 pro capitula. Corollae flavae, 8–9 mm. longae, tubo brevissimo; antherae nigrescento-virides, 2.8–3 mm. longae; styli rami filiformi, 1–1.2 mm. longi. Achaenia compressa, 2.8–3 mm. longa, flavescentia, scabra, costis 10–14, 2–4 valde crassiori-

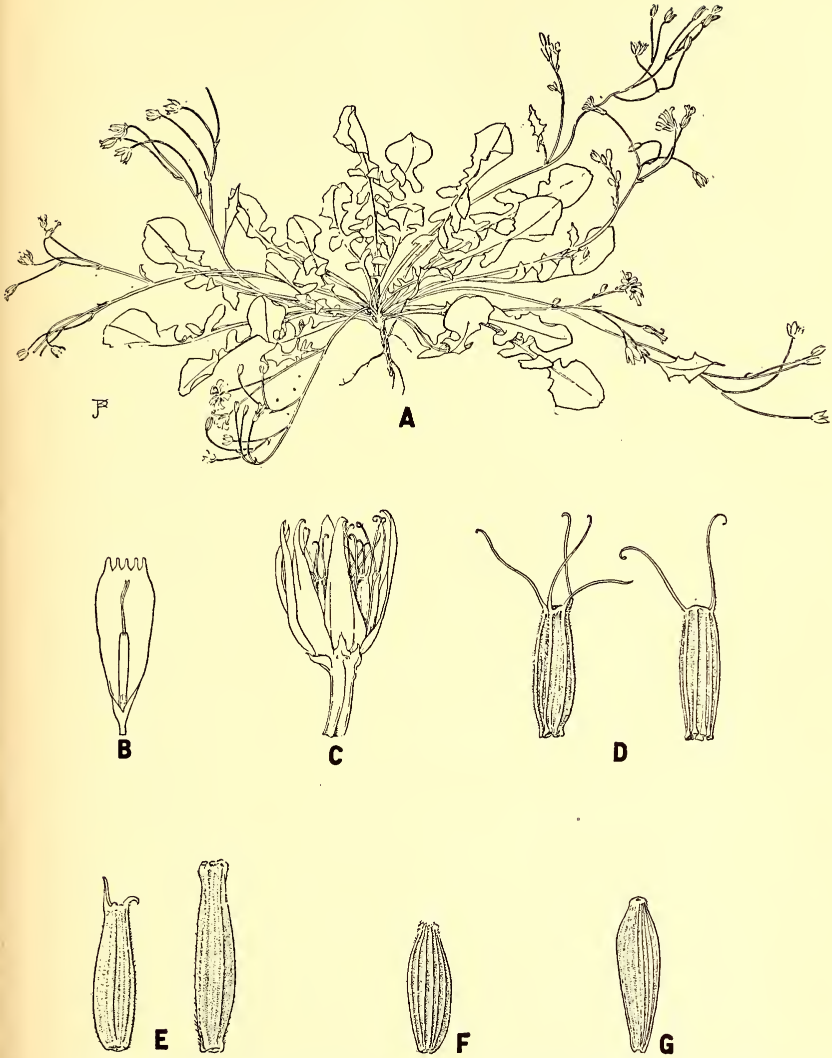


Plate XXVII. Figures A–D, *Lapsana uncinata* Stebbins: A, habit ×1/3; B, corolla ×2 2/3; C, involucre ×2 2/3; D, achenes ×5 1/3. Fig. E, *Lapsana apogonoides* Maxim., achenes ×5 1/3. Fig. F, *Lapsana humilis* (Thunb.) Makino, achene ×5 1/3. Fig. G, *Lapsana communis* L., achene ×5 1/3.

bus; pappus uncinis 2–4, 1.2–2.2 mm. longis constans (pl. XXVII, figs. A–D).

Plant completely glabrous, spreading; basal leaves 4–10 cm. long, runcinate-pinnatifid, the lobes deltoid, obtuse, remotely denticulate, the terminal larger. Stems several from the root crown, 7–15 cm. long, decumbent, leafless or with a single, reduced cauline leaf, its lobes acute. Inflorescence of 5–15 heads on slender, erect peduncles 1.5–5 cm. long, these subtended by small, acute bracts. Involucres in flower about 5.5 mm. long, elongating in fruit to about 6.5 mm., calyculate, the outer bracts small, deltoid, remotely ciliate, the inner 5–6, lanceolate in flower, becoming much broadened and more or less concave in fruit, obtuse at the apex, the midrib obscure below, but often thickened above into a cord-like protuberance. Florets 10–12 per involucre, the corollas pale yellow, 8–9 mm. long, spreading at anthesis, their tube 1 mm. long, glabrous. Anther tube greenish to blackish, 2.8–3 mm. long, style branches filiform, yellow, 1–1.2 mm. long. Achenes compressed, 2.8–3 mm. long, stramineous or reddish yellow, scabrous, 10–14 ribbed, 2 or 4 of the ribs much stronger than the others, pappus of 2–4 stout hooks, these 1.2–2.2 mm. long and minutely scabrous.

China. Near Ta T'ung, Anhwei, 22 April 1924, *A. N. Steward 5248* (type Herb. Univ. Calif. no. 234,000, duplicate in Herb. Univ. Nanking, China). Fragments from the type collection are in the United States National Herbarium, the Gray Herbarium, the herbaria of the New York Botanical Garden, and of the Royal Botanic Gardens, Kew, England.

Although this species simulates *Lapsana apogonoides* Maxim., except in its peculiar pappus, a few other differences between the two species may be noted. *L. apogonoides* has much smaller corollas (4–5 mm. long) which are hardly at all spreading at anthesis, shorter anthers (1.5 mm. long), larger achenes (3.5–4.2 mm. long) which are paler in color, and less prominently ribbed. *L. humilis* (Thunb.) Makino, which also has the habit of *L. apogonoides* and *L. uncinata,* has still smaller flowers, and reddish achenes which about equal in size those of *L. uncinata,* but are somewhat more flattened and have thinner ribs (pl. XXVII, fig. F).

The achenes of these three species may be ranged in a series showing, from *Lapsana uncinata* through *L. apogonoides* to *L. humilis,* a progressively greater reduction of the pappus and the strength of the ribs, along with an increasing degree of compression of the achene. This is accompanied by an increasing reduction in the size of the involucres and florets. This tendency toward a phylogenetic reduction in the size of the floral parts can be found in most genera of the Cichorieae. It has been noted by Babcock and Cameron in *Crepis* (Univ. Calif. Publ. Agr. Sci. 6: 287–324. 1934) and by Babcock and Stebbins in the related genus *Youngia*

(Publ. Carnegie Inst., Wash. no. 484. 1937). *L. uncinata,* therefore, may be considered a primitive, relic species, representing a type ancestral to the other oriental species of *Lapsana.*

Lapsana communis, with its European and western Asiatic relatives, represents a different group of species, whose relationship to the oriental species on the basis of leaf shape, the character of the involucres, corollas, anthers and styles, and the general shape of the achenes, is undoubtedly fairly close, but which differ in their upright habit, the greater compression of their achenes, and certain details such as the pubescence of the corolla tube and the color of the anthers and the style branches. In their floral and achenial characteristics these species may be compared with the more reduced of the oriental species. Hence *L. uncinata* is in floral characteristics the most primitive species of its genus, and its type of pappus, probably the original one in *Lapsana,* has been lost in the other species through reduction. Therefore if the pappus is to be considered a primary criterion of classification in the Cichorieae, as it has by most students of the tribe, *Lapsana* must be considered to occupy a very isolated position in it. However, the resemblance of this genus, not only in habit but in involucral and floral characteristics as well, to two oriental genera of the Crepidinae, *Ixeris* and *Youngia,* is considerable, and strongly suggests an actual relationship between them.

University of California, Berkeley,
August, 1937.

TWO NEW SPECIES OF LINANTHUS FROM WESTERN NORTH AMERICA

Herbert L. Mason

In the progress of studies in the genus *Linanthus* of the family Polemoniaceae the following new species have been discovered. It will be noted in the descriptions that the term 'tube' as applied to the corolla is used in a somewhat restricted sense. The corolla in this genus varies from salverform through funnelform to campanulate. This variation is effected through difference in proportion of the tube, the throat and the lobes of the corolla. The term 'tube' is herein used to apply only to the essentially cylindrical portion of the corolla, whereas the term 'throat' designates that portion of the corolla expanding from the top of the tube to the base of the corolla lobes. The proportion of these three regions of the corolla to one another is often an important diagnostic character of species. Likewise the position of the stamens on the throat or on the tube is usually constant within the species.

In citing specimens, the following abbreviations are used for the various herbaria: University of California, Berkeley (UC), Utah State Agricultural College, Logan (IU), State College of Washington, Pullman (WS), Willamette University, Salem, Oregon (WU).

Linanthus mohavensis sp. nov. Herba annua compacta nana 1-6 cm. alta; cotyledones oblongae; folia opposita, supra pilosa, subtus glabra, in tres lobos lineares acerosos palmatim divisa, lobis interdum pro parte connatis valde venosis, venis usque ad basin distinctis; flores nocturni; cymae dichotomae, floribus solitariis termalibus; calycis tubus interdum ad basin versus sparse pilosus infra sinus usque ad basin membranaceus post anthesin accrescens demum intra nervos propter capsulae dehiscentiam fissus; calycis lobi intus pilosi, aliter glabri, demum inaequales, apicibus acerosis; corolla lutea vel faucibus interdum purpureotinctis 5-7 mm. longa calycem aequans vel vix longior denique capsula accrescente expulsa; stamina circa 1 mm. longa faucium basi affixa; filamenta glabra; anthera orbicularia; stylus usque ad medium in tres lobos lineares divisus; capsula cylindrica trilocularis tubum calycis sub aequans; semina in quoque loculo plures reniformia apud hilum constricta sub aqua inmutata. (Pl. XXVIII, figs. k-p.)

Diminutive compact annual, 1-6 cm. high; cotyledons oblong, leaves opposite, pilose above, glabrous beneath, with prominent veins free to the base, palmately divided into 3 linear, sometimes partially united acerose lobes; anthesis nocturnal; inflorescence dichotomously cymose, flowers solitary in the forks of the cyme; calyx membranous to the base below the sinuses, the membrane growing with the calyx and at length splitting with the dehiscing capsule, lobes pilose within, calyx otherwise glabrous or with a few scattered hairs below, tips acerose, becoming unequal; corolla yellow, sometimes purple-tinted in the throat, 5-7 mm. long, equalling or barely exceeding the calyx, at length pushed out by the growing capsule; stamens included, about 1 mm. long, inserted at the base of the throat of the corolla, filaments glabrous, anthers orbicular; style included, divided to about the middle into 3 linear lobes; capsule cylindrical, about equalling the calyx tube, 3-celled; seeds several to each carpel, reniform, strongly constricted at the hilum, not mucilaginous when wetted.

West side of Searles Lake, one mile south of Trona, San Bernardino County, California, March 29, 1935, *H. L. Mason 8232* (type, U.C. Herb. 567794); Poison Canyon, San Bernardino County, California, April 30, 1935, *H. L. Mason 8294*.

Linanthus mohavensis Mason occurs on gravelly talus and mesas of the Searles Lake region, in association with *Linanthus Jonesii* (Gray) Greene, *Gilia latifolia* Gray, *Mohavea brevifolia* Cov., *Phacelia pachyphylla* Gray and *Atrichoseris platyphylla* Gray. Although growing in association with *Linanthus Jonesii* Gray and being most closely related to it by virtue of several characters in common, it does not even superficially resemble it in field aspect. The low compact mode of growth, the smaller flowers, the stamen insertion, the nature of the pubescence, and the forked leaves readily distinguish it from that species. The following key will serve to point out the relationships of the four species in this section of the genus.

Testa of the seed bladdery, hyaline and membranous at least on the angles; seed ellipsoid, depression of the hilum not conspicuous; calyx glabrous; plants 5–30 cm. high; corolla usually white with brownish-purple patches on the back (occasionally yellow in no. 2).

Filaments with a hairy pad at the base; leaves palmately divided .... 1. *L. dichotomus* Benth.

Filaments glabrous, leaves simple .... 2. *L. Bigelovii* (Gray) Greene

Testa not bladdery nor hyaline, closely investing the seed; seed reniform or subreniform, deeply constricted at the hilum; calyx pubescent; plants 2–10 cm. high; corollas commonly yellow.

Leaves simple; calyx glandular-pubescent externally; stamens inserted in the corolla-tube ... 3. *L. Jonesii* (Gray) Greene

Leaves 3-lobed; calyx glabrous externally; stamens inserted at the base of the corolla-throat ..... 4. *L. mohavensis* Mason

Linanthus septentrionalis sp. nov. Herba annua erecta caulibus plerumque simplicibus, 5–30 cm. altis; folia opposita glabra vel pubescentia segmentis linearibus palmatim 5-7-partita; cymae paniculatae, pedicellis filiformibus 5-20 mm. longis; calycis tubus infra sinus usque ad basin membranaceus, lobis fere ad apices membranaceo-marginatis, cum calyce pari passu accrescentibus; corolla 1-4 mm. longa, calyce sesquilongior, lobis albis vel pallide coeruleis patente rotatis campanulatisve, faucibus tubo brevioribus, annulo piloso media parte vel rarius basi filamentorum instructis; stamina aequalia exserta basi faucium affixa; filamentis glabris vel basi sparse pilosis; stylus exsertus; stigma trilobum; capsula cylindrica trilocularis; semina in quoque loculo 2-4 sub aqua mucilaginosa. (Pl. XXVIII, figs. a-e.)

Erect annual, usually simple, 5-30 cm. high; leaves opposite, palmately divided into 5–7 linear segments, glabrous or pubescent, 5-20 mm. long; inflorescence cymose-paniculate; flowers solitary on filiform pedicels, 5-20 mm. long; calyx membranous to the base below the sinuses, the membrane flanking the lobes almost to the tips above the calyx-tube, growing with the calyx; corolla $1\frac{1}{2}$ times the calyx, 1-4 mm. long, the lobes rotately or campanulately spreading, the throat shorter than the tube, with a hairy ring on the middle portion above the point of stamen-insertion or more rarely only on the base of the filaments; lobes white or pale blue; stamens inserted at the base of the throat, equal in length, exserted, filaments glabrous or with a few hairs at the base; style exserted, stigma 3-lobed; capsule cylindric, 3-celled, each cell with 2-4 seeds; seeds producing mucilage when wetted.

Camp Roosevelt, Tower Junction, Yellowstone National Park, Wyoming, July 10, 1936, *H. L. Mason 3497* (type, U.C. Herb. 552425).

Linanthus septentrionalis Mason is a small flowered delicate annual of the Great Basin and Rocky Mountain region which superficially, closely resembles *L. Harknessii* Curran of the high Sierra Nevada, the Cascade Mountains and westward. In general it is more robust, has a larger corolla, with hairs on the inside as well as sometimes on the filaments and has many more seeds to the capsule than does *L. Harknessii.* These characters however place it in close relationship with *L. pharnaceoides* (Benth.) Greene rather than with *L. Harknessii.* The following key will bring out the characters that may serve to separate the three species.

Seeds 1 to each cell of the ovary; corolla glabrous within, barely exserted from the calyx; filament glabrous . . 1. *L. Harknessii* Curran

Seeds several to each cell of the ovary; corolla rarely glabrous within, usually with a hairy ring at or above the stamen insertion, or the base of the filaments hairy.

Corolla 2–4 mm. long, 1½–2 times the calyx; hairs dense to sparse in a ring on the throat of the corolla, rarely absent; filaments glabrous or with a few hairs; plants from east of the Sierra and Cascade axis to the Rocky Mountains . . . . 2. *L. septentrionalis* Mason

Corolla 6–10 mm. long, 3–5 times the calyx; hairs dense, on the base of the filaments only; plants from the northern Great Basin and the valleys and foothills of California . . . . . . 3. *L. pharnaceoides* (Benth.) Greene

---

EXPLANATION OF THE FIGURES. PLATE XXVIII.

PLATE XXVIII. Figs. a–e, *Linanthus septentrionalis* Mason: *a* flower; *b* habit; *c* opened corolla; *d* seeds; *e* capsule and calyx. Figs. f–j, *Linanthus Harknessii* Curran: *f* habit; *g* flower; *h* seeds; *i* capsule and calyx; *j* opened corolla. Figs. k–p, *Linanthus mohavensis* Mason: *k* habit; *l* flower; *m* capsule and calyx; *n* seeds; *o* opened corolla; *p* leaf. Figs. q–u, *Linanthus Jonesii* (Gray) Greene: *q* capsule and calyx; *r* habit; *s* flower; *t* seeds; *u* opened corolla.

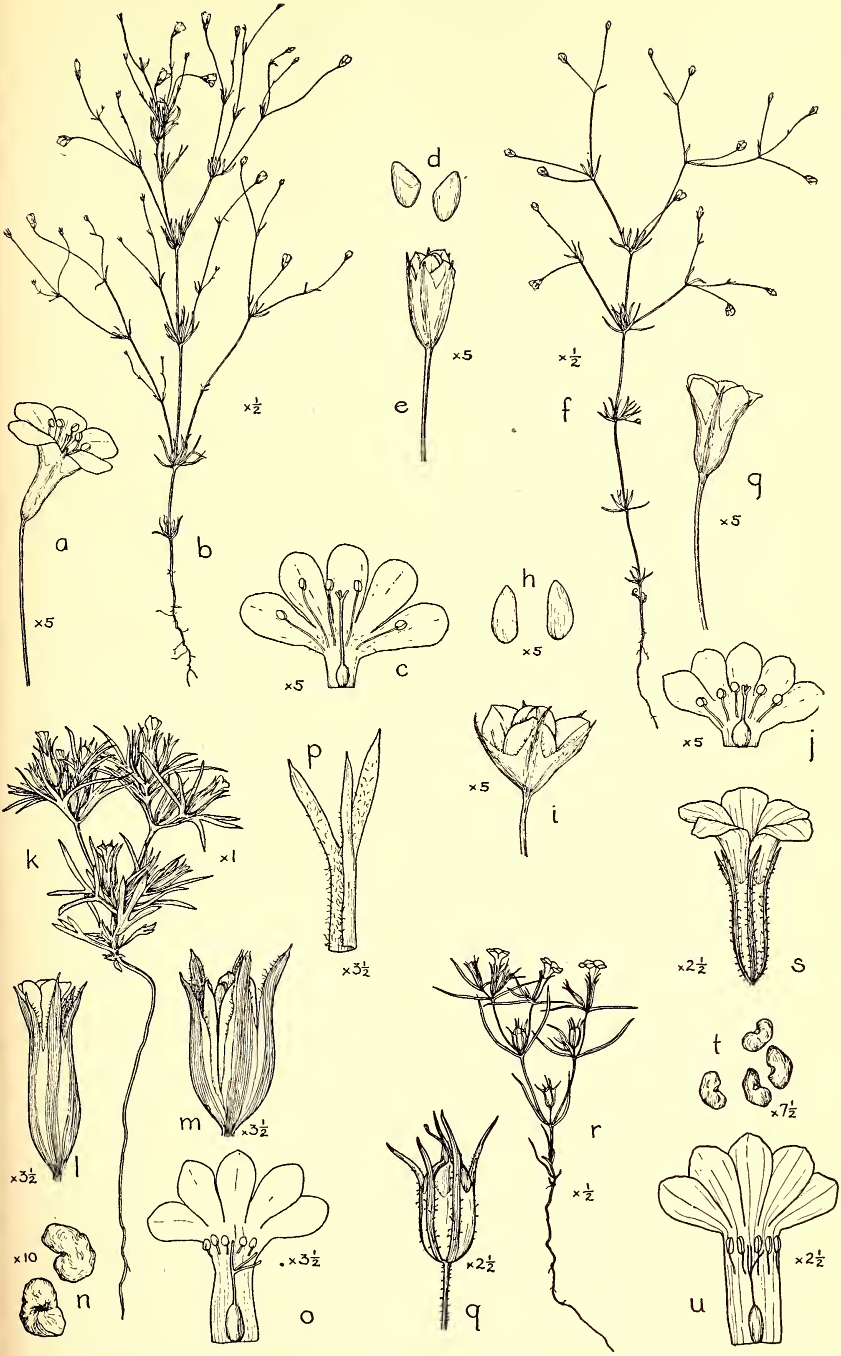


PLATE XXVIII. COMPARATIVE SKETCHES OF LINANTHUS. (See explanation of figures on page 160.)

Specimens examined. BRITISH COLUMBIA. Nicola, 8 mile creek, 6000 ft. *G. V. Copley 68* (WS); Sophia Mountain, *J. M. Macoun 66,561* (WS); Lake Osoyoos, *J. M. Macoun 68,708* (WS). WASHINGTON. Columbia County: Blue Mountains, *C. V. Piper 2398* (WS). Lincoln County: Sprague, 1800 feet, *Sandberg and Leiberg 201* (WS, UC). Okanogan County: east of Omak, *C. B. Fiker 698* (WS). Whitman County: Kamiak Butte, *A. D. E. Elmer 803* (WS). OREGON. Deschutes County: 10 miles east of Bend, *M. E. Peck 19,742* (UC, WU). Harney County: east side of Harney Valley, *J. B. Leiberg 2376* (UC). IDAHO. Blaine County: Camp Creek, *Macbride and Payson 2956* (UC); Tikura, *Nelson and Macbride 1291* (UC, WS). Boundary County: Snowy top Mountain, *F. A. Warren 311* (WS). Kootenai County: Dry Prairies, *J. H. Sandberg 7219* (WS). Nez Perce County: 3500 feet, *A. A. Heller 3432* (WS). Owyhee County: Silver City, 7000 feet, *J. F. Macbride 358* (WS). Shoshone County: Clarkia, along St. Maries River, *C. R. Quick 1095* (UC). MONTANA. Carbon County: Bridger, Bracket Creek divide, July 16, 1902, *J. W. Blankinship* (WS). Gallatin County: Bozeman, *J. W. Blankinship 357a* (WS); Spanish Basin, 6500 feet, *Rydberg and Bessey 4821* (WS); 15 miles south of West Yellowstone, *B. Maguire 1199* (IU). Jefferson County: Boulder Divide, Aug. 4, 1898, *E. N. Brandegee* (UC). Mineral County: Bitterroot Mountains, *H. L. Mason 10,050* (UC). Missoula County: Fort Missoula, *J. E. Kirkwood 1294* (UC). Park County: Big Mud Creek, *W. N. Suksdorf 376* (WS, UC). Powell County: Ovando, *J. E. Kirkwood 1424* (UC). WYOMING. Lincoln County: Headwaters of Hoback River, 9000 feet, *L. Williams 1281* (IU). Teton County: Snake River at mouth of Pacific Creek, 6500 feet, *L. Williams 1636* (WS). Yellowstone National Park: Camp Roosevelt, Tower Junction, *H. L. Mason 3497* (type, UC). UTAH. Cache County: Intervale, Blacksmith Fork Canyon, 5700 feet, *B. Maguire 3670* (IU); Logan Canyon 20 miles above Logan, *H. L. Mason 10,039* (UC); Tony Grove, *J. B. Wann 3669* (IU). Wasatch County: American Fork Canyon 8000 feet, 1902, *M. E. Jones* (IU). NEVADA. Esmeralda County: *W. H. Shockley 660* (UC). Nye County: Toyabe Mountains north of Twin Lakes, *Linsdale 758* (UC). CALIFORNIA. Inyo County: White Mountains, *V. Duran 2756* (UC). Mono County: Conway Grade, between Mono Lake and Bridgeport, 7800 feet, *D. D. Keck 2914* (UC).

University of California,
Berkeley, October, 1937.

NOTES ON SOME SAN DIEGO COUNTY ENDEMICS

Frank F. Gander

Since the ranges of certain endemic species of San Diego County are not well known it seems advisable to publish additional information furnished by specimens in the Herbarium of the San Diego Society of Natural History. This is not a complete list of all species endemic to this county. The collections cited below help to define ranges or to extend them beyond reported limits. Numbers cited in parentheses refer to herbarium accession numbers. Unless otherwise stated collections were made by the author. I am indebted to Dr. Philip A. Munz of Pomona College for some of the determinations.

Bloomeria Clevelandii Wats. Common on mesas and slopes about San Diego, northeast to the vicinity of Fletcher Hills and southeast to Otay Mountain: San Diego (10,992, 15,010), *Daniel Cleveland* (6396, 6400, 6405, 6406, 6408); Woodwardia Canyon of Otay Mountain (15,007); mesa northeast of Murray Dam, near Fletcher Hills (15,088).

Brodiaea Orcuttii (Greene) Baker. Occurs near streams, in seepage areas, and in beds of vernal pools from San Marcos to Otay Mountain: Kearney Mesa (11,099, 11,333); San Diego (15,216); four miles west of San Marcos (16,052); Woodwardia Canyon of Otay Mountain (16,055).

Calochortus Dunnii Purdy. Dry stony slopes of the Cuyamaca Mountains at altitudes from 3500 to 4500 feet: Inspiration Point, *Florence Youngberg* (11,740); Otay Mountain (11,722).

Chorizanthe Orcuttiana Parry. Rare; reported only from Point Loma and Kearney Mesa: Point Loma, *T. S. Brandegee* (1218), *D. Cleveland & Charles Orcutt* (7857); *Daniel Cleveland* (7858); Kearney Mesa (10,604).

Caulanthus stenocarpus Payson. Harbison Canyon southwest of Alpine (14,699). Heretofore reported only from Bernardo near Lake Hodges.

Sedum variegatum Wats. This yellow-flowered form is common in depressions of the mesas from Kearney Mesa to Otay, and inland to El Cajon: East San Diego, *Ralph W. Sumner* (2071); National Ranch, *Daniel Cleveland* (8324, 8325); El Cajon, *Daniel Cleveland* (8326); near mouth of Mission Gorge (15,954); San Diego State College (15,955); Lemon Grove (15,956); Otay (15,957); Kearney Mesa (16,031).

Heuchera brevistaminea Wiggins. Known only from the Laguna Mountains: Shrine Camp, Vallecitos View, *Charles F. Harbison* (12,088); Garnet Peak, *Charles F. Harbison* (12,089).

Ribes canthariforme Wiggins. Common in the shade of large boulders on sheltered slopes near Morena Dam and on the north slope of Lyons Peak. On March 12, 1936, the writer found many plants in full bloom on the sheltered hillside below the dam (13,919). Every bush observed at this site was crowded close against the shaded side of a large boulder and was often completely hidden by the rest of the chaparral. At the type locality, a short distance east of the south end of the Morena Dam, one bush was found (13,918). On March 29, 1936, the species was also found in abundance on the upper part of the north slope of Lyons Peak, about 13 miles due west of the type locality, extending from near the top, at 3755 feet, down to about 3100 feet (14,296). Most of the plants found here were in the shelter of large boulders, but a few were seen in dense chaparral in sheltered places. This species of *Ribes* may occur quite widely in the southern part of San Diego County, as the area has been incompletely explored botanically and it is easily overlooked.

Astragalus oocarpus Gray. Occurs on dry slopes in our mountains: Julian, *Daniel Cleveland* (8536); falls of San Diego River, *Daniel Cleveland* (8537); Witch Creek (11,943); Santa Ysabel (16,168, 16,201); Pine Hills (16,205); Carrizo Creek near Lake Henshaw (16,171); Black Canyon near Mesa Grande (16,332); Palomar Mountain (16,328).

Ceanothus cyaneus Eastwood. Occurs in scattered clumps in the chaparral from Mussey Grade to near Alpine, and abundantly on the northeast slope of El Cajon Mountain: Mussey Grade (15,098); four miles west of Alpine (15,279, 16,297); Barona Valley (15,585); northeast slope of El Cajon Mountain, altitude 3000 feet (15,628); southeast base of El Capitan (15,-752); top of rocky bluff between San Vicente Creek and San Diego River at their junction near Lakeside, the type locality, *M. Phillbrook & F. Gander* (15,224).

Ceanothus austromontanus Abrams. Occurs in the chaparral from near Cuyamaca Lake to near Lake Henshaw: Inspiration Point (11,304); Pine Hills (16,111); Cuyamaca Lake (16,208); south of Lake Henshaw on road to Mesa Grande.

Clarkia delicata (Abrams) Nelson & Macbride. Occasional in openings in the chaparral near Mesa Grande and San Felipe Creek to Campo, Potrero Grade and Harbison Canyon: five miles south of Mesa Grande (11,359); burn in Harbison Canyon (14,698).

Acanthomintha ilicifolia Gray. In adobe lands from Kearney Mesa, San Diego, and Bonita inland to Viejas Grade: Viejas Grade, *Daniel Cleveland* (6668, 6670, 6671); San Diego, *Daniel Cleveland* (6669); Bonita, *H. E. Hansen* (11,457); San Diego

State College (15,023); slope at mouth of Mahogany Canyon, San Diego (15,451); slope at junction of Alvarado Canyon and Mission Valley (15,453); Kearney Mesa (16,020).

Salvia Palmeri (Gray) Greene. Apparently a hybrid between *Salvia apiana* Jepson and *Salvia Clevelandii* (Gray) Greene, this species has been seldom collected: east of Mount Woodson, near Ramona (16,064). The type material was secured by Dr. Edward Palmer on the Tighe Ranch at the foot of the grade on the old road between Ramona and Ballena. It has also been reported from Torrey Pines Park and from Descanso Grade.

Pogogyne nudiuscula Gray. Found only in depressions on the mesas, mostly near San Diego: San Diego, (11,338), *Mary S. Snyder* (4351); *Daniel Cleveland* (6672, 6675, 6676, 6677); Loma Alta on Otay Mesa (11,557).

Pogogyne Abramsii J. T. Howell. Known only from depressions in the mesas near San Diego: San Diego (15,036), *Daniel Cleveland* (6673); Miramar (11,332); Kearney Mesa (16,006).

Monardella lanata Abrams. Known previously only from the region between Descanso and Alpine: Otay Mountain (11,-679); Mt. Woodson (16,065, 16,070).

Ambrosia pumila (Nutt.) Gray. Common around San Diego and in El Cajon Valley, ranging north to San Luis Rey Valley, south to National City, and inland to two miles east of El Cajon: San Diego, *Daniel Cleveland* (8638, 8639, 8640, 8641, 8642); Old Mission Dam in Mission Gorge (5647); Santee (11,492, 15,779); east of El Cajon (12,059); Bostonia cut-off near railroad crossing (15,777); junction of Bostonia cut-off and Lakeside road (15,778); National City (15,581); Sweetwater Dam (15,999); Bostonia (16,001); Lake Hodges (16,019); Mission Valley, west of San Diego Mission (16,048).

Geraea viscida (Gray) Blake. Known only from dry slopes and hills in southern San Diego County: Campo, *Fidella G. Woodcock* (5569, 5570, 5571, 5572, 5573); *George Stenberg* (11,454); Jacumba, *Daniel Cleveland* (8849); Hipass (15,295).

Artemisia Palmeri Gray. This species has been reported previously only from Jamul Valley, National City, and La Jolla: Jamul, *Susan G. Stokes* (13,463); east of Mount Woodson (16,-066) San Vicente Creek near Foster (16,202); Bostonia cut-off near junction with Lakeside road (16,338); Japatul Valley (16,339).

Natural History Museum,
San Diego, California,
November 11, 1936.

THE CALIFORNIA NUTMEG TREE IN CULTIVATION

Albert Wilson

The interest in native plants is ever present among California garden lovers. Catering to this interest are several nurseries devoted entirely or in part to the culture and sale of native plants. Such well known shrubs as *Fremontia, Ceanothus, Carpenteria, Romneya, Ribes sanguineum* and *Mahonia* are often to be found thriving under cultivation. Also sprinkled in the gardens of the state are many specimens of California pines, cypress, sequoias and even oaks.

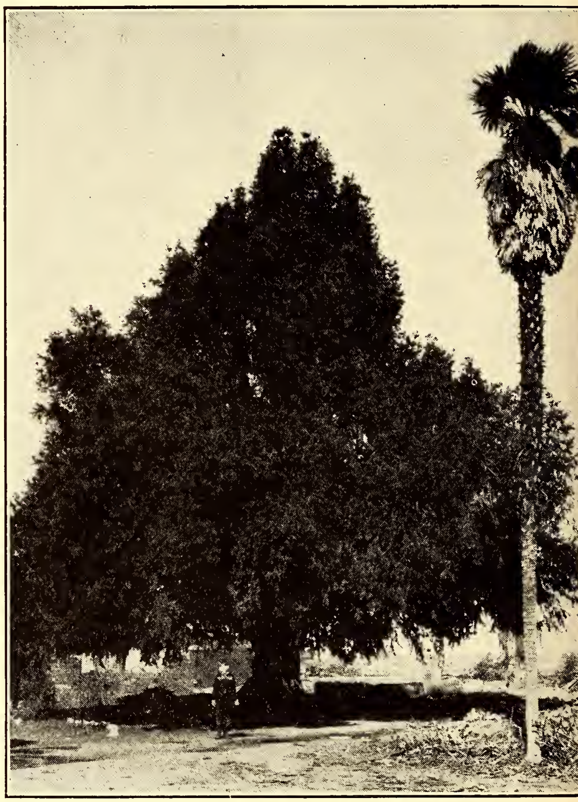


Fig. 1. *Torreya californica* growing at corner of the old Seale estate, California Avenue and Byron streets, Palo Alto, California.

Among the coniferous natives of the state, *Torreya californica* Torr., a handsome tree known commonly as California nutmeg, is found in a few well established gardens. It is not unusual to find trees of great diameter and height in their native habitat, but to find a large *Torreya* in a garden is a rare experience. Of cultivated specimens the most outstanding is in the park opposite the post office in Watsonville, California. Like a forest tree, singled out and favored with an abundance of sunlight and moisture, this beautiful tree is fifty feet high with a trunk three feet in diameter.

On the San Francisco peninsula, particularly in the Palo Alto district, several noteworthy specimens of *Torreya californica* are growing as garden subjects. By far the most conspicuous is a large tree in the Seale Tract on California Avenue at Byron Street, Palo Alto. This tree tapers to a point and is forty feet tall. The trunk is six feet in diameter at ground level and four feet in diameter four feet above the ground. Here the trunk leads off into many large branches causing the plant to appear bushy, thus resembling an English yew. The branches spread to a diameter of more than fifty feet. This tree was growing adjacent to the old Seale mansion, which has just been torn down. It might be safe to estimate its age as approximately sixty or seventy years, since the Seale estate is about one hundred years old, and all members of the family were garden minded.

In Menlo Park on the campus of the Park Military School for Boys on Ravenswood Avenue, opposite the Southern Pacific depot, there is another large cultivated specimen of the California nutmeg. The tree, easily recognized by its dark foliage, stands thirty feet tall, has a spread of twenty-seven feet and arches decidedly to the west. The trunk is three feet in diameter at ground level. Roughly estimated this tree is about fifty years old. The garden, that of the old Mills estate, is of long cultivation. On the grounds of the Leroy Nickel estate on Middlefield Road in Menlo Park there is to be seen another fine specimen of *Torreya californica.* This tree is about thirty-five feet tall with a three foot trunk at ground level and with a spread of twenty-five feet to its branches. Mrs. Nickel reports that it was planted about thirty years ago. A fourth Menlo Park specimen, no doubt much younger than the others, is to be found on the Donohoe estate on Middlefield Road. This tree is eighteen feet tall.

Torreya californica may be regarded as very satisfactory in cultivation and is to be recommended for the garden. All of the specimens mentioned above produce abundant fruit and the seeds germinate easily.

Menlo Park, California,
March 13, 1937.

REVIEW: TWO NEW CATALOGUES OF CASCADIAN PLANTS

The Flora of Crater Lake National Park. By F. Lyle Wynd. The American Midland Naturalist. Volume XVII, Number 6. Pp. 881–949. The University Press, Notre Dame, Indiana. 1936.

The Plants of Mt. Rainier National Park, Washington. By Harold St. John and Fred A. Warren. The American Midland Naturalist. Volume XVIII, Number 6. Pp. 952–985. The University Press, Notre Dame, Indiana. 1937.

The first is a very incomplete list, with keys, taxonomic notes and a synonymy of the names used in the principal manuals, of the plants of the Crater Lake area. Neither habitat data nor localities are given, but most of the specimens upon which the list is based are in the Herbarium of the University of Oregon, at Eugene. The other paper offers a few introductory remarks upon the climate, topography, geology and vegetation of Mt. Rainier, but the bulk of the work is a list of indigenous and adventive species, without keys, but with habitat notes, some localities and a few citations of specimens. Mr. Warren's collection of specimens, deposited at the State College of Washington at Pullman, which substantiated many of the species included in this list, was unfortunately destroyed by herbarium beetles several years ago.

It is a happy circumstance that the one treatment deals with an important section of the southern Cascade Range, whereas the other treats the highest and one of the northernmost peaks of this range. The publication of any key or list of plants of the Cascade Mountains is a welcome addition to the botany of the Northwest and serves to call attention to the desirability of more thorough studies of the same areas.—L. C.

NOTES AND NEWS

Word has been received from Honolulu, Hawaii, of the death on November 7, 1937, of Mr. Leo D. Whitney, formerly a graduate student in the Department of Botany, University of California, Berkeley. Mr. Whitney went to the Hawaiian Islands in October, 1935, as Assistant Agronomist, Hawaii Agricultural Experiment Station, and later was also appointed instructor in the University of Hawaii. He was an enthusiastic and energetic young botanist. News of his untimely death came as a shock to friends here and in the islands.

With the objective of collecting certain fern species from the type localities, Dr. and Mrs. E. B. Copeland left Berkeley, California, on December 18, 1937, for Mexico. Expeditions will be made to Acapulca, Oaxaca, and Orizaba.

Ynes Mexia left Berkeley, California, October 3, 1937, on her fourth collecting trip in Mexico. At present she is at Balsas, State of Guerrero.

Recently appointed research associates in the Department of Botany, University of California, Berkeley, are: Dr. Mildred E. Mathias, specialist in Umbelliferae; Dr. E. B. Copeland, recently technical adviser and botanist, Bureau of Plant Industry, Philippine Islands; Dr. F. W. Foxworthy, forest research officer, retired, Federated Malay States.

VOLUME IV NUMBER 6

MADROÑO

A WEST AMERICAN JOURNAL OF BOTANY

Contents

Published at Lime and Green Streets, Lancaster, Pennsylvania

April, 1938

MADROÑO

A WEST AMERICAN JOURNAL OF BOTANY

Entered as second-class matter October 1, 1935, at the post office at Lancaster, Pa., under the act of March 3, 1879.

Established 1916. Published quarterly. Subscription Price $2.50 per year. Volume I, Numbers 1 to 17, complete, $5.00. Volume II, Numbers 1 to 17, complete, $5.00. Volume III, Numbers 1 to 8, complete, $5.00. Single numbers $0.75.

Papers up to 15 or 20 pages are acceptable. Longer contributions may be accepted if the excess costs of printing and illustration are borne by the contributor. Range extensions and similar notes will be published in condensed form with a suitable title under the general heading "Notes and News." Articles may be submitted to any member of the editorial board. Manuscripts may be included in the forthcoming issue provided that the contributor pay the cost of the pages added to the issue to accommodate his article. Reprints of any article are furnished at a cost of 4 pages, 50 copies $3.70; 100 copies $4.10; additional 100's .75¢; 8 pages, 50 copies $5.40; 100 copies $6.00, additional 100's $1.20. Covers, 50 for $2.50; additional covers at $1.50 per hundred. Reprints should be ordered when page proofs are returned.

Published at Lime and Green Streets, Lancaster,
Pennsylvania, for the

CALIFORNIA BOTANICAL SOCIETY, INC.

Annual membership dues of the California Botanincal Society are $2.50, $2.00 of which is for a year's subscription to Madroño. Dues should be remitted to the Treasurer. General correspondence and applications for membership should be addressed to the Secretary.

PHYLOGENETIC RELATIONS OF PINUS JEFFREYI AND PINUS PONDEROSA

N. T. Mirov

At present the phylogenetic relations of *Pinus Jeffreyi* Balf., Jeffrey pine, and *Pinus ponderosa* Laws., ponderosa pine (western yellow pine), are not accurately known.

Although fossil three-needle pine material occurs as far back as Jurassic, there is none of it which has been definitely assigned to either of the species under consideration. These species may be said to have practically no established fossil record, and it is not certain which of the two pines is geologically older. Long ago Lemmon (3) stated that *P. Jeffreyi* was not only an older form than *P. ponderosa,* but that it should be considered the ancestor of this comparatively younger species. Unfortunately Lemmon does not give any support for his statement. Later Simonsen and Rau (6) advanced a theory that pine species containing in their oleoresin saturated fatty hydrocarbons are probably geologically older than the pines containing unsaturated hydrocarbons, terpenes. It has been found by several investigators that oleoresin of *P. Jeffreyi* contains a saturated hydrocarbon, heptane, and no terpenes, while oleoresin of *P. ponderosa* contains a mixture of terpenes and no heptane. Additional information concerning the differences in oleoresin composition of the two pines may be found in a previous article by the author (5).

It has been suggested by Dr. Herbert L. Mason of the Department of Botany, University of California, Berkeley, that, from a distributional point of view also *P. Jeffreyi* is geologically older than *P. ponderosa.* It is an endemic species restricted almost entirely to California and associated with many other endemic plants. On the contrary, *P. ponderosa* has a much larger range that stretches far beyond the boundaries of the Jeffrey pine endemic group. Hence, it is concluded that *P. ponderosa* is the younger species. Moreover, Jeffrey pine is extremely stable, that is, it does not vary much, thus apparently exhibiting characteristics of racial senility. On the other hand, the extreme variability of *P. ponderosa* may be considered an indication of its relatively younger age.

The writer has been interested for some time in the chemical composition of seed oil of the two species. It has been found that the degree of unsaturation of the seed oil is much higher in *P. ponderosa* than in *P. Jeffreyi.* In general, oil of pine seed consists of triglycerides of unsaturated (oleic, linoleic and linolenic) acids, the amount of saturated compounds being very small. The degree of unsaturation of an oil is governed by the number of double bonds in its molecules. Oleic acid has one, linoleic two,

---

Madroño, Vol. 4, pp. 169–200, April 15, 1938.

and linolenic three, double bonds. With iodine an addition reaction takes place; one molecule of oleic acid reacts with two molecules of iodine, one molecule of linoleic with four, and one molecule of linolenic acid with six molecules of iodine. Iodine number is simply the percent of iodine absorbed by the oil. Analysis of oil samples extracted from seed of the two pines has shown that the iodine number of *P. ponderosa* varies between 147 and 154, the average of twenty samples being 151, while that of *P. Jeffreyi* is between 129 and 138, with 134 as an average for twenty samples. In the following discussion the writer will attempt to show how this difference in iodine numbers can be tied up with the phylogeny of the two pines under consideration.

Ivanov (2) has shown that oils of primitive plants had a high degree of saturation. As evolution of a certain branch of plant life progressed, unsaturation of the oils increased. According to Ivanov, probably the iodine numbers of plants of the Carboniferous and Permian had hardly reached 100–120. Progressively higher iodine numbers appeared later. Although there are many apparent contradictions to Ivanov's postulations, there is also ample experimental evidence to support the theory as a whole.

Ivanov's theory has found reflection in a recent communication by McNair (4) briefly abstracted in the American Journal of Botany. McNair agrees with Ivanov that the "average iodine numbers increase in value with the increase in evolutionary position" of the pines.

In the following table compiled chiefly from Ivanov's "Vegetable Oils," the increase in iodine numbers with evolution of gymnosperms is shown. The information concerning the geologic age of fossil gymnosperms (represented in the table by their nearest living equivalents) was supplied by Dr. Ralph W. Chaney, Professor of Paleontology, University of California, Berkeley.

Species	Geologic ages of most nearly related fossil gymnosperms	Iodine number	Remarks
Zamia integrifolia	Mesozoic	73	
Cycas revoluta	Mesozoic	94	
Ginkgo biloba	Eocene to Miocene	107	
Taxodium distichum	Eocene to Miocene	107	
Pinus monophylla	Miocene to Pliocene	108	Adams and Holmes (1)
Pinus sabiniana	Pliocene to Pleistocene	112	Author's data
Pinus radiata	Pleistocene	152	Author's data

From this table it is seen that in gymnosperms the evolutionary development was followed rather closely by increase of unsaturation of seed oils. The position of *Ginkgo* in this table is perhaps questionable, but it should be remembered that the

Ginkgoales had been developed as an independent branch of gymnosperms for a very long time. When the iodine numbers obtained for the two pines under consideration are compared with the general tendencies of iodine values shown in the table, the conclusion seems to be in favor of a relatively old age for *P. Jeffreyi.*

It appears from the foregoing that in addition to Lemmon's "hunch" of a more ancient origin of *P. Jeffreyi* as compared with *P. ponderosa,* we have now both biochemical and distributional evidence of the relative phylogeny of the two pines.

California Forest and Range Experiment
Station, Berkeley, February, 1938.

Literature Cited

1. Adams, Maxwell and August Holmes. Pine nut oil. Jour. Ind. and Eng. Chem. 5: 4, 285–287. 1913.
2. Ivanov, S. L. Vegetable oils. (In Russian) Moscow. 120 pp., illus. 1924.
3. Lemmon, J. G. Revision of broken cone pines. California State Bd. Forestry. 3rd Bien. Rpt. 196–201. 1889–1890.
4. McNair, James B. The phylogeny of Pinus species in relation to glyceride properties. Am. Jour. Bot. 24: 10, 742. 1937.
5. Mirov, N. T. Chemical analysis of the oleoresins as a means of distinguishing Jeffrey pine and western yellow pine. Jour. For. 27: 2, 176–187. 1929.
6. Simonsen, John L. and Madyar Gopal Rau. The constituents of some Indian essential oils. Indian Forest Records 9 (4): 8. 1922.

ON THE IDENTITY OF CLAYTONIA NEVADENSIS WATSON

Carl. W. Sharsmith

Claytonia nevadensis was described by Watson in 1876 from a specimen collected by J. G. Lemmon in the Sierra Nevada of California. Since this first description, the species has been misunderstood repeatedly, mainly because of lack of knowledge or confusion concerning the nature of the underground parts. These parts consist of a tangled mass of slender, branching rhizomes with fibrous adventitious roots, not easily disengaged from the substratum, especially since the plant usually grows among rocks in shallow springs and runnels. The type of *C. nevadensis* Wats., (Pl. XXIX, fig. 1) upon which Watson's and later Rydberg's (N. Am. Fl. 21: 301. 1932) descriptions were based, and the type of *C. chenopodina* Greene (Pl. XXIX, fig. 2) have been examined. The underground parts of both types, especially of Greene's, are meagerly represented so that their partial or complete misinterpretation by these authors is readily understandable.

Watson, in the key to the treatment of his type material, vaguely described the underground system as composed of a "thickened caudex," while in the text he more correctly designates it as "a rather slender rootstock." He erroneously described the plant as "apparently propagating by runners." The term "thickened caudex" gives a misleading picture of the nature of the underground parts but this part of the description was perpetuated and accentuated by Rydberg (N. Am. Fl. 21: 297, 301. 1932) by his use of the phrase "cespitose rootstock." In the type specimen of *C. chenopodina* Greene, only the upper portion of the slender, branching rhizome remains. Greene, mistaking the rhizomes for a root system, described the plant as having "a fascicle of rather thick and fleshy roots." The somewhat fasciculate appearance of the specimen is due to a lateral rhizome branch which arises in close proximity to a constriction of the main rhizome. The rhizome branch and the fragment of main rhizome beyond the constriction are very similar in appearance. They do not appear as if they were originally at all "thick and fleshy." The underground parts of this specimen are typical of those of *C. nevadensis,* in which the rhizome branches are occasionally somewhat fasciculate, but there is never a cluster of thick, fleshy roots as described by Greene.

The new section *Chenopodinae* in Poellnitz's treatment of *Claytonia* (Poellnitz, K. v., *Claytonia* Gronov. und *Montia* Mich., in Fedde, Rep. Spec. Nov. Reg. Veg. 30: 280, 286. 1932) is an example of the extent to which an error may be perpetuated. This section is erected largely on the basis of the "fascicle of several rather thick and fleshy roots" described by Greene for *C. chenopodina.* "Subhastate" leaves were also used by Poellnitz as a sectional character, since Greene had so described the earlier leaves of *C. chenopodina.* Poellnitz, however, had not seen Greene's type. The leaves present on the specimen are of the form usual in *C. nevadensis.*

Claytonia nevadensis Wats. and *C. cordifolia* Wats., were cited as synonyms of *Montia asarifolia* (Bong.) Howell by Gray in the Synoptical Flora. He indicated *C. nevadensis* as "a reduced form" of *Montia asarifolia.* Jepson, in dealing with this problem (Madroño 1: 147. 1923), clearly pointed out the differences which separate *Claytonia nevadensis* from *Montia asarifolia* Gray (*sensu lato*). As to California specimens, Jepson was dealing with *Claytonia cordifolia* Wats., a plant of the northern Rocky Mountains, Cascades and northern California, probably distinct from *Montia asarifolia* (Bong.) Howell. Although separating *Claytonia nevadensis* from *Montia asarifolia,* Jepson noted their close relationship. His arguments as to the identity of *Claytonia nevadensis* as a distinct species are supported by the series of specimens which have been available to the writer.

A specimen kindly loaned by Dr. Jepson (Mount Leavitt, Tuolumne County, California, *A. L. Grant 420*) is the first collection of *C. nevadensis* which includes really adequate underground parts.

It is the material upon which Jepson based his concepts in transferring the species to *Montia nevadensis* (Wats.) Jepson. He correctly described the underground system as composed of "slender, stolon-like rootstocks." The specimen from Mount Leavitt clearly shows the rhizomatous condition of the species. Its rhizomes are slender and abundantly branched, with the branches occasionally fasciculate along the main rhizome.

The writer was present when the type of *Montia alpina* Eastwood was collected (Mount Dana, Tuolumne County, California, in a cold spring on the northwest slope at 11,000–11,500 feet, August 5, 1931, *H. P. Bracelin 526*) and since has made further observations and collections at this locality over a period of several seasons. These collections have served as a basis of comparison with the types mentioned above as well as with the specimens cited at the end of this paper. The description of *Montia alpina* contains an adequate characterization of the underground parts.

There are two collections on the type sheet of *Claytonia nevadensis,* of which the lower, attributed to Lemmon, is the type. The upper plant (Plumas County, California, August, 1877, *Mrs. R. M. Austin*) is fragmentary but seems referable to *Claytonia cordifolia* Wats. The label under the type specimen reads: "Coll. J. G. Lemmon: Sierra County, &c., 1874." It was Lemmon's custom to put his address on his labels, and he sometimes gave no clue as to the actual place of collection. Rydberg (N. Am. Fl. 21: 301. 1932) cites "Sierra Nevada, (side of Mount Dana), California" as the type locality of the species. He seems to have had information in addition to what appears on the type label. Lemmon, in his collecting as state botanist, visited the Mount Dana region several times. Since *Claytonia nevadensis* is very conspicuous in midsummer, growing in dense masses in the shallow springs on the northwest plateau of Mount Dana, but is relatively scarce elsewhere on the better known parts of the mountain, it is quite possible that this was the site of Lemmon's collection and is thus the type locality of Watson's species as well as of *Montia alpina* Eastwood. As further evidence that the original specimen may not have come from Sierra County, it may be noted that no other collections of the plant have been made north of Mount Leavitt in the Sonora Pass region of Tuolumne County.

The writer would restrict the use of *Montia* to those forms with a gamopetalous corolla split on one side and with three stamens (the *M. fontana* L. group). Thus considered, the species under discussion, with its regular petals only slightly united at the base and its five stamens, falls into *Claytonia,* if this genus is viewed in the broad sense as by Poellnitz (Fedde, Rep. Spec. Nov. Reg. Veg. 30: 280, 286. 1932). The position of the species in *Claytonia* becomes open to question, however, if Rydberg's construction of the genus is accepted. In the nature of the underground parts *C. nevadensis* is closer to *Limnia* than to *Claytonia* as these genera are interpreted by Rydberg. *Limnia* is considered by him as having rootstocks and *Claytonia* as having corms or thick, fusiform roots. He includes *Claytonia asarifolia* and *C. cordifolia,* both closely related to *C. nevadensis* in *Limnia,* which, according to his conception, has three ovules per capsule and, in the perennial species, rhizomatous underground parts. Apparently on the basis of six ovules per capsule he places *C. nevadensis* in *Claytonia* rather than in *Limnia.* Since *C. nevadensis* combines the ovule number of Rydberg's narrow concept of *Claytonia,* with the rhizomatous condition of the perennial forms of *Limnia,* this species would appear to break down the distinctions between these two genera as interpreted by him.

In the latest treatment of the Portulacaceae (Pax, F., and Hoffman, K., Portulacaceae, in Engler and Prantl, Pflanzenf., ed. 2, 16C: 257. 1934), there is again an erroneous conception of the under-ground system of *Claytonia nevadensis.* It is included with those species which have a "flaschenförmiger, fleischiger Wurzel", and placed in section *Belia* (Steller) Rydb. of *Claytonia.* Actually, the nature of the underground system of this species should place it with *Montia* as these authors conceive it. Although they place stress upon the underground structures in differentiating between *Claytonia* and *Montia,* and follow an arrangement different from those of Rydberg and of Poellnitz, these authors admit the difficulties of the generic problems involved and the uncertain state of knowledge concerning these groups. Until generic distinctions in this family are clarified, the writer prefers to view *Claytonia* in the broader sense (including *Limnia*), and to delimit *Montia* as stated above. Presumably differences in floral structure are of more profound taxonomic significance than the nature of the underground parts, in which different forms of storage organs such as rhizomes, corms, or fleshy roots, may be developed.

Claytonia nevadensis Wats., in Brewer and Watson, Bot. Calif. 1: 77. 1876. *Montia asarifolia* Gray Syn. Fl. N. Am. 1: 273. 1897, *pro parte non* Howell, 1893. *Claytonia chenopodina* Greene, Leaflets Bot. Obs. and Crit. 2: 281. 1912. *Montia nevadensis* Jepson, Madroño 1: 147. 1923. *Montia californica* Jepson, Man. Fl. Pl. Calif. 349. 1925, as synonym. *Montia alpina* Eastwood, Leafl. West. Bot. 1: 11. 1932.

Specimens examined: California. Sierra Nevada, 1874, *J. G. Lemmon* (type of *Claytonia nevadensis,* Gray Herb.); in lava loam, Mono County, at 10,000 feet, August 4, 1912, *Hatton and Maule* (type of *Claytonia chenopodina* Greene, U. S. Nat. Herb.); foot of Mount Leavitt, altitude 10,000 feet, Tuolumne County, August 29, 1915, *A. L. Grant 420* (Herb. W. L. Jepson); alpine slopes above Slate Creek, northeast of White Mountain, Mono

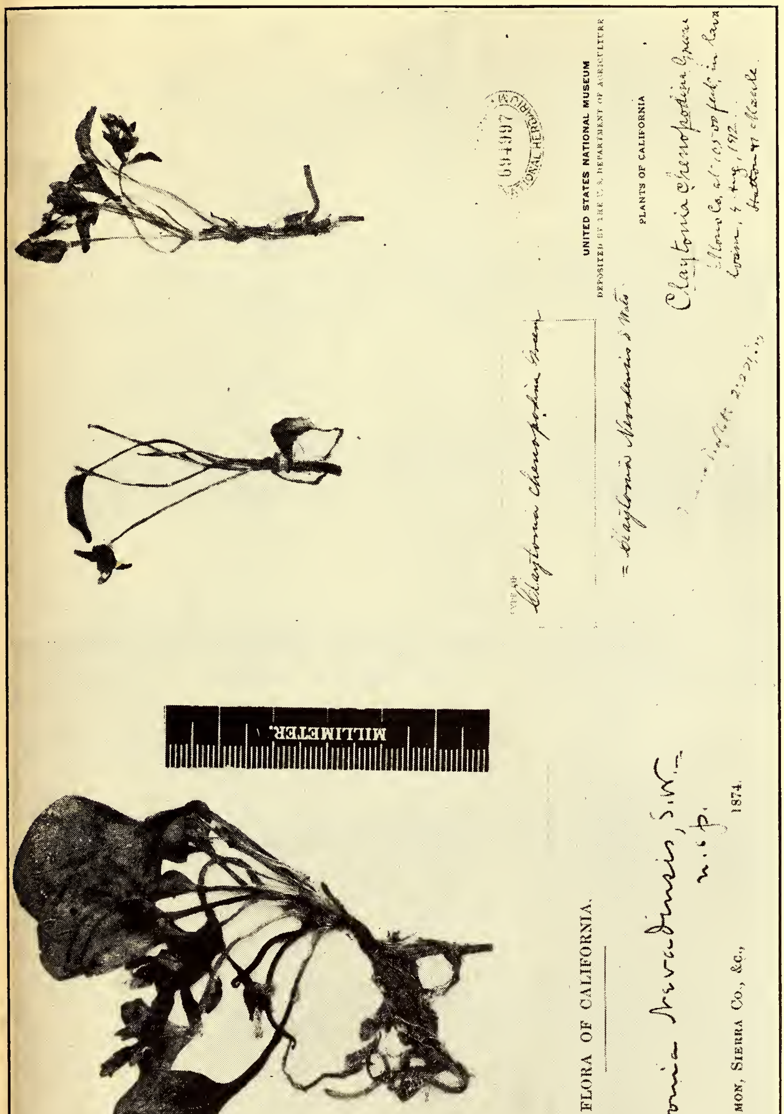


FIGURE 1 FIGURE 2

PLATE XXIX. Fig. 1. *Claytonia nevadensis* Wats., photograph of part of type sheet. Fig. 2. *Claytonia chenopodina* Greene, photograph of type specimen.

County, altitude 11,000 feet, in moist, flat, stony streamway, the roots from beneath stones, September 12, 1929, *H. M. Hall 12,755* (Herb. Univ. Calif.); in a cold spring on the northwest slope of Mount Dana, Tuolumne County, at 11,000–11,500 feet, August 5, 1931, *Mrs. H. P. Bracelin 526* (type of *Montia alpina* Eastwood, Herb. Calif. Acad. Sci., No. 189,088); in dense masses in shallow springs, northwest plateau of Mount Dana, altitude 11,500 feet, Tuolumne County, August 9, 1933, *C. W. Sharsmith 342* (Herb. Univ. Calif.); same locality, September 10, 1934, *C. W. Sharsmith 2019* (Herb. Univ. Calif.); same locality, September 18, 1936, *C. W. Sharsmith 2324* (Herb. Univ. Calif.); Tioga Crest, east of Saddlebag Lake, altitude 11,400 feet, Mono County, July 31, 1936, *H. L. Mason 11,462* (Herb. Univ. Calif.).

University of California,
Berkeley, May 12, 1937.

PICEA BREWERIANA IN SHASTA COUNTY

Philip G. Haddock

Rumors of the occurrence of the weeping spruce (*Picea Breweriana* Wats.) in the Mount Shasta region are verified by the finding in May, 1936, of a small grove of the species on Castle Crags in the northwestern corner of Shasta County. The group occurs at an elevation of approximately six thousand feet and is near the quarter-section corner between sections 4 and 5, Township 38 N., Range 4 W. of the Mount Diablo Meridian. All of the trees seen are located in the saddle or in the gulch to the north between the main higher group of crags and the dome-like rock termed Castle or Battle Rock, which stands out a little to the east of the others. It is estimated that there are about twenty individuals, which would average fifty feet in height and up to two feet in diameter, breast high. They are associated with *Abies magnifica, Pinus Jeffreyi, P. Lambertiana, Arctostaphylos nevadensis, A. patula, Castanopsis sempervirens* and *Ledum glandulosum.*

This spruce is one of the most restricted in range of any species of *Picea.* It occurs in greater abundance to the northwest, in southern Oregon, and to the southwest, in Trinity County, California. The Castle Crag locality is perhaps the most easterly station. Unfortunately, the boundary of Castle Crag State Park is so situated that this grove is narrowly excluded from the preserve.

Berkeley, California,
July 22, 1937.

THE INTRODUCTION OF ACACIAS INTO CALIFORNIA

H. M. Butterfield

A visitor to almost any city in the milder districts of California, from San Diego County north to Sonoma County and inland, is impressed with the fact that two of the most common ornamental trees are exotics. The acacia and the eucalyptus were brought in so many years ago that they appear quite as much at home as most native trees. Previous to 1849 there were no Australian acacias in California. It may be true that *Acacia Farnesiana* was grown about the Spanish misisons at San Diego and Santa Barbara[1] at an earlier date, yet this species is often considered American. The Spanish explorers apparently found it at an early period and ultimately brought it to California by way of Mexico. Paxton in the *Botanical Dictionary* listed this species as having been introduced from San Domingo in 1656. This fact tends to show that early writers associated the first plants of *Acacia Farnesiana* with America, even though the species is now found in many countries.

When gold was discovered in California, people were attracted from all parts of the world. Australians probably brought seeds of the acacia and supplied them to early growers. California nurserymen were soon importing seeds directly from Australia. Many facts regarding these early importations are now available.

Some of the first nurserymen in California had been trained in Europe and were familiar with the acacias already introduced into England. Other nurserymen had English reference books which listed many species. Perhaps most readers of today would be surprised to find a long list of acacias in Paxton's *Botanical Dictionary,* published in London in 1849. When William C. Walker, one of the earliest growers of acacias in California, was making up his catalog for 1858–59 he wrote regarding certain species of Australian trees "not in Paxton's" so we know that these early California nurserymen did use references to check on the acacias which were being imported. Ferdinand von Mueller also began to write of his discoveries in Australia before 1860 so early California nurserymen were able to read about many species of *Acacia.*

Botanical publications furnish dates when various species of *Acacia* were introduced into England. For example, we find that *A. verticillata* was imported into England as early as 1780, *A. pubescens* in 1790, *A. longifolia* in 1792, *A. armata* in 1803, *A. decurrens* var. *mollis* in 1810, *A. melanoxylon* in 1819, *A. cultriformis* and *A. decurrens* var. *dealbata* in 1820. We would naturally ex-

---

[1] Shinn, Chas. H. An economic study of acacias. U. S. Dept. Agric. Bull. 9: 1–38. 1913.

pect the first California nurserymen to include these species in their first plantings. That was exactly what happened.

To look back over a period of about eighty-five years and say that certain species of acacias were the first to be planted in California may be difficult, yet it is possible to offer some interesting facts. Colonel J. L. L. F. Warren, the editor of *The California Farmer,* a paper started in 1853, was also a Sacramento nurseryman. He visited various nurseries and gardens in central California and reported his observations. After a visit to the garden of Mrs. C. V. Gillespie in San Francisco, he reported that the acacias grown by this lady were the first in California. During the early fifties Colonel Warren's nursery was at 15 J Street, Sacramento. His catalog was issued here under the name *Warren and Sons Garden and Nurseries.* A copy of this catalog for 1855, located in the Bancroft Library of the University of California, lists *"Acacia armata," "Acacia dealbata," "Acacia florabunda,"* and *"Acacia longifolia."* The spelling of *Acacia longifolia* var. *floribunda* does not agree with modern usage and *Acacia dealbata* is now referred to *Acacia decurrens* var. *dealbata,* but all of the above acacias are easily recognized today. These four species, listed within perhaps two or three years of their introduction, are probably the first Australian acacias in California. Acacia seeds were being advertised for sale in 1854 by Colonel Warren, according to Charles H. Shinn[1]. Colonel Warren is also reported to have sold plants of *Acacia decurrens* and *A. melanoxylon.* His catalog of 1853–54 does not include *A. melanoxylon* which was, however, listed before 1860.

Acacias sold in early days were soon widely distributed. According to the *The California Farmer,* E. L. Beard had two trees at Mission San Jose in 1855; Dr. Cobb of San Jose had an acacia tree in 1855 that was already 15 feet high and had a spread of 25 feet; Captain Walsh of Benicia and Captain C. M. Webber, founder of Stockton, each had an acacia tree in 1855. The Stockton tree, the editor stated, was only a year old. This would suggest that the others were older.

Reminiscences of early residents are useful in determining dates of introduction, yet memory is sometimes faulty. Lists in old nursery catalogs and advertisements in old papers furnish evidence that is largely beyond dispute. In addition to the catalog of Warren and Sons for 1853, there is a catalog of the "Shell mound Nurseries and Fruit Gardens" for the year 1856 in which the Australian acacia is listed at $1.00 for plants 12 to 18 inches high. R. W. Washburn was owner and a Mr. Sanford manager of the nursery which was located near Brooklyn, now a part of Oakland, California.

Two brothers, William and James O'Donnell, had a nursery on Mission Street, San Francisco, in the early fifties named "The United States Nursery." According to *The California Farmer* they had in 1856 "two acacias of rare beauty and size" which they sold at $50 each. In the same year William O'Donnell moved to San Jose, where he established the "Mountain View Nursery" at 532 William Street between Ninth and Eleventh streets, and there continued to grow the acacia. By 1858, according to the report of the California State Agricultural Society for that year he was growing five thousand acacias.

William C. Walker operated his "Golden Gate Nursery" at Fourth and Folsom streets, San Francisco, until after 1865. He began advertising the acacia as early as 1857 when he reported ten kinds. Until the master copy[2] of his 1858 catalog was located the species which he offered for sale were unknown. Mr. Walker also listed the acacia seeds brought in late in 1859. But let us go over the species offered for sale in 1858, giving them in the exact order found in the old catalog and with the original spelling. Synonyms recognized today are given in brackets.

Acacia lophantha [Albizzia lophantha]
" speciosa [Albizzia Lebbek]
" leptophylla [A. Farnesiana]
" armata
" dealbata [A. decurrens var. dealbata]
" latifolia
" verticillata
" salicifolia [?]
" capensis [A. horrida]
" longifolia
" strombulifera [Prosopis strombulifera]
" falcifolia [A. procumbens]
" Farnesiana
" linearis or longissima
Acacia julibrissin [Albizzia julibrissin]
" dodoenifolia [A. dodonaefolia]
" cornigera
" suaveolens
" trinerva [A. trineura or A. trinervata ?]
" rugosa [A. rugata or A. concinna ?]
" melanoxylon [Walker's synonym of A. latifolia probably incorrect]
" vestita
" barbon (Poinciana Gillesii) [this is Walker's listing]
Silver Wattle [A. decurrens var. dealbata]
Acacia heterophylla

The botanical names given by Mr. Walker may seem a little out of date at this time and yet up to 1900 or later the species of *Albizzia* were still being listed under the genus *Acacia*. Any student of botany who cares to look up the names offered by Mr. Walker will realize that early nurserymen were very well informed for their day, in fact few references of today will include all of the acacias listed in Mr. Walker's catalog of 1858 to 1861.

In 1857 Mr. Walker advertised ten kinds of acacias and five hundred plants. By 1858 the number of species had been more than doubled. By 1861 Mr. Walker was advertising seventy spe-

[2] Copy of Walker's catalog in possession of Miss Alice Eastwood, California Academy of Sciences, Golden Gate Park, San Francisco.

cies and varieties. No California nurseryman since his time has listed so many Australian acacias. New species have been introduced from time to time but Mr. Walker was one of the greatest specialists in growing acacias that California has ever had. Mr. Walker continued to issue nursery catalogs until 1865 or later and fortunately copies of his 1860, 1861 and 1865 catalogs have been preserved from the estate of Captain C. M. Webber. A list therefore of the seventy kinds of acacias advertised can now be presented. To make checking easier, the species listed by Mr. Walker are here arranged alphabetically with synonyms in brackets. Some species and varieties listed are still of doubtful identity; evidently Mr. Walker listed the same species under different names, not realizing at the time that they were synonymous. In reality there were not seventy distinct species, yet every reader will marvel at the long list of acacias, several of which are still rare or unusual. The following species were listed by Mr. Walker in 1860 and 1861:

Acacia argyrolofera [A. brachybotrya var. argyrophylla ?]
" armata
" bienana [A. bynoeana ?]
" bispinata [A. bispinosa]
" caesia
" capensis [A. horrida]
" celastrifolia [A. myrtifolia var. celastrifolia]
" chordaphylla [A. rigens]
" cornigera
" cultriformis
" cuspidata [A. diffusa var. cuspidata]
" dealbata [A. decurrens var. dealbata]
" decipiens
" decurrens [A. decurrens var. normalis]
" dodoenifolia [A. dodonaefolia]
" Douglasii [listed by Paxton, 1868]
" exudens [A. exsudens, A. verniciflua]
" falcifolia [A. procumbens]
" Farnesiana
" floribunda [A. longifolia var. floribunda]
" floribunda pendula ?
Acacia floribunda latifolia ?
" glandulosa [Prosopis glandulosa]
" glauca pendula [A. pendula var. glaucescens ?]
" grandis [A. pulchella var. grandis]
" Guilfoyliana [possibly variety named after M. Guilfoyle]
" heteroclada [A. heteroclita ?]
" heterophylla
" hybrida [A. armata]
" Hugelii [A. Huegelii]
" impressa
" ixiophylla
" julibrissin [Albizzia julibrissin]
" latifolia
" La Trobei [A. acinacea var. Latrobei]
" leptophylla [A. Farnesiana]
" leucophylla [Leucaena glauca]
" linearis
" linifolia
" longiflora floribunda [A. longifolia var. floribunda]

Acacia longiflora magnifica [possibly a variety of A. longifolia]
" longifolia
" longissima [A. linearis]
" lophantha [Albizzia lophantha]
" melanoxylon
" mimeroides [?]
" molissima [A. decurrens var. mollis]
" montana
" monospermum [?]
" mucronata [A. longifolia var. mucronata]
" myrtifolia
" myrtifolia elegans [variety of A. myrtifolia ?]
" nigricans
" neiomanii [?]
" paradoxa [A. armata]
" pendula
" pubescens

Acacia pudalosa [A. paludosa, A. pennata]
" pulchella
" pulchella spinosa [a variety ?]
" pyracantha [A. pycnantha ?]
" rotundifolia [A. obliqua]
" rugosa [A. rugata, A. concinna ?]
" salicifolia [A. salicina ?]
" sophora [A. longifolia var. sophorae]
" speciosa [Albizzia Lebbek]
" spectabilis
" strombulifera [Prosopis strombulifera]
" suaveolens
" trinerva [A. trinervata, A. trineura, A. trinervia ?]
" verticillata
" vestita

A word concerning the prices charged by Mr. Walker may be of interest. In 1858 the following prices were asked: *Acacia linearis* and *Albizzia Julibrissin,* $5; *Acacia decurrens* var. *dealbata,* $3–$5; *A. longifolia,* $2.50; *A. verticillata* and *A. dodonaefolia,* not priced. In 1860 prices had dropped materially and were quoted as follows: *Acacia armata,* $1; *A. cultriformis,* $1.50; *A. decurrens* var. *dealbata,* $2.50; *Albizzia Julibrissin,* $2.50; *Acacia verticillata,* $1.50. Others were not priced, indicating that they may have been scarce.

Seeds of acacia were received by Mr. Walker from Mr. M. Guilfoyle who had established his "Exotic Nursery" at Double Bay, Sydney, about 1852. (His son, W. R. Guilfoyle[3], did much to establish the Melbourne Botanical Gardens.) It is possible that Mr. Walker had heard of M. Guilfoyle's nursery through Dr. Herman Behr who had spent several years in Australia and who was active in the Academy of Sciences, San Francisco, as early as 1854. The following kinds of acacia seed were received by Mr. Walker from M. Guilfoyle in 1859 and were later made available for sale: *Acacia cultriformis, A. spectabilis, A. decurrens* var. *mollis, A. verticillata,* and *A. diffusa* var. *cuspidata.* Mr. Walker issued a catalog as late as 1865; his name disappeared from the San Francisco directory about 1867.

The Suscol Nurseries established by Simpson Thompson in 1853 about six miles south of Napa where, some time before, land

[3] Information received by author from M. Guilfoyle's daughter, 1935.

had been secured from General Vallejo, are also of interest in connection with the acacia. This nursery sold acacias in 1858, but judging from the catalog of 1861, did not continue to handle them.

About 1860 Stephen Nolan of Oakland established his Belleview Nursery and there started to raise the acacia. Mr. Nolan was born on the Island of Jersey in 1818, and since he was apprenticed in England, he was doubtless familiar with the Australian acacia when he came to California. Before starting his nursery, Mr. Nolan had worked on the Potter estate, and the fact that he later listed a plant, which he considered a hybrid, as *Acacia Potteri* might indicate that he had worked with acacias while there. In addition to growing acacias in his nursery, Mr. Nolan also introduced eucalyptus[4] about 1860, and in a short time he became one of the most important growers of Australian plants that California has ever had. While we do not know all that Mr. Nolan handled in the sixties, we do have his catalog for 1871[5]. He listed thirty-four species of acacias in that year. Prices ranged from twenty-five cents to seventy-five cents each for most kinds. The following list of species grown by him may be of interest:

Acacia armata [also listed by Nolan as A. undulata]
“ calamifolia
“ celastrifolia [A. myrtifolia var. celastrifolia]
“ chordophylla [A. rigens]
“ cultriformis
“ dealbata [A. decurrens var. dealbata]
“ floribunda [A. longifolia var. floribunda]
“ homalophylla
“ imbricata [A. lineata]
“ implexa
“ latifolia
“ leiophylla [A. saligna]
Acacia leucantha [A. leucacantha ?]
“ linearis
“ longifolia
“ melanoxylon
“ mollisima [A. decurrens var. mollis]
“ prominens [A. linifolia var. prominens]
“ pycnantha
“ reclinata [A. leprosa]
“ retinodes
“ Sophorae [A. longifolia var. Sophorae]
“ trinervata
“ verrucosa [A. venulosa ?]

In attempting to give synonyms for old names of *Acacia* there is always some possibility of error. Nurserymen, printers, and others have always had trouble in copying correctly and for certain species several names have been in use. *Acacia floribunda* of the gardens in early days may have been *A. retinodes*. *A. floribunda* is often referred to *A. longifolia* var. *floribunda*. Today we

[4] Butterfield, H. M. Introduction of Eucalyptus into California. Madroño 3: 149–154. 1935.

[5] Copy of the catalog in possession of Mrs. W. F. Snyder of Berkeley, daughter of Stephen Nolan.

have both *A. retinoides* var. *floribunda* and *A. longifolia* var. *floribunda* so we can only guess at what early nurserymen meant. *Acacia Reimeri,* possibly named for E. L. Reimers of San Francisco, was mentioned in early literature. This acacia may have been a seedling that differed from the parent plant, or the original label may have been lost and a new name substituted. Considerable variation exists in certain species, and hybrids have been found from time to time, so it would not be strange if these early nurserymen had difficulty in properly classifying certain seedlings; an easy solution was to give a new name.

During the sixties certain additional species of *Acacia* were doubtless imported but little is known about this period. Julius Ferrer[1] of San Francisco, according to his report in the *Pacific Rural Press* at a later date, was growing at his nursery in 1862 the following species: *A. cyanopyhlla, A. cuneata, A. decurrens* var. *dealbata, A. linearis, A. longifolia, A. linata, A. melanoxylon, A. decurrens* var. *mollis, A. pendula,* and *A. Riceana.*

Most of the early acacias in California were started from imported seed but some plants also were brought in. As early as 1859 Mr. Walker brought in to San Francisco *Acacia pubescens* in a Wardian case. George Gordon, nurseryman of Menlo Park, imported some trees of *Acacia latifolia* about 1869. Unfortunately these plants were infested with the cottony cushion or white scale (*Icerya purchasi*)[6]. Oranges brought in from Australia at the same time also became infested and, when shipped to southern California, spread this serious insect pest to citrus orchards. It gradually spread throughout the state and by 1877 was attacking acacias in Marin County. Perhaps this experience aided in the development of mineral oil sprays, and it did lead to the introduction from Australia of the Vedalia (*Rodolia cardinalis*), a small red ladybird beetle which preys on this scale.

The change that took place in California gardens from 1860 to 1880 was remarkable. Dr. Herman H. Behr, a friend of Ferdinand von Mueller, who came to California in 1851, became associated with the California Academy of Sciences in San Francisco and was instrumental in introducing the various Australian plants into California. In 1870 W. H. Hall started acacia plantings in Golden Gate Park, setting out twelve hundred trees, representing ten species[1]. While Dr. Behr did not do any of the planting, his friendship with von Mueller probably had something to do with the introductions of the acacias. In 1880 Dr. Behr was led to say, "The vegetation of the peninsula [referring to the peninsula from San Francisco south through San Mateo and Menlo Park] is at present more Australian than Californian."[7] In later years as many as fifty thousand acacia trees were set out in Golden Gate Park in a single year, partly to help bind the sand and

---

[6] Essig, E. O. A history of entomology. p. 119. Macmillan Co., 1931.
[7] Pacific Rural Press, San Francisco, February 21, 1880.

partly as ornamentals. *Acacia longifolia* was used extensively for this purpose. In time perhaps half a million acacia trees, representing sixty species, were planted in Golden Gate Park. Mr. John McLaren should be honored for his part in this enterprise. Some of these *Acacia* species[8] are listed below: *A. acinacea, A. acuminata, A. adunca (crassiuscula), A. aestivalis, A. alata, A. armata, A. aspera, A. Baileyana, A. Betchei, A. Cavenia, A. confusa, A. cultriformis, A. Cyclops, A. decurrens* var. *dealbata, A. decurrens* var. *mollis, A. dentifera, A. Dietrichiana, A. dodonaefolia, A. elata, A. Farnesiana, A. fimbriata* (form of *A. linifolia* var. *prominens*), *A. glaucescens, A. hastulata, A. implexa, A. iteaphylla, A. juncifolia, A. Koa, A. leprosa, A. lineata, A. longifolia, A. longifolia* var. *floribunda, A. longifolia* var. *latifolia, A. longifolia* var. *Sophorae, A. melanoxylon, A. microbotrya, A. obliqua, A. oxycedrus, A. pendula, A. pentadenia, A. podalyriaefolia, A. pravissima, A. prominens (A. linifolia* var. *prominens*), *A. pruinosa, A. pulchella* var. *hispidissima, A. pycnantha, A. retinodes, A. retinodes* var. *floribunda, A. retinodes* var. *gracillima, A. Riceana, A. salicina* var. *Wayae, A. saligna, A. stenoptera, A. tenuifolia, A. verticillata.*

Several nurserymen sold acacias in San Francisco between 1870 and 1880. E. L. Reimers exhibited several of his acacias at the Bay District Horticultural Fair held in San Francisco in 1871, among them *Acacia conspicua (A. vestita), A. cordata* (trade name not recognized), *A. alata, A. pulchella,* and *A. rubra (A. rubida* ?)[9]. He had also many of the old favorites.

The Pacific Nursery of San Francisco, operated by F. Lüdemann, included the following species of *Acacia* in a catalog for 1874–75[10]: *A. albicans [Pithecolobium albicans], A. conspicua [A. vestita], A. farinosa, A. fragrans [Albizzia fragrans], A. La Trobay [A. acinacea, A. Latrobei].*

With the establishment of the College of Agriculture at the University of California in 1874 a new influence was exerted on horticulture. Landscape men of the old school actually objected to the large number of Australian trees set out on the new campus. Dr. Eugene Hilgard arrived in 1875 to serve as Director, and E. J. Wickson joined him later. Both took an active interest in the distribution of acacias to people throughout California. All through the earlier days of the University standard species such as *A. melanoxylon* and *A. decurrens* or its varieties received much attention. A total of five thousand individuals and 25 species had been planted on the campus by 1875. Acacia seeds of new species, such as *A. pulchella* var. *grandis,* were received as early as 1879. In time the institution attracted the attention of such men as Baron von Mueller. We find in the report of the Experiment Station for 1886 that this noted botanist

[8] List supplied by Miss Katherine D. Jones, College of Agriculture, University of California.

[9] For detailed list see "The California Horticulturist," 1871.

[10] Catalog in the Bancroft Library, University of California.

sent seeds of *A. sentis* and *A. spectabilis.* It was also in 1886 that seeds of *A. arabica* were received. Dr. Herman Behr and others doubtless assisted in forwarding acacia seeds for further increases. Two years later an inventory of the trees on the campus showed well over twenty species of acacias. Most of those grown were early introductions, but a few such as *A. Cavenia, A. Greggii, A. imbricata* (*A. lineata*), and *A. Riceana* were not so widely known. The planting of new species of acacias on the campus at Berkeley continued until well after 1900. *Acacia elata* was planted in 1901.[11] Specimens of *Acacia cultriformis* and several other species planted at about this time are still living.

In 1885 forestry experiment stations were established at Chico and Santa Monica under the State Board of Forestry. Some acacias were set out before the University of California took over the stations in 1893. At that time *A. retinodes, A. cyanophylla,* and *A. latifolia* were doing well but probably many trees had succumbed because of poor care. Planting continued after the University took over the work, especially during the years 1900 to 1910. A survey of the trees at the Santa Monica Forestry Experiment Station in 1917 by W. Metcalf, now extension forester in the College of Agriculture, University of California, showed the following species: *A. arabica, A. Baileyana, A. binervata, A. cultriformis, A. cyanophylla, A. Cyclops, A. decurrens, A. decurrens* var. *dealbata, A. decurrens* var. *mollis, A. Dietrichiana, A. elata, A. Jonesii, A. leprosa, A. longifolia, A. longifolia* var. *floribunda, A. Maideni, A. melanoxylon, A. neriifolia, A. pruinosa, A. pycnantha, A. saligna, A. verniciflua* (listed as *A. virgata*).

Conditions at the Chico Forestry Experiment Station were not so favorable for acacias and yet attempts were made to grow many species. Some of those growing in 1893 in the nursery[12] are: *A. arabica, A. argyrophylla* (*A. brachybotrya*), *A. Bartheriana* (*A. Berteriana*), *A. capensis, A. cyanophylla, A. dodonaefolia, A. glauca* (*A. glaucescens*), *A. glomerata* (*A. glomerosa* ?), *A. holocericena* (*A. holocericea* ?), *A. leucocephala* (*Leucaena glauca*), *A. lophantha* (*Albizzia lophantha*), *A. lunata, A. melanoxylon, A. monophylla* (?), *A. ornithoflora* (*A. armata* ?), *A. ovalifolia* (?), *A. peregrina* (*Piptadenia peregrina* ?), *A. pycnantha, A. spectabilis* var. *excelsa, A. trinervis* (*A. trineura* or *A. trinervata* ?).

For several years after 1885 nurserymen showed very little interest in new species of acacias. Here and there a nurseryman would include some new species, but no large number was added. John Rock, who came to San Jose in 1865 and helped start the California Nursery at Niles in 1885, had doubtless seen California horticulturists wax enthusiastic about Australian acacias, yet he always showed only a moderate interest by listing a few popular species. In 1888 Mr. Rock included *A. falcata* in his catalog.

[11] Jones, Katherine D. Acacias in California. National Horticultural Magazine. January, 1933.

[12] California Agricultural Experiment Station Report. 1893.

Many years later, in 1915, his successors were still adding a few new species such as *A. Baileyana, A. juniperina, A. neriifolia,* and *A. podalyriaefolia,* but the additions were made cautiously and in accordance with demand. The handling of new species of ornamentals is not always profitable. Introduction of other new species had to await the interest of enthusiastic plant importers such as Dr. F. Franceschi (Dr. F. Fenzi) and E. O. Orpet of Santa Barbara, or of horticulturists connected with some institution not dependent on the financial outcome, such as Golden Gate Park or the University of California.

The history of the introduction of acacias into California is by no means limited to central California, even though the first acacias were grown near San Francisco and Oakland. Several nurserymen and private growers in Santa Barbara, Los Angeles, and San Diego counties have imported new species. The following listed by Dr. Franceschi and P. Reidell in their catalog for 1908 and later were of special interest: *A. accola, A. Baileyana, A. elongata,* var. *angustifolia, A. extensa, A. leptoclada, A. obliqua, A. pendula, A. penninervis, A. podalyriaefolia, A. pravissima, A. subulata.* Other plants listed with these in the 1908 catalog were *Pithecolobium flexicaulis, Acacia corymbosa* and *A. notabile* (*A. notabilis* ?).

Mr. E. O. Orpet of Santa Barbara has grown some interesting species of *Acacia* in recent years, including *A. Bakeri, A. obtusata,* and *A. mucronata. Acacia pulcherrima* reported growing at Mr. Orpet's nursery is probably *Stryphnodendron floribundum.*

Still another important center of introduction in southern California is to be found about San Diego where Miss Kate Sessions, T. Wayland Vaughn and others have shown an active interest in novelties. Mr. Vaughn has been associated with Scripps' Institute of Oceanography where such species of *Acacia* as *A. cardiophylla, A. decurrens* var. *Leichardtii, A. falcata, A. flexifolia, A. hakeoides, A. leptoclada, A. linifolia* var. *prominens, A. nonuttiana* (?), and *A. viscidula* have been grown. Other *Acacia* species reported about San Diego include *A. aneura, A. Bancrofti, A. Betchei, A. decora, A. decurrens* var. *pauciglandulosa, A. penninervis,* and *A. polybotrya* var. *foliolosa.* The San Diego climate should prove to be very favorable for some of these less common species.

The United States Department of Agriculture, through the Office of Foreign Seed and Plant Introduction, has imported certain species of *Acacia.* Several of these are native to Africa and are of questionable ornamental value. Others listed have been grown previously, but the reintroduction of *Acacia* species has taken place many times and we can expect many will be reintroduced in the future. Perhaps only a few of the three hundred Australian species are really adapted to California and only a few will live for any long period.

Inquiry is often made as to the location of old acacia trees in California. Most acacias are shallow-rooted and interfere with the growth of other plants near by; they also clog sewers at times and break sidewalks. For such reasons the trees are often removed while still young. Low winter temperatures which occur occasionally have wiped out many acacias, the freeze of 1913 having killed most of those at the Chico Forestry Experiment Station, and the freeze of 1933 having killed all of the acacias on the State Capitol grounds at Sacramento. Very old acacias have been removed in cities as business enterprises grew and needed space, and even under favorable conditions some of the species introduced would not have survived very long in California. These several factors help to account for the scarcity of old acacias in the state.

A few old trees of *Acacia melanoxylon* planted in 1879 are still growing along Berkeley streets. One of these trees now measures 2.9 feet in diameter breast high and is 70 feet tall. Old trees of *Acacia verticillata* are also found in Berkeley. Probably old acacia trees are still alive in other parts of California. Readers are invited to report such specimens, giving the age and any interesting facts associated with their introduction. Readers can assist also in completing this story of the Australian *Acacia* in California by reporting rare species not included in this record.

College of Agriculture,
University of California,
November, 1936.

HARRY STANLEY YATES

Harry Stanley Yates, the only child of Francis Frederick Yates of Kidderminster, England, and Jennie Gibson Yates of Worcester, Massachusetts, was born in Marshall, Minnesota, on October 2, 1888, and died in Berkeley, California, January 17, 1938. The family came to California in 1890 and settled on an orange ranch near Pomona. In 1912 he was married to Alice B. Weber, a botanist and a fellow member of the University of California class of 1912. Dr. Yates is survived by his wife, his daughter, Elizabeth Yates Biernoff, and his son, Francis Gordon Yates.

After graduating from Pomona High School in 1908, he attended the University of California at Berkeley, graduating in 1912. The degrees Master of Arts and Doctor of Philosophy were conferred upon him by the University of California in 1914 and 1915. He was a life member of the Malayan Branch, Royal Asiatic Society, and of the National Geographic Society, a charter member of the California Botanical Society, and a member of the University of California chapter of Sigma Xi.

Upon receiving his doctor's degree he accepted a position as mycologist for the Bureau of Science, Manila, Philippine Islands. After spending five years in this position he became research botanist for the United States Rubber Company on its plantation at Kisaran, Asahan, Dutch East Indies, East Coast Sumatra. In 1929 he returned to the United States with his family, and in

1932 became associated with the California Forest Experiment Station as botanist for the Vegetation Type Survey of California and western Nevada. In this work he was responsible for training the field men in plant identification, for checking the field determinations and for the organization and development of an herbarium for the permanent preservation of the specimens upon which the maps are based. At the time of his death this herbarium contained a collection of more than twenty-three thousand plants.

From his student days, Dr. Yates was an enthusiastic collector, some eight thousand specimens having been donated to the University of California Herbarium as a result of his labors. His earlier collections were largely fungi, while his later ones were more general. In 1915 he made a valuable collection of the plants of the Trinity National Forest, California. In the Philippines he continued his interest in general collecting, but his best known collections are those made in Sumatra, a set of six thousand flowering plants and one thousand fungi of this series being deposited in the University of California Herbarium. In recent years, he became especially interested in California grasses, and his extensive collections are a distinct contribution to our knowledge of the grasses of this state. The large collections of the genus *Arctostaphylos* that passed through his hands in connection with his duties in the Vegetation Type Map Survey gave him a very complete knowledge of this genus. Although the work is unpublished, it was organized for use by the field crews and proved to be a very workable treatment of a difficult group.—HERBERT L. MASON.

LIST OF PUBLISHED WRITINGS

1915. Stock Poisoning Plants of California (with H. M. Hall). Calif. Agric. Exp. Stat. Bul. No. 249: 219–247.

1916. The Comparative Histology of Certain Californian Boletaceae. Univ. Calif. Publ. Bot. 6: 221–274, pls. 21–25.

1917. Copra and Coconut Oil (with H. C. Brill and H. O. Parker). Philippine Jour. Sci. 12: 55–86.

Fungi collected by E. D. Merrill in southern China. Philippine Jour. Sci. 12: 313–316.

The revegetation of Volcano Island, Luzon, Philippine Islands, since the eruption of Taal Volcano in 1911 (with W. H. Brown and E. D. Merrill). Philippine Jour. Sci. 12: 177–248, pls. 4–16.

The rate of growth of some trees on the Gedeh, Java (with W. H. Brown). Philippine Jour. Sci. 12: 305–310.

Some recently collected Philippine fungi. Philippine Jour. Sci. 12: 361–380.

1918. Fungi from British North Borneo. Philippine Jour. Sci. 13: 233–240.

Some recently collected Philippine fungi, II. Philippine Jour. Sci. 13: 361–384.

1919. The growth of Hevea brasiliensis in the Philippine Islands. Philippine Jour. Sci. 14: 501–523.

Pink Disease of Citrus (with L. H. Atherton). Philippine Jour. Sci. 14: 657–671, pls. 1–7.

ERIOGONUM ABERTIANUM AND ITS VARIETIES

F. Raymond Fosberg

Dr. John Torrey described *Eriogonum Abertianum* in Major Emory's "Notes of a Military Reconnoissance" (p. 151, 1848). The plant is an annual, ordinarily dichotomously or trichotomously branched near or above the base, canescently tomentose to villous, with campanulate involucres bearing many flowers; the perianth parts are in two series, the outer three expanded, more or less orbicular, membranous-scarious, covering the narrow inner ones. This species is closely related to *E. pharnaceoides* Torr., differing in the pubescence, the leaf shape, and in the more expanded outer perianth segments which are thinner and more scarious. It is also related to *E. ovalifolium* Nutt., from which it differs in being an annual, in the pubescence and shape of its leaves, and in the open rather than condensed inflorescence.

A study of material from the Mesilla Valley, New Mexico, indicated that there were two different entities which keyed, in the Flora of New Mexico by Wooton and Standley, to *Eriogonum Abertianum.* In the synonymy was given the name *Eriogonum cyclosepalum* Greene (Muhlenbergia 6: 1. 1910) the description of which seemed to fit one of the Mesilla Valley plants. The remainder of the material agreed better with *E. pinetorum* as described by Greene in the same paper than with *E. Abertianum* Torr. as interpreted by him.

In an effort to settle the problem, *Eriogonum Abertianum* and related species were studied in the herbaria of Pomona College, California Academy of Sciences, Los Angeles Museum, and the University of California, Berkeley. The material examined included isotypes and cotypes of *E. pinetorum* Greene, *E. cyclosepalum* Greene, *E. arizonicum* Gandoger, *E. Abertianum* var. *neomexicanum* Gandoger, and *E. Abertianum* var. *ruberrimum* Gandoger. Dr. Gleason had photographed for me at the New York Botanical Garden the type of *E. Abertianum* in the Torrey Herbarium.

As shown by these photographs, Dr. Torrey had at hand only one sheet which bears material collected by Abert. This sheet contains two specimens, one a small fragment of the top of a plant, labelled "July 17, Lt. Abert," and another marked "Oct. 14th, 1846, Emory." A careful study of Emory's Report shows that on July 17 Lieutenant Abert was near the junction of the Pawnee River with the Arkansas River, in Pawnee County, Kansas, considerably out of the present range of the species, and on October 14, Emory was along the Rio Grande, apparently in Sierra County, New Mexico. Both of these plants seem to be *Eriogonum Abertianum* var. *neomexicanum* Gandoger. The other sheet in Torrey's herbarium bears four specimens. The plant on the left of the sheet, no. 1, collected in August by Dr. Bigelow from "Near San Diego (Vall. of R. Grande)" is *E. Abertianum* var. *bracteatum*. The remaining three specimens should all be referred to *E. Abertianum* var. *cyclosepalum*. They were collected in Mexico by Dr. Parry: no. 2 at Chihuahua; nos. 3 and 4 from Janos [Janas?], northern Chihuahua. All of these plants were named simply "*Eriogonum Abertianum*" by Torrey.

The groups of plants in this complex are best treated as varieties of a single species, *Eriogonum Abertianum* Torr., because of the insignificance of the characters in which they differ. Miss S. G. Stokes (The Genus Eriogonum, 36. 1936) recognizes subsp. *typicum* and subsp. *lappulaceum*, considering other described segregates as mere ecological variations. The varieties treated in this paper, except var. *lappulaceum* would be included by her in subsp. *typicum*. Since these plants as observed in the field do not behave as ecological variants, I cannot agree with her treatment.

Key to the Varieties of Eriogonum Abertianum

Outer sepals obovate, almost truncate at top....... 7. *E. Abertianum* var. *lappulaceum*

Outer sepals nearly circular, broadest in the middle.

  Plant paniculate above; bracts inconspicuous, upper part of plant not leafy.

    Peduncles mostly under 0.5 mm. long; outer sepals dark reddish, 2 mm. broad or narrower .... 2. *E. Abertianum* var. *ruberrimum*

    Peduncles mostly over 0.5 mm. long, outer sepals only slightly reddish, 2.5 mm. broad or wider. 1. *E. Abertianum* var. *neomexicanum*

  Plant not paniculate above, peduncles of involucres axillary, plant leafy or conspicuously bracteate to top.

    Peduncles mostly under 1 cm. long, heads usually under 1 cm. across, plant bracteate above.... 5. *E. Abertianum* var. *bracteatum*

    Peduncles mostly over 1 cm. long, heads usually over 1 cm. across, plant bracteate or foliaceous above.

      Leaves reduced to lanceolate bracts above, basal leaves attenuate at base, their petioles 2 cm. long or under........ 6. *E. Abertianum* var. *Gillespiei*

      Leaves not much reduced above, basal leaves usually truncate or cordate at base, petioles of basal leaves usually over 2 cm. long.

        Plants branching at base, usually floriferous to base; outer sepals 3.5–4.5 mm. broad, slightly longer than broad .... 4. *E. Abertianum* var. *cyclosepalum*

        Plants branching dichotomously or trichotomously somewhat above base, floriferous above only; outer sepals 2.5–3.5 mm. broad, slightly broader than long .... 3. *E. Abertianum* var. *villosum*

1. Eriogonum Abertianum Torr. var. neomexicanum Gandoger, in Compt. Rend. Soc. Bot. Belg. 42: 196. 1906. *E. pinetorum* Greene, Muhlenbergia 6: 3. 1910.

Erect plants, soft villous but not conspicuously whitish except on young parts, seldom branched at base but usually repeatedly dichotomously or trichotomously branched above into a definite panicle, peduncles and upper branches usually filiform; petioles 1–2 cm. long, leaves near base broadly oblong-ovate to narrowly ovate, obtuse to acute at apex, truncate to attenuate at base, reduced above to small linear bracts 5 mm. or less long in the paniculate inflorescence; peduncles 0.5–3 cm. long, filiform, usually 1 at a node, surmounted by a single turbinate involucre, 2–2.5 mm. high, 3 mm. in diameter with lanceolate lobes usually 2.5–4 mm. long; flowers rather numerous, exserted on fine filiform pedicels, the rather spherical inflorescence 5–10 mm. in diameter; outer sepals 2.5–3 mm. broad, circular or slightly longer than broad, membranous-scarious, yellowish-white, tinged with red.

Specimens examined. Kansas. Arkansas River, Pawnee Co., July 17, 1846, *Lt. Abert* (type, New York Bot. Gard.). Arizona. Tucson, *Thornber 196;* Tucson, May 10, 1896, *J. W. Toumey;* Outlaw Cañon, Chiricahua Mts., *Goodding 2373;* Pearce, Cochise Co., Aug. 19, 1910, *W. W. Jones;* Antelope, *C. A. Purpus 52;* Clifton, *A. Davidson 445.* New Mexico. Rio Grande, Sierra Co., Oct. 14, 1846, *Lt. Emory* (cotype). Dona Ana County: vicinity of Pyramid (Bishop's Cap) Peak, Mesilla Valley, south end of the Organ Mts., *F. R. Fosberg S3300, S3487, S3550, S3653, S3700, S3744, S3790, S3794, S3801, S4047;* mesa west of the Organ Mts., Oct. 17, 1903, *E. O. Wooton;* Organ Mts., *E. O. Wooton 427* (type of var. *neomexicanum*); Mogollon Mts., Sierra Co., *H. L. Rusby 359.*

2. Eriogonum Abertianum Torr. var. ruberrimum Gandoger, in Compt. Rend. Soc. Bot. Belg. 42: 196. 1906.

Similar to var. *neomexicanum* but with peduncles mostly under 0.5 cm. long; flowers just as numerous in the involucre, but not so far exserted, heads very compact, 5–6 mm. in diameter; outer sepals 1.5–2 mm. broad, nearly circular, dark reddish in color.

Specimens examined. Mexico. Near Casas Grandes, Chihuahua, *C. H. T. Townsend & C. M. Barker 369* (type).

3. Eriogonum Abertianum Torr. var. villosum var. nov.

Planta erecta alba-villosa ad basin versus simplex; pedunculi robusti in axillis superioribus solitarii, 2–6 cm. longi; sepala exteriora quam longa latiora.

Erect plant, up to 4 dm. tall, more or less white villous, more so in young plants, stem usually not branched at base, dichotomously or trichotomously (often several times) branched above, floriferous ordinarily at upper nodes only, leafy to the top, the leaves somewhat smaller above, but not conspicuously reduced; leaves oblong-ovate, acute to obtuse at apex, truncate or at least abruptly contracted at the base; petioles 2–3 cm. long on lower leaves, becoming shorter above to about 0.5 cm; peduncles solitary in the upper axils, rather robust, usually 2–6 cm. long (very short in material collected at Douglas, Ariz., by L. N. Goodding, May 22, 1907); involucre solitary, 3 mm. high, 3 mm. in diameter, turbinate, with ovate-lanceolate lobes about as long as the tube; flowers many, exserted on rather long pedicels, the spherical inflorescence 1–1.5 cm. in diameter; outer sepals 2.5–3.5 mm. broad, nearly circular, slightly broader than long, with a narrow sinus at the base, membranous-scarious.

Specimens examined. Arizona. Road to Soldier's Camp, Santa Catalina Mts., alt. 6000 ft., *G. J. Goodman & C. L. Hitchcock 1263* (type, Herb. Univ. Calif. no. 426,460); Douglas, *L. N. Goodding 2265* (low plant, very villous, peduncles mostly short, possibly quite young); Lowell, *W. F. Parish 233* (in habit resembling var. *cyclosepalum*); Chiricahua Mts., Sept., 1881, *J. G. Lemmon and wife;* Tucson, May 10, 1896, *J. W. Toumey;* Nogales, May 24, 1892, *T. S. Brandegee;* Douglas, May 17, 1915, *Carlson;* Ox Bow Hill, Apache Trail, *Eastwood 17524.* New Mexico. Mimbres River, Grant Co., July 1, 1904, alt. 5500 ft., *O. B. Metcalfe 1057;* Mogollon Creek, Mogollon Mts., Socorro Co., alt. 8000 ft., *O. B. Metcalfe 234;* Deming, Grant Co., alt. 4400 ft., *J. W. Gillespie 5321.* Texas. El Paso, April 18, 1884, *M. E. Jones.* Mexico. San Requis, Lower Calif., May 2, 1889, *T. S. Brandegee;* Dry Mts., east of Rio San Miguel, Chihuahua, *C. V. Hartman 654* (last two collections extremely villous).

4. Eriogonum Abertianum Torr. var. **cyclosepalum** (Greene) comb. nov. *E. cyclosepalum* Greene, Muhlenbergia 6: 1. 1910.

Very similar to var. *villosum* in general appearance and in pubescence but branched at base, depressed in habit, 1 dm. or less tall, floriferous to the base; peduncles 1–3 cm. long; involucres turbinate, the tube 2 mm. high, 3 mm. in diameter, the lobes very large, more or less spatulate with rounded apex, 6–10 mm. long, 1–2 mm. broad; flowers many, the cluster 1–1.5 cm. in diameter; outer sepals 3.5–4 mm. broad, nearly circular but slightly longer than broad, membranous-scarious, yellow tinged with red.

Specimens examined. New Mexico. Mesa west of the Organ Mts., Dona Ana Co., May, 1905, *E. O. Wooton;* Silver City, *Eastwood 8419.* Texas. El Paso, *M. E. Jones 3738;* Fort Bliss, April 22, 1915, *Carlson.* Mexico. Chihuahua, April, *Dr. Parry;* Janos [Janas?] March, *Dr. Parry;* San Luis Potosi, *J. G. Schaffner 2178.*

5. Eriogonum Abertianum Torr. var. **bracteatum** var. nov.

Planta basi ramulosa, viridis; ramuli adscendentes pluriramulosi saepe ad basin floriferi; folia parva supra reducta; pedunculi axillares, 5 mm. longi; involucra parva 2 mm. lata altaque, lobis 4–6 mm. longis; sepala exteriora quam longa latiora.

Plant branched at the base, soft villous, green in color, branches ascending, many times dichotomously or trichotomously branched, floriferous often almost to base, forming usually a small rounded plant, ordinarily not more than 2 dm. tall, but when in very favorable localities reaching a height of 4 dm.; leaves small, the lower short-petioled, ovate, usually obtuse at apex, attenuate at base, rapidly reduced to narrowly lanceolate, sessile bracts above, these seldom over 1 cm. long, but quite abundant; peduncles mostly about 5 mm. long, in axils from top often practically to base of plant; involucre small, turbinate, 2 mm. high, 2 mm. in diameter, with oblong-lanceolate lobes 4–6 mm. long, few-flowered; flowers exserted on rather long pedicels, the spherical inflorescence 5–10 mm. in diameter; outer sepals 3–3.5 mm. broad, nearly circular, slightly broader than long, with a narrow sinus at the base, membranous-scarious, yellow, tinged with red.

Specimens examined. NEW MEXICO. Near San Antonio, Socorro Co., *Ferris & Duncan 2309;* vicinity of Pyramid (Bishop's Cap) Peak, near south end of Organ Mts., Dona Ana Co., *F. R. Fosberg S3244, S3307, S3486* (type, Herb. Los Angeles Mus.), *S3641, S3654, S3793.* TEXAS. Gravelly mesa north of Chisos Mts., Brewster Co., *J. A. Moore & J. A. Steyermark 3267;* Fort Davis, Davis Mts., Jeff Davis Co., *Ferris & Duncan, 2641.* Locality uncertain. "Near San Diego (Vall. of R. Grande)," August, *Bigelow.*

6. ERIOGONUM ABERTIANUM Torr. var. **Gillespiei** var. nov.

Planta var. *bracteato* similis sed diffusior; pedunculi 1–2 cm. longi; involucra multiflora 3 mm. alta, 3–4 mm. lata.

Similar to var. *bracteatum,* but plant more diffuse; peduncles mostly longer, 1–2 cm. long; involucres larger, many-flowered, 3 mm. high, 3–4 mm. in diameter, lobes 2.5–4.5 mm. long; inflorescence 1–1.5 cm. in diameter, outer sepals apparently not yellowish, as in var. *bracteatum,* but whitish, tinged with red, midrib very noticeable, dark red.

Specimens examined. ARIZONA. Apache Gap, Pinal Co., 2500 ft., *J. W. Gillespie 8797* (type, Herb. Univ. Calif. no. 489,490).

7. ERIOGONUM ABERTIANUM Torr. var. **lappulaceum** (Greene) comb. nov. *E. lappulaceum* Greene, Muhlenbergia 6: 2. 1910. *E. Abertianum* subsp. *lappulaceum* Stokes, Gen. Eriog. 37. 1936.

Erect or ascending, 1.5 dm. high, softly villous but not hoary, branches few, alternate, in no degree cymose or paniculate; leaves on lower undivided portion of stem rhombic-ovate to elliptic, short petioled; involucres few-flowered, the lobes oblong, longer than the body, often equalling the flowers, outer sepals obovate, almost truncately obtuse at apex (*ex. char.*).

I have not seen specimens of this variety but, judging from the description, it belongs here. Greene cites only one collection: Camp Charlotte, Texas, 1889, *Nealley*.

University of Hawaii, Honolulu,
June, 1936.

AN UNDESCRIBED SPECIES OF VIOLA FROM UTAH

Milo S. Baker

Viola Clauseniana sp. nov. Herba acaulescens; rhizoma simplex, carnosum radices numerosas adventitias ferens; folia 3–5 cm. lata, 4–5 cm. longa subtus venis sparsissime pilosa aliter glabra, prostrata deltoidea decurrentia crasse et acute serrata apicibus obtusis; petioli 5–11 cm. longi alati; stipulae 1.5–2 cm. longae anguste lanceolatae, inconspicue glanduloso-dentatae; pedunculi 8–14 cm. longi crassi erecti; bracteolae 5–6 mm. longae subulatae floribus propinquae; sepala 2–3 mm. lata 7–9 mm. longa ovato-lancolata acutiuscula crasse nervata auriculis sparse pubescentibus; corolla lilacina petalis omnibus in parte inferiore pallidioribus; petala superiora 7 mm. lata 15 mm. longa anguste obovata, petala lateralia 7 mm. lata 15 mm. longa oblongo-obovata imberbia, petalum infimum 8 mm. latum 20 mm. longum oblongo-spatulatum calcare obtuso complanatiusculo incluso; staminum appendices anteriores ochroleucae posteriores 1.2 mm. lata 3 mm. longae virides; pistillum 5 mm. longum; stylus capitellatus ovario non flexus, tuba stigmatosa brevi nuda, foramine diametro tertiam partem capituli; flores cleistogami complures; capsula 6–7 mm. lata 8–10 mm. longa oblonga apice truncato; semina 1.2 mm. lata 2 mm. longa nigra minute scabrida, pondere 1 mg.; caruncula subterminalis seminis dimidio brevior.

Acaulescent; rootstock simple, fleshy, giving rise to numerous adventitious roots; leaves prostrate forming a rosette which may reach 28 cm. in diameter; glabrous except for occasional hairs along the veins on the ventral surface of the leaves; leaf blades conspicuously deltoid, decurrent on the petiole, coarsely and sharply serrate, obtuse at apex, 3 to 5 cm. wide, 4 to 5 cm. long, on winged petioles 5 to 11 cm. in length; stipules narrowly lanceolate, faintly glandular-toothed, 1.5 to 2 cm. long; peduncles unusually stout, erect 8 to 14 cm. high, bractlets subulate, near the flower 5 to 6 mm. long; sepals conspicuously nerved, slightly pubescent on the auricles, ovate-lanceolate, somewhat acute, 2 to 3 mm. wide, 7 to 9 mm. long; corolla light violet with a lighter center, 2.5 cm. in diameter; upper petals narrowly obovate 7 mm. wide, 15 mm. long; lateral petals oblong-obovate, wholly beardless, 7 mm. wide, 15 mm. long; spur petal oblong-spatulate 8 mm.

wide at end and 20 mm. to end of broad somewhat flattened obtuse spur; anterior appendages of stamens tan colored, closely enclosing style, posterior appendages green, 1.2 mm. wide, 3 mm. long; pistil 5 mm. long, style without flexure at ovary, capitate, naked, stigmatic tube short, foramen one-third diameter of head; cleistogamous flowers abundant after early spring, producing most of the seeds; capsule oblong, truncate at apex, 6 to 7 mm. wide, 8 to 10 mm. long; seeds minutely roughened, nearly black, 1.2 mm. wide, 2 mm. long, weight 1 mg., caruncle latero-terminal, extending about one-half the length of the seed.

Type: Zion National Park, Utah, July 5, 1936, *M. S. Baker 8438* (Herb. Univ. Calif. no. 575768). This species was collected at the base of Weeping Rock on the south side of the canyon where sunlight seldom, if ever, reaches. In competition with rather rank vegetation, the leaves of some of the plants are erect and very tall but in the open they spread out without reaching a great height. Transplanted to the garden at Kenwood, California, the plants grow vigorously producing an enormous number of seeds, mainly from cleistogamous flowers which develop capsules until growth is stopped by winter cold. The area in which this species grows is very small, scarcely one hundred feet in diameter (as remembered), densely covered with shrubs, trees and herbaceous plants. The only known plants grow near a trail used by thousands of tourists and, unless measures are taken to protect them, are in great danger of extermination. Mr. K. E. Weight, naturalist during the summer of 1936, reports that this species does not occur elsewhere in the Park.

Viola Clauseniana belongs in section *Nomimium* Ging, subsection *Plagiostigma* Godr. group *Boreali-Americanae* Becker, series *Cucullatae* Gersh. It is sharply distinguished from any other known member of this series by the beardless petals, the deltoid leaf outline and the prostrate habit of the leaves. *Viola nephrophylla* Greene is its nearest known relative.

At a higher elevation (9000 feet) at Navaho Lake, only a few miles distant, was found another member of this group, *Viola arizonica* Greene. This species however is much more closely related to *V. nephrophylla* than to *V. Clauseniana.* At a lower elevation and only about thirty miles distant by airline, the writer collected *V. nephrophylla* in typical form. This locality is seven miles north of Kanab, Utah, along the highway to the north rim of Grand Canyon. These plants showed not the slightest variation toward the species under discussion. Under such circumstances one is forced to the conclusion that *V. Clauseniana* is a relict of an earlier age, not closely related to any living species, which has survived at this one spot in Zion National Park.

This violet is named in honor of Dr. Jens Clausen, cytogeneticist of the Carnegie Institution of Washington, Stanford

University, California, who has been most helpful in solving many problems connected with our western violets.

Santa Rosa Junior College,
Santa Rosa, California,
December 6, 1937.

REVIEWS

Botanical Studies in the Uinta Basin of Utah and Colorado. By Edward H. Graham. Annals of the Carnegie Museum. Volume XXVI. Pp. 1–432. Pl. I–XIII. Carnegie Museum, Pittsburgh, Pennsylvania. 1937.

This comprehensive study of one of the little known natural areas of the western United States represents the results of three Carnegie Museum expeditions to the Uinta Basin in the summers of 1931, 1933, and 1935. In this work 1104 species of vascular plants are recorded from the Basin, an area of 12,000 square miles. Five new species and two new varieties are included. The annotated list of species is based upon collections by the author of some 3500 numbers and a few additional collections by others. Most of these specimens are deposited in the herbarium of the Carnegie Museum. In addition to the annotated list there are discussions of the history of exploration in the Basin, the physiography and climate of the area, the altitudinal vegetation zones and plant communities. The geographic affinity of the flora and endemism are discussed briefly. A list is given of range extensions. The bibliography of the region lists 93 publications.

This study shows a minute attention to detail in its preparation; most of the identifications were checked by specialists; and the entire volume shows the author's intimate knowledge of the botany of the region. Such a complete survey of a natural geographic area is a definite contribution to our knowledge of western flora.—Mildred E. Mathias.

Illustrated Dictionary of Botanical Terms. Excerpt from "An Introduction to Botany" by John Lindley, 1848, containing pages 319, 346–383. Reprinted by Alice Eastwood, California Academy of Sciences, San Francisco, with the cooperation of the San Francisco Garden Club. 1938. Paper. $.50.

Originally published in 1848 this illustrated glossary of botanical terms with Latin equivalents used in the description and naming of plants has proved most useful to professional and amateur botanists. The reprinting of the pages of this glossary in a convenient pamphlet is a valuable contribution. Copies are obtainable from Miss Eastwood.—Mildred E. Mathias.

The California Salvias. A Review of Salvia, Section Audibertia. By Carl Epling. Annals of the Missouri Botanical Garden. Volume XXV, Number 1. Pp. 95–188 with 19 plates and 14 text figures. St. Louis, February, 1938.

In Audibertia, a section of the genus *Salvia* confined to arid southwestern North America, Dr. Epling recognizes eighteen species which he treats under five sections. Three of these, *Greeneostachys, Jepsonia,* and *Parishiella,* are new; two, *Echinosphace* and *Pycnosphace,* reduced from the sectional rank given by Bentham. One new subspecies, *Salvia carnosa* subsp. *Gilmani,* and twelve new hybrids are described. The distribution of each species is shown by a map and the habit and floral characters of each beautifully illustrated by a full page plate. The introduction includes a discussion of the distribution and habitats of the species of the section and their relation to the shrub formations of the Colorado Desert and the coastal plain and foothill region of southern and central California. Because of the interchanging of blocks of characters in the species throughout the section a hybrid origin is postulated for the group; the species show no evidence of a monophyletic origin. The subsections are segregated mainly upon stamineal and other floral characters; habit and leaf characters have also proved useful. This conservative and competent revision is the result of ten years of field work and herbarium study on the part of the author, and is a worthy successor to his many valuable contributions to the taxonomy of the Labiatae. It is one of seven important botanical papers appearing in the current issue of the "Annals" which is dedicated to Dr. Jesse More Greenman, Curator of the Herbarium of the Missouri Botanical Garden, and which was prepared in honor of his seventieth birthday by a group of his former students.—E. Crum.

A Revision of the Genus Lomatium. By Mildred E. Mathias. Annals of the Missouri Botanical Garden. Volume XXV, Number 1. Pp. 225–297. St. Louis, February, 1938.

This largest and perhaps most difficult of West American umbelliferous genera is interpreted as consisting of 63 species and 20 varieties. Two species and two varieties are described as new. A conservative point of view has been maintained throughout the treatment, despite the superabundance of names and the frequent paucity of available specimens of some units. The appearance of the publication, in itself, should stimulate collectors working in regions immediately concerned to obtain adequate material for the solution of the few problems and the filling of occasional gaps in distribution which still remain.

One notes, gratefully, that the key does not rely unduly upon the number of oil tubes in the fruit for the separation of species and varieties, but that vegetative, floral and habital characters as well as geographical ranges are used to facilitate identification. The species are clear-cut and in the great majority of cases present a logical distribution pattern which conforms with that in other large genera whose taxonomy and distribution have been studied. Species of narrowly restricted range occur only in such areas as are suspected, on other evidence, of possessing endemic floras. Many of the "one-specimen species" have been found to fit snugly into groups of wider occurrence.

In previous papers, the author has shown a preference for the generic name *Cogswellia* Spreng., both because of the questionable identity of the type species of *Lomatium* Raf. (which antedates it by one year) and the close similarity of the latter name to *Lomatia* R. Br. of the Proteaceae. The present manuscript was written with the intention of retaining *Cogswellia,* but a hurried poll of available authorities on nomenclature, taken at the suggestion of the editor, necessitated a last-minute substitution of *Lomatium.* Now that all the transfers have been made to *Lomatium,* it is to be hoped that this interpretation of the International Rules of Nomenclature will be upheld.

One can readily recognize in the treatment the background of the author's extensive knowledge of the Umbelliferae and her unusually broad field experience with the family. Because of the thoroughness and practicality of the treatment, one awaits with interest the appearance of revisions of other troublesome genera of this family.—L. Constance.

Plants of Zion National Park. By Clifford Presnall and Pauline Mead Patraw. Zion-Bryce Museum Bulletin No. 1. Zion-Bryce Natural History Association in cooperation with the National Park Service. June, 1937. Pp. 1–69 with 15 plates and 15 text figures. Paper. $.50.

A brief synoptical treatment of the common flowering plants and ferns of Zion National Park. The common names are emphasized in accordance with the intended popular appeal. The work consists of a list of over five hundred of the known species of the Park. In most cases a brief statement of characters or habitat accompanies the names. There are no formal descriptions or keys. The illustrations are line drawings and photographs. The printing is by the offset process.—Herbert L. Mason.

Die Bedeutung der Polyploidie für die Verbreitung der Angiospermen, erläutert an den Arten Schleswig-Holsteins, mit Ausblicken auf andere Florengebiets. By G. Tischler. Bot. Jahrb. Band LXVII, Heft 1. Pp. 1–36. Leipzig. 1935.

The chromosome numbers of 66.7 per cent of the species of angiosperms of Schleswig-Holstein are recorded, and 44.1 per cent are found to be polyploid. Families rich in polyploids are the Polygonaceae, Rosaceae, Malvaceae, Rubiaceae, Gramineae, and Cyperaceae, while the Leguminosae and Umbelliferae have relatively few such species. Of the circumpolar types found in this province, 60 per cent are polyploid, while of those of a more southerly range than the area investigated, only 27.1 per cent are of this type. In Iceland and the Faroe Islands the percentage of polyploids is higher than in Schleswig-Holstein; in Sicily it is lower. The majority of the polyploid species of Iceland are wide ranging types rather than species endemic to the island or to the Arctic flora. In the flora of a restricted locality, such as an estuary and its borders, many polyploids are found among the species occupying that as well as other habitats, and fewer among the species peculiar to that habitat. The greater variability of polyploids is responsible for this condition, since it broadens their range of tolerance to different habitats.—G. L. Stebbins, Jr.

NOTES AND NEWS

Ceanothus thyrsiflorus: extension of range. A considerable stand of this species, previously not known to occur south of Monterey County, was observed by Mr. Maunsell Van Rensselaer on a north slope of upper Canada Honda, southwest of Lompoc, Santa Barbara County, California (February 27, 1938, *M. Van Rensselaer,* Herb. Univ. Calif.). The shrubs were from twenty to twenty-five feet in height; some with a branch spread of over thirty feet.—H. E. McMinn.

The Wild Flower Show of Santa Rosa Junior College which is held biennially will open on Sunday, May 15, 1938 in the Science Building of the College at 1: 00 P. M. In 1936 Professor Milo S. Baker and his assistants had representatives of over one thousand native Californian species on display.

The "Helen Stafford Thorne Ceanothus Fund" was recently established by the western member clubs of the Garden Club of America in honor of Mrs. Oakleigh Thorne who has been its active representative on the Pacific Coast for many years. The fund has been given to the Blaksley Botanic Garden to be used in furthering the study of the genus *Ceanothus.* (Santa Barbara Museum of Natural History Leaflet 13: 22. 1938.)

Dr. W. A. Setchell, Professor of Botany, Emeritus, University of California, Berkeley, has received notice of his election as a Foreign Member of the Royal Society of Science and Arts, of Gothenburg, Sweden. This honor comes as a result of studies made in cooperation with Swedish botanists.

PROCEEDINGS OF THE CALIFORNIA BOTANICAL SOCIETY

November 18, 1937. A meeting was held at 8: 00 p. m. in Room 2093, Life Sciences Building, University of California, Berkeley. The president, Dr. F. W. Foxworthy, occupied the chair. Lecture: "An American botanist in Europe" by Professor H. E. McMinn, of the Department of Botany, Mills College, California. Mr. McMinn recounted experiences during a recent visit to botanical institutions of Sweden, Norway and other European countries.

December 16, 1937. A meeting was held in Room 2093, Life Sciences Building, University of California, Berkeley. The president, Dr. F. W. Foxworthy, called for the report of the nominating committee. Professor E. B. Babcock, chairman, submitted the following names: President, Professor H. E. McMinn, Mills College, California; First Vice-President, Mrs. Viola Brainerd Baird, Berkeley, California; Second Vice-President, Mr. Maunsell Van Rensselaer, Blaksley Botanic Garden, Santa Barbara, California; Treasurer, Dr. David D. Keck, Carnegie Institution of Washington, Stanford University; Secretary, Miss Ethel Crum, University of California, Berkeley. The business meeting was followed by a lecture: "A quest for western wild violets" by Viola Brainerd Baird. Mrs. Baird, daughter of Ezra Brainerd, the well known authority on North American violets, described the haunts of the western species of the genus. Her lecture was illustrated with a complete series of colored slides reproduced from original paintings by F. Schuyler Mathews.

January 27, 1938. A meeting was held at 8:00 p. m. in Room 2093, Life Sciences Building, University of California, Berkeley. The president, Dr. F. W. Foxworthy, occupied the chair. The officers nominated at the preceding meeting were unanimously elected. Following the business meeting Dr. Lincoln Constance, of the University of California, Berkeley, lectured on "Endemism in the Pacific Northwest."

The following fall and winter meetings have been held by the Santa Barbara Branch of the California Botanical Society.

October 19, 1937. Lecture: "A quest for western wild violets" by Mrs. Viola Brainerd Baird, Berkeley.

November 16, 1937. Lecture: "The forest and the trees" by Dr. George J. Peirce, Department of Botany, Stanford University.

February 1, 1938. Lecture: "Plant exploring in Mexico" by Mr. Otis McAllister, for many years a resident of Mexico City.

March 12, 1938. A joint conference of officers of the two branches of the California Botanical Society was held. The parent organization was represented by Professor H. E. McMinn, president, Dr. George J. Peirce, former president, and Dr. Herbert L. Mason, chairman of the editorial board of Madroño. President Maunsell Van Rensselaer and the board of control represented the Santa Barbara Branch.

March 14, 1938. Lecture: "Why an American botanist visits European herbaria to study native American plants." Professor H. E. McMinn, Mills College, California.—E. Crum, Secretary.

Silver Jubilee Celebration

1913—1938

Twenty-fifth anniversary of the founding

of the

CALIFORNIA BOTANICAL SOCIETY

To Honor the Charter Members of the Society

April 23, 1938

Dinner at 6: 15 P. M.

at the

Berkeley Women's City Club

2315 Durant Ave., Berkeley, California

Price One Dollar
Per Plate

Send reservations with check to Dr. Lincoln Constance, Department of Botany, Life Sciences Building, University of California, Berkeley.

VOLUME IV NUMBER 7

MADROÑO

A WEST AMERICAN JOURNAL OF BOTANY

Contents

Published at Lime and Green Streets, Lancaster, Pennsylvania

July, 1938

MADROÑO

A WEST AMERICAN JOURNAL OF BOTANY

Entered as second-class matter October 1, 1935, at the post office at Lancaster, Pa., under the act of March 3, 1879.

Established 1916. Published quarterly. Subscription Price $2.50 per year. Volume I, Numbers 1 to 17, complete, $5.00. Volume II, Numbers 1 to 17, complete, $5.00. Volume III, Numbers 1 to 8, complete, $5.00. Single numbers $0.75.

Papers up to 15 or 20 pages are acceptable. Longer contributions may be accepted if the excess costs of printing and illustration are borne by the contributor. Range extensions and similar notes will be published in condensed form with a suitable title under the general heading "Notes and News." Articles may be submitted to any member of the editorial board. Manuscripts may be included in the forthcoming issue provided that the contributor pay the cost of the pages added to the issue to accommodate his article. Reprints of any article are furnished at a cost of 4 pages, 50 copies $3.70; 100 copies $4.10; additional 100's .75¢; 8 pages, 50 copies $5.40; 100 copies $6.00, additional 100's $1.20. Covers, 50 for $2.50; additional covers at $1.50 per hundred. Reprints should be ordered when page proofs are returned.

Published at Lime and Green Streets, Lancaster,
Pennsylvania, for the

CALIFORNIA BOTANICAL SOCIETY, INC.

Annual membership dues of the California Botanincal Society are $2.50, $2.00 of which is for a year's subscription to Madroño. Dues should be remitted to the Treasurer. General correspondence and applications for membership should be addressed to the Secretary.

A CRANBERRY FROM THE TAHOE NATIONAL FOREST

William A. Dayton

No botanical manual or other floral publication, so far as the writer has ascertained, attributes cranberries to the California flora. Mr. Leland S. Smith of the Supervisor's staff of the Tahoe National Forest, an indefatigable collector and observer of Sierran plants, has collected two very interesting specimens of cranberry in Nevada County.

Oxycoccus macrocarpos[1] (Ait.) Pursh. Hydraulic digging, one mile south of North Columbia, 3000 feet elevation, with ponderosa pine (western yellow pine), willows and sphagnum and other mosses, November 14, 1936, *L. S. Smith 2800* (United States Forest Service serial no.73019), sterile specimen; bog, southwest side of Columbia Hill diggings, 2900 feet elevation, July 17, 1937, *L. S. Smith 2800A* (United States Forest Service serial no. 75678), specimen in immature fruit, with some late flowers. Duplicates of the above collections are deposited in Forest Service herbaria at Nevada City and San Francisco, California, and at Washington, D. C.

In a memorandum of July 26, 1937, Mr. Smith writes:

> This species evidently blooms earlier than I thought, as I found a large amount of half-formed berries. Flowers no doubt appear around July 1 or possibly some years, in June.
>
> I have visited other similar sites and have not found any indication of this species being present. So far as I can learn, this is the only place on the Forest where it is found, and no one now living in the locality (North Columbia) knows anything about it. It was only recently discovered, and it seems possible that some cranberries were dropped or thrown into the water in the early days by some miner, and became lodged in this pocket, at the end of the hydraulic mining in this vicinity, which was in the early eighties.
>
> Fruit was collected here, and made very fine jelly and sauce. The bog is limited in size, and area of cranberry plants will not grow much unless seed is carried to other bogs by rodents or birds.

This material was provisionally identified by Mr. Smith as *Vaccinium oxycoccos*[1] L. var. *intermedium* A. Gray. It seems natural that, if any cranberry were to be found in California, it would be this variety. However, in view of the rather long, narrowly oblong, clearly revolute leaves, distinctly rounded and blunt at both ends, the small but foliaceous and relatively broad bractlets subtending the pedicels, and the large fruits, typically longer than broad, the plant, is, in my judgment, the commonly cultivated cranberry, *Oxycoccus macrocarpos* (Ait.) Pursh (*Vaccinium macrocarpon* Ait.), sometimes called big cranberry or American cranberry. The so-called small (European) cranberry, *Oxycoc-*

Madroño, Vol. 4, pp. 201–240, July 1, 1938.

[1] In this case the Latin ending *-us* is usual in literature, but in view of the original spelling the Greek termination *-os* should be used.

cus palustris Pers. (*O. oxycoccos* (L.) MacM., *Vaccinium oxycoccos* L.) is also native in parts of our country and is occasionally cultivated. Its smaller, round fruits are considered by many to have a flavor superior to those of *Oxycoccus macrocarpos*. In our Northwest there occurs a native variety of the small cranberry, to which I have applied[2] the name "western cranberry," *O. palustris* var. *intermedius* (A. Gray) Howell (*O. oxycoccos intermedius* (A. Gray) Piper, *O. intermedius* (A. Gray) Rydb., *Vaccinium oxycoccos* var. *intermedium* A. Gray). This differs from typical forms of the species, chiefly in its coarser stems, blunter, broader and less revolute leaves, larger fruit, and in a pronounced tendency for the shoots to proliferate after flowering.

Herbarium material of these three cranberries is often badly mixed and it is quite possible to match Mr. Smith's Tahoe plants with specimens in folders labeled *Oxycoccus macrocarpos, O. palustris* or *O. palustris* var. *intermedius*. Perhaps the best generally available key to these three forms is that by Rydberg (Fl. Rocky Mts. 646. 1917). Dr. Rydberg regarded *O. intermedius* as a species, although, as its name implies, it appears to be intermediate between *O. palustris* and *O. macrocarpos*. It may be a natural hybrid between those species, a problem which should be investigated by geneticists and cytologists.

The generic separation of *Oxycoccus* from *Vaccinium*, which dates from Tournefort, is, of course, a matter of taxonomic concept. The writer prefers to maintain this separation as was done by Dr. Frederick V. Coville. One can hardly forbear an expression here of sorrow and regret at the passing of Dr. Coville, our foremost American student of Vacciniaceae.

Mr. Smith properly mentions the possibility that this cranberry had been introduced accidentally by man in this California bog. The possibility of introduction by birds, such as grouse, or by other animals should also be considered. I see no reason, however, why some cranberry might not locally be native "in the higher northern parts of the Sierra Nevada" of California, as Brewer and Watson suggested (Bot. Calif. 1: 450. 1876) about sixty years ago. At any rate, Mr. Smith's keen eye and enthusiasm has added another genus and species to the known flora of California.

Range Forage Investigations,
Division of Range Research,
United States Forest Service,
Washington, D. C.,
November 24, 1937.

[2] Dayton, W. A. Important western browse plants. U. S. Dept. Agric. Misc. Publ. 101. 1931.

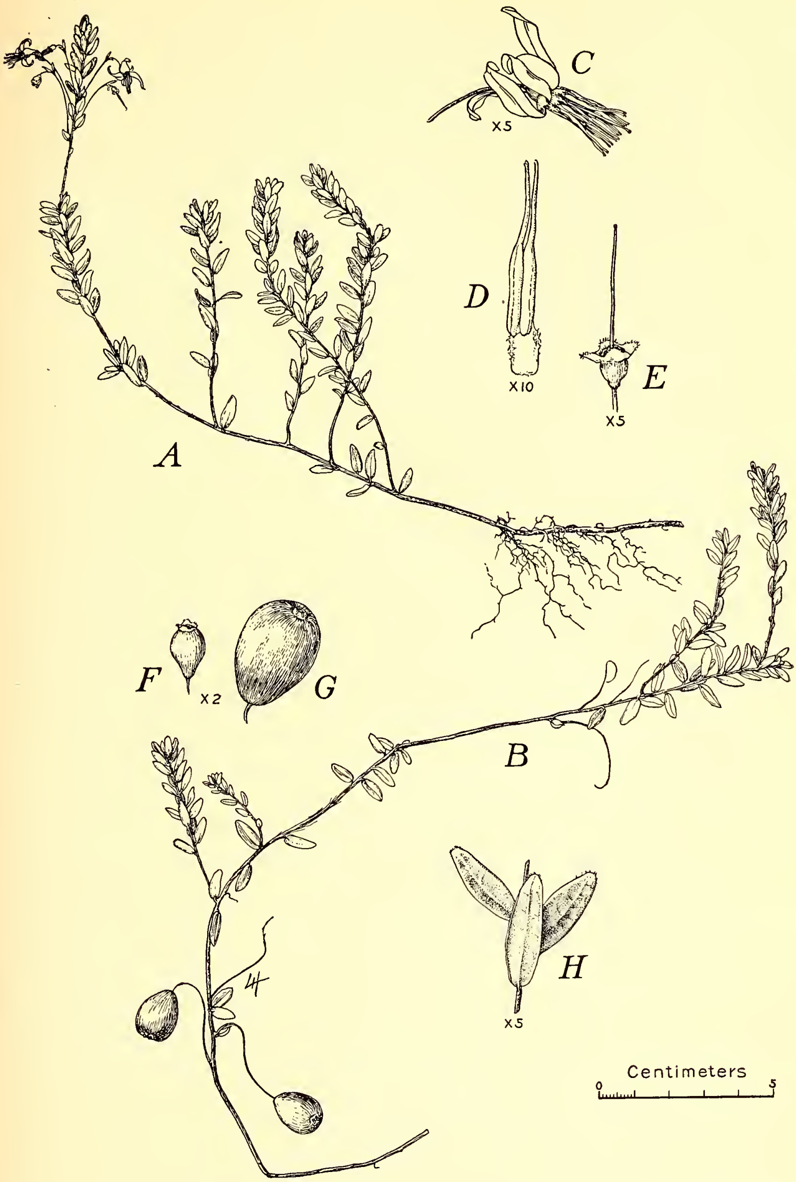


PLATE XXX. OXYCOCCUS MACROCARPOS (Ait.) Pers. A, late flowering specimen; B, immature fruiting specimen; C, flower; D, stamens; E, calyx and style; F, G, immature fruits; H, portion of stem with leaves. Drawing by Miss Leta Hughey of the United States Forest Service from specimen collected in Tahoe National Forest, California, by L. S. Smith (no. 2800A).

STUDIES IN THE GENUS STREPTANTHUS NUTT. I. TWO NEW SPECIES IN THE SECTION EUCLISIA NUTT.

John L. Morrison

During the course of monographic studies in *Streptanthus* it has become necessary to describe two hitherto unrecognized species. The decision to recognize the following as new species was based on differences in the structure, shape, size and color of organs as well as upon geographic distribution. The fused filaments of the upper and lower pairs of stamens, the obtuse, crisped petal blade, the non-bracteate inflorescence, and the annual duration of the plants indicate the close relationship betwen these species and the others at present included in Section *Euclisia.*

Streptanthus batrachopus sp. nov. Herba annua omnino glabra glaucaque maculata; caules erecti simplices vel superne ramosi, 4.0–18.0 cm. alti; folia pauca, plerumque basalia crassa, subtus purpurea, supra fulva vel purpureo-maculata, 0.3–3.2 cm. longa, 0.2–1.0 cm. lata; folia inferiora, spatulato-obovata vel oblonga, saliente lobata, petiolis longis; folia superiora sessilia auriculata amplexicaulia, lineari-lanceolata vel oblonga, subintegra; flores erecti, 0.4–0.5 cm. longi; sepala 0.4 cm. longa, viridia purpureave, ovata, basi carinata, apicibus patentibus acutis, marginibus hyalinis, saepe rubescentibus; petala valde exserta alba, venis mediis purpureis, lineari-lanceolata spatulatave, acuta 0.6–0.7 cm. longa; stamina triseriata, superiorum filamentis 0.6 cm. longis ad apicem connatis, antheris reductis, inferiorum filamentis 0.5 cm. longis, usque ad 0.2–0.3 cm. connatis, antheris longioribus, lateralium filamentis 0.3 cm. longis, liberis, approximatis, antheris longissimis; siliquae 2.5–3.0 cm. longae, erectae, leviter torulosae, falcatae, apicibus patentibus, virides purpureo-maculatae; stylus 0.1 cm. longus; stigma integrum; pedicelli 0.2–0.3 cm. longi, adscendentes; semina fulva, striato-reticulata, alata, 0.2 cm. longa; cotyledones accumbentes.

Annual; stem erect, simple or branched above, entire plant glabrous and glaucous, mottled, 4.0–18.0 cm. high; leaves few, mostly basal, thick, purple beneath and brown or purple spotted above, 0.3–3.2 cm. long; 0.2–1.0 cm. wide; lower leaves long-petioled, spatulate-obovate to oblong, saliently-lobed; upper leaves sessile, auriculate-clasping, linear-lanceolate to oblong, sub-entire; flowers erect, 0.4–0.5 cm. long; sepals green or purple, ovate and keeled at base, narrowed above, tips spreading, margins hyaline or reddish, 0.4 cm. long; petals well exserted, white with purple midvein, linear-lanceolate to spatulate, acute, 0.6–0.7 cm. long; stamens in three pairs, anthers saggitate; upper pair 0.6 cm. long, filaments connate to the apex, anthers reduced;

lower pair 0.5 cm. long, filaments connate for about half to two-thirds their length, anthers longer; lateral pair free, approximate, 0.3 cm. long, anthers longest; silique 2.5–3.0 cm. long, erect, falcate-spreading, slightly torulose, green, spotted with purple, style about 0.1 cm. long, stigma entire; pedicels 0.2–0.3 cm. long, ascending; seeds brown, striate-reticulate, winged, about 0.2 cm. long, cotyledons accumbent.

Serpentine outcrops in Marin County, California, Mt. Tamalpais, North Side Trail, one-fourth mile northeast of Rifle Camp, June 8, 1937, *J. L. Morrison 2493* (type, Herb. Univ. Calif. no. 575762); May 23, 1937, *J. L. and F. L. Morrison 2363* (Herb. Univ. Calif.); Big Carson Ridge, 5.5 miles northwest of Mt. Tamalpais, between Pine Mountain and San Geronimo Ridge, May 30, 1937, *J. L. Morrison 2440* (Herb. Univ. Calif.).

Streptanthus batrachopus is known at present only from two outcrops of serpentine in Marin County. The plants are fairly abundant locally, growing in serpentine talus. Associated plants include: *Allium falcifolium* Hook. & Arn., *Cheilanthes siliquosa* Maxon, *Eriogonum vimineum* Dougl. var. *caninum* Greene, *Streptanthus glandulosus* Hook. var. *pulchellus* (Greene) Jepson, *Epilobium minutum* Lindl., *Arenaria Douglasi* Fenzl, *Ceanothus Jepsoni* Greene, *Arctostaphylos montana* Eastw., *Quercus durata* Jepson and *Cupressus Sargentii* Jepson. Careful exploration of the many other serpentine outcrops in the Mt. Tamalpais area has so far failed to extend the range of this species. This name was chosen because of the resemblance of the leaves of this species to a frog's foot.

This species seems to be most closely related to *Streptanthus Breweri* Gray, a serpentine endemic ranging in the inner and middle Coast Ranges from Tehama County to San Benito County. The key below indicates the differences between the two species:

Leaves broadly ovate, remotely denticulate to entire, sessile or with a very short petiole, auriculate, concolorous above at maturity, average length 4.1 cm.; flowers many, 0.6–0.8 cm. long; stigma sessile; seeds wingless .... *Streptanthus Breweri*

Leaves spatulate-obovate, saliently few-lobed, long-petioled, anthocyanous below, greenish-yellow above, mottled with brown, purple or red; average length 1.2 cm.; flowers few, 0.4–0.6 cm. long; style 0.1 cm. or more in length; seeds winged ... *Streptanthus batrachopus*

Streptanthus callistus sp. nov. Herba annua, compacta, omnino sparse hispida; caules erecti, 3.0–6.0 cm. alti, simplices vel plerumque ramosissimi, ramis divaricatis, apicibus adscendentibus; folia basalia subsessilia, oblongo-orbiculata, crasse dentata, 0.2–0.6 cm. longa; folia superiora orbiculato-obovata vel oblonga, basi lata, auriculata, amplexicaulia, dentata, 0.5–1.5 cm. longa, 0.4–1.4 cm. lata, saepe rubescentia, pilis rigidis, hyalinis, attenuatis, utrinque sparse hispida; racemi flores terminales steriles reducti, calycibus elongatis, hispidis, partibus ceteris obsolescentibus; flores fertiles numerosi; pedicelli, breves, crassi, adscendentes; sepala viridia, hispida, ovato-lanceolata, acuta, saccata, dorsaliter carinata, 0.5 cm. longa; petala purpurea, conspicue, venata, spatulato-oblanceolata, obtusa, 1.0 cm. longa, marginibus undulatis albidis, laminis 5 cm. latis; stamina triseriata, antheris leviter sagittatis, superiorum filamentis 0.6 cm. longis fere usque ad apicem connatis, antheris reductis, inferiorum filamentis 0.4–0.5 cm. longis, usque ad 0.2–0.3 cm. connatis, antheris longioribus, laterialum filamentis 0.3 cm. longis, liberis, approximatis, antheris longissimis; siliquae 1.5–2.0 cm. longae, teretes, erectae, incurvatae, attenuatae, valvis conspicue uninervatis, pilis complanatis, hispidis; septorum cellulae tortuosae; semina olivacea, globosa, non alata; cotyledones accumbentes.

Low compact annual, sparingly hispid throughout; stem erect, simple or mostly much branched, branches at right angles to the main stem, curving upwards, 3.0–6.0 cm. high; basal leaves subsessile, 0.2–0.6 cm. long, oblong-orbicular, coarsely dentate; upper leaves sessile, 0.5–1.5 cm. long, 0.4–1.4 cm. wide, dentate, often reddish, very sparsely hispid above and below with stiff, hyaline, tapered trichomes, orbicular-obovate to oblong, base broad, auriculate-clasping; raceme terminated by sterile flowers reduced to elongated, hispid calyces, with petals, stamens and pistil rudimentary; fertile flowers numerous on short, stout, hispid, ascending pedicels; sepals 0.5 cm. long; green, hispid, ovate-lanceolate, acute, keeled, saccate; petals mulberry purple[1] to cotinga purple with prominent veins, 1.0 cm. long, spatulate-oblanceolate, obtuse, margins undulate, whitish, lamina 0.5 cm. wide; stamens in three pairs, anthers slightly saggitate; upper filaments 0.6 cm. long, connate nearly to the apex, anthers reduced; lower filaments 0.4–0.5 cm. long, connate for 0.2–0.3 cm. anthers longer; lateral filaments 0.3 cm. long, free, approximate, anthers longest, free tips of the connate filaments mulberry purple; silique 1.5–2.0 cm. long, terete, erect, incurved, tapering, valves with a strong midvein, hispid with flattened trichomes, cells of the septum all tortuous; seeds greenish-brown, orbicular, not flattened, wingless, cotyledons accumbent.

---

[1] Color Standards and Nomenclature. Robert Ridgway. Washington, D. C. Published by the author. 1912.

Explanation of the Figures. Plate XXXI

Plate XXXI. Figs. 1–10, *Streptanthus callistus* Morrison: *1* habit; *2* terminal cluster of sterile flowers; *3* flower; *4* petal; *5* seed; *6* flower; *7* androecium and gynoecium; *8* leaf; *9* silique; *10* sepal. Figs. 11–15, *Streptanthus hispidus* Gray: *11* seed; *12* habit; *13* leaf; *14* androecium and gynoecium; *15* flower. Figs. 16–19, *Streptanthus insignis* Jepson: *16* seed; *17* leaf; *18* flower; *19* silique. Figs. 20–28, *Streptanthus batrachopus* Morrison: *20* silique; *21* habit; *22* sepal; *23* flower; *24* petal; *25* androecium and gynoecium; *26* leaf; *27* seed; *28* leaf. Figs. 29–31, *Streptanthus Breweri* Gray: *29* silique; *30* leaf; *31* seed.

Plate XXXI. Comparative drawings of five species of Streptanthus. (See explanation of figures on page 206.)

Arroyo Bayo, Mt. Hamilton Range, Santa Clara County, California, 6.8 miles east southeast of Isabel Creek on the road to San Antonio Valley, elevation 2000 feet, May 5, 1935, *C. W. and H. K. Sharsmith 3074* (type, Herb. Univ. Calif. no. 575766; isotype, Gray Herbarium); May 13, 1937, *D. D. Keck and J. Clausen 4541* (Herb. Carnegie Inst. Wash., Stanford Univ.); April 27, 1938, *J. L. Morrison and A. Carter 3019* (Herb. Univ. Calif.).

Streptanthus callistus was discovered by Herbert L. Mason, Carl W. and Helen K. Sharsmith in 1935. In 1937 a few plants were collected by David D. Keck and Jens Clausen who report it as "very rare." The writer collected mature siliques and seed in this area in October, 1937, and on April 27, 1938, the plants were found to be abundant in the area. This very narrow endemic, known only from the type locality, occupies low, south-facing knolls, where the soil is very loose and dry. Associated with it are found: *Malacothrix obtusa* Benth., *Eriogonum* sp., *Chaenactis glabriuscula* DC., *Mimulus Bolanderi* Gray, *Lessingia germanorum* Cham., *Linanthus Bolanderi* (Gray) Greene, and *Salvia columbariae* Benth. The species name is derived from a Greek word meaning most beautiful.

This plant is related to *Streptanthus hispidus* Gray, known only from Mt. Diablo, from which it is readily separated by the short, terete, curved pods with small, rounded, wingless seeds. *Streptanthus insignis* Jepson, known from the inner South Coast Ranges of western Fresno, San Benito and eastern Monterey counties, is also related to *Streptanthus callistus* by reason of the similarity in the terminal, sterile flowers. These three related species may be distinguished by the following characters:

Siliques flattened, straight, erect, 5.0–7.0 cm. long; seeds winged, 0.2 cm. long.
- Plants densely hispid, low, compact, 5.0–30.0 cm. high; leaves spatulate-oblanceolate, saliently lobed, reddish or purple below; blade of petal light purple, calyx densely hispid, sterile flowers either very rarely present or slightly developed, not forming a terminal color spot; stigma entire ..... *Streptanthus hispidus*
- Plants sparsely hispid, slender, 10.0–45.0 cm. high; leaves deeply lobed, almost pinnatifid; blade of petal white, with a black-purple midvein, calyx purple, sparsely hispid, terminal cluster of sterile flowers always present, black purple or garnet, forming a prominent terminal color spot; stigma slightly two lobed .... *Streptanthus insignis*

Siliques terete, incurved, erect, 1.5–2.0 cm. long; seeds not flattened, wingless, 0.1 cm. long .... *Streptanthus callistus*

University of California, Berkeley,
March 15, 1938.

THE NATIVE CALIFORNIAN SPECIES OF THE GENUS COREOPSIS L.

HELEN K. SHARSMITH

For the past three years the writer has been engaged in a floristic survey of the Mount Hamilton Range, a northern unit of the inner South Coast Ranges of California. The interior and eastern regions of the Mount Hamilton Range are comparatively isolated, and in the past they have received little botanical exploration. Recent field work has resulted, therefore, in the accumulation of information on several new or little known species of Californian plants. This paper is an outgrowth of field acquaintance with the four species of *Coreopsis* which grow in the Mount Hamilton Range.

From the time of De Candolle to recent years, the Californian species of *Coreopsis* have had a varied generic history involving *Leptosyne* DC., *Agarista* DC., *Tuckermannia* Nutt., and *Pugiopappus* Gray. In the Synoptical Flora of North America (1^2: 299–301. 1884), Gray included these four genera, along with *Coreocarpus* Benth. and *Acoma* Benth., in an amplified version of *Leptosyne*, limiting the genus *Coreopsis* to the eastern side of the continent. This was the accepted interpretation of many subsequent botanists. Harvey M. Hall (Univ. Calif. Publ. Bot. 3: 139–143. 1907) followed Bentham and Hooker (Genera Plantarum 2: 385. 1873) and O. Hoffmann (in Engler and Prantl, Natürlichen Pflanzenfamilien 4^5: 243. 1894) in uniting *Leptosyne* with *Coreopsis*. In "A redisposition of the species heretofore referred to *Leptosyne*" (Proc. Am. Acad. 49: 335–346. 1913), S. F. Blake amply substantiated this viewpoint, but removed *Coreocarpus*, a Sonoran genus of three species, from the aggregate genus *Coreopsis*. His paper gives a complete presentation of the generic and intrageneric relationships involved. According to his conception the native Californian species of the genus *Coreopsis* belong to the subgenus *Leptosyne* (DC.) Blake. This subgenus also embraces six Mexican species and reaches south as far as Guatemala.

The eight Californian species of *Coreopsis*, including six annuals and two perennials, are almost entirely restricted to the botanical province of California. They are most abundant in the cismontane and desert areas of southern California, and only *C. Stillmanii* reaches north of central California. Two of the eight species, *C. maritima* and *C. californica*, transgress the political boundaries of the state, but neither is found any considerable distance beyond. The accompanying map (text fig. 1) represents the distribution of the genus in California.

Field observations have indicated that fresh material is necessary for adequate taxonomic treatment of the annual species

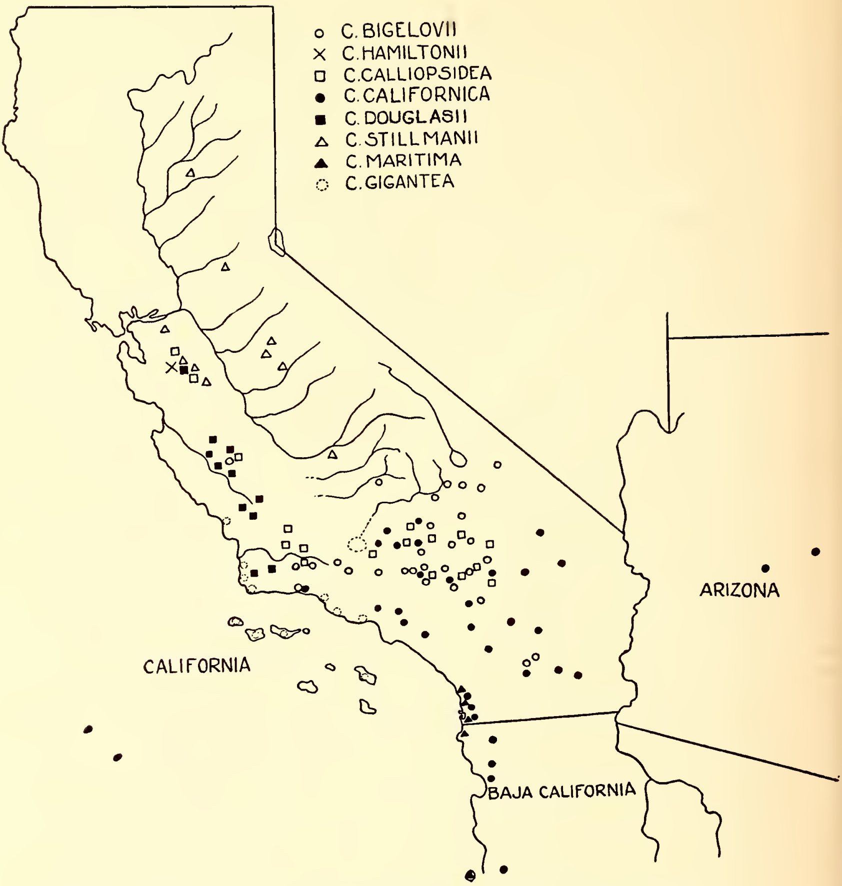


Fig. 1. Distribution of native Californian species of *Coreopsis*.

of *Coreopsis* found in California. Many of the distinguishing characters, particularly those of the leaves and of the involucre, are lost in the pressed specimens. All six annual species were studied from fresh material, either from that gathered in the field or from garden cultures. In addition heads preserved in formalin were obtained for two of the southern Californian species.

In addition to field observations and study of fresh material, herbarium specimens were borrowed from the following Californian institutions, and appreciation is expressed to the curators of these herbaria: California Academy of Sciences, San Francisco (CA), Dudley Herbarium, Stanford University (SU), Pomona College, Claremont (P), Santa Barbara Museum of

Natural History (SBM), University of California (UC), University of California at Los Angeles (UCLA), Vegetation Type Map Herbarium, California Forest and Range Experiment Station, Berkeley (VTM).

Acknowledgment is due to the following persons for the generous responses made to the requests of the writer: Dr. G. Ledyard Stebbins, Jr., and Dr. Herbert L. Mason of the University of California, Berkeley; Dr. Carl Epling, University of California at Los Angeles; Mr. Frank W. Peirson, Altadena, California; Mr. Maunsell Van Rensselaer, Blaksley Botanic Garden, Santa Barbara, California; Sir Arthur W. Hill, Director, Royal Botanic Gardens, Kew, England.

Key to the Native Californian Species of Coreopsis

Annuals; stems slender, 5–60 cm. tall; cismontane and desert species.
  Achenes dimorphic; disc achenes ciliate, pappus paleae 2, ray achenes glabrous, epappose. Section *Pugiopappus* (Gray) Blake.
    Outer series of involucral bracts linear, obtuse, shorter to longer than the ovate inner series; leaves mostly basal and scapes naked.
      Ligules horizontal in anthesis; receptacular bracts falling attached to disc achenes; palea of disc achenes mostly 2 mm. long.
        1. *C. Bigelovii.*
      Ligules strongly reflexed in anthesis; receptacular bracts falling separately from disc achenes; palea of disc achenes 1 mm. long.
        2. *C. hamiltonii.*
    Outer series of involucral bracts broadly ovate, acute, shorter than the oblong-ovate inner series; lower $\frac{1}{3}$ to $\frac{1}{2}$ of stems leafy, leaves only slightly clustered at base; palea of disc achenes mostly 4 mm. long .... 3. *C. calliopsidea.*
  Achenes monomorphic, non-ciliate; pappus reduced to a cupule. Section *Euleptosyne* (Gray) Blake.
    Leaves linear to filiform, fleshy, 1 mm. wide, entire or with 1–2 linear pinnae, terminal lobe not broader; annulus of disc corollas bearded; outer involucral bracts narrowly lanceolate, gibbous at base.
      Leaves filiform, terete, only slightly flattened above, erect; achenes dull, tan to light brown or reddish, roughened with clavellate or capitate hairs on body and wing, and with a central corky ridge, corky wing irregularly thickened ...... 4. *C. californica.*
      Leaves linear, grooved above, rounded beneath, spreading; achenes shining, body dark brown, smooth, glabrous or with a few coarse hairs or callous papillae, corky wing light tan, thin.
        5. *C. Douglasii.*
    Leaves flat, only slightly fleshy, pinnate or bipinnate into spatulate lobes 1–3 mm. broad, terminal lobe usually broadest; annulus of disc corollas mostly glabrous; outer involucral bracts linear to linear-spatulate, not gibbous at base .... 6. *C. Stillmanii.*
Perennials; stems stout, 3–30 dm. tall; coastal and insular. Section *Tuckermannia* (Nutt.) Blake.
  Heads few (2–4) at ends of branches, on naked peduncles 15–50 cm. long; coastal San Diego County to northern Baja California and adjacent islands .... 7. *C. maritima.*
  Heads numerous and cymosely clustered at ends of branches, on leafy peduncles 6–20 cm. long; coastal southern California and adjacent islands from San Luis Obispo County to Los Angeles County.
    8. *C. gigantea.*

1. Coreopsis Bigelovii (Gray) Hall, Univ. Calif. Publ. Bot. 3: 141. 1907. *Pugiopappus Bigelovii* Gray, Pac. R. Rep. 4: 104. 1857. *P. Breweri* Gray, Proc. Am. Acad. 7: 660. 1873. *Leptosyne Bigelovii* Gray, Syn. Fl. 1, pt. 2: 300. 1884.

Erect, essentially glabrous annual with several (1–30, mostly 5–10) scapose stems from a taproot: scapes yellowish green to stramineous, somewhat leafy below and occasionally branching near base, sometimes with 1 or 2 appressed bracts above the leaves, monocephalous, 10–60 (mostly 25–30) cm. tall, usually stout: leaves 4–12 cm. long, alternate, basally clustered, only slightly fleshy, flattened, lightly grooved above, rounded below, somewhat glaucous, spreading; blade ovate, 2–8 cm. long, once or twice pinnate into linear, obtuse, often callous tipped lobes 5–30 mm. long and 1–2 mm. wide, rachis as wide as lobes; petiole 1–5 mm. long, 1–2 mm. wide, channelled, expanded at base, sometimes irregularly margined with minute glandular capitate hairs: heads erect, 1–1.5 cm. high, 2–4.5 cm. wide: involucre glabrous, cylindric or slightly barrel shaped, with sharply truncate base; bracts of outer series 4–7, linear, 5–12 mm. long (often longer than inner bracts), dark green, glaucous to shining, slightly fleshy, mostly loosely spreading from base; bracts of inner series 6–8, ovate, 6–10 mm. long, 3–6 mm. wide; acute with apical tuft of hyaline hairs, greenish yellow, shining, many nerved, scarious margined, erect or sometimes with tips spreading, reflexed in fruit: ray florets 5–10, mostly 8, pistillate, fertile; ligule golden yellow, obovate, 5–25 (mostly 15) mm. long, 3–12 (mostly 8) mm. wide, with truncate and erose apex, spreading horizontally; tube 2 mm. long with scattered glandular capitate hairs; style branches linear, obtuse: disc florets 20–50, perfect, golden yellow, all fertile, or the central sometimes sterile; tube 2 mm. long; annulus glandular pubescent; throat expanded, 1.5 mm. long; corolla lobes triangular ovate, acute, glandular papillate, spreading; anther tips ovate cordate; style tips triangular acute, glandular papillate; pollen grains spherical, with short spines: receptacular bracts lanceolate to oblanceolate, 4–10 (mostly 5–8) mm. long, 1 mm. broad, subacute to acute, hyaline, slightly callous thickened on midrib, exceeding body of disc achenes and often equalling the pappus palea, closely adhering to back of and persistently attached to base of disc achenes: ray achenes obcompressed, oblong to obovate, 3–5 mm. long, 2 mm. wide, glabrous, epappose; body brown or mottled with tan, often almost covered with tan, corky, microscopically foveolate roughenings, flat or somewhat ridged on inner face, rounded on back; marginal callous wing narrow, smooth or corky roughened similarly to but more densely than body: disc achenes obcompressed, oblong to oblanceolate, 4–6 mm. long, 1–1.5 mm. wide; body dark brown, sometimes mottled with tan, shining, microscopically latticed, truncate at base with an evident callous; back completely glabrous, covered with the persistent receptacular bract; inner face flat or with slight central ridge, glabrous except for a central row of more or less prominent cilia similar to but shorter than marginal cilia; marginal cilia silky, white, upwardly directed, two-celled, microscopically bidentate at apex, 1–1.5 mm. long; pappus palea of two, persistent, lanceolate, triquetrous, acuminate, hyaline, denticulate membranes 2 (or 3) mm. long.

Range. Desert and cismontane areas of southern California and the southern Sierra Nevada of California, altitude 150–1500 m.; from San Diego County north to Tulare County, west to Santa Barbara County, and north to southern Monterey County.

Type. "On the Mohave Creek, in the desert east [west] of Colorado," March, 1854, *J. M. Bigelow.*

Specimens examined. San Diego County: Colorado Desert, *W. G. Wright* (UC). Riverside County: near Banning, April 23, 1922, *M. F. Spencer 2040* (P). San Bernardino County: Barstow, May 1, 1922, *M. F. Spencer 1954* (P); 7 miles east of Daggett, April 6, 1924, *P. A. Munz and D. Keck 7842* (P); Mescal Creek, April 29, 1902, *H. M. Hall 3027* (UC); Cajon Pass, May, 1905, *H. M. Hall 6219* (UC); Trona road, May 8, 1937, *Annetta Carter 1305* (UC). Los Angeles County: Mandeville Canyon, March, 1929, *I. W. Clokey and B. Templeton 4520* (P); Saugus, April 23, 1903, *G. B. Grant 5424* (P, UC); Antelope Valley, May 1–3, 1902, *H. M. Hall 3074* (UC); 5 miles south of Muroc, April 1, 1932, *H. L. Mason 6882* (UC); between Rock Creek and Little Rock Creek, April 27, 1926, *H. L. Mason 3046* (UC). Kern County: between Mohave and Lancaster, April 20, 1930, *H. L. Mason 5567* (UC); Greenhorn Range, June 2–10, 1904, *H. M. Hall and H. D. Babcock 5078* (UC); Kern Canyon, April 12, 1905, *A. A. Heller 7662* (UC); vicinity of old Fort Tejon, June 16–19, 1905, *H. M. Hall 6307* (UC). Inyo County: April 17, 1891, *T. S. Brandegee* (UC); 10 miles sw. of Shoshone, April 17, 1932, *C. L. Hitchcock 12340* (P, UC); Argus Mountains, April 18, 1930, *Harold Bailey and W. Robison* (P, UCLA, UC). Tulare County: near Oak Grove, April 23, 1925, *R. Bacigalupi 1209* (P); Kaweah River Basin, April, 1901, *Ralph Hopping 38* (UC); Tule River, March 22, 1925, *P. A. Munz 9136* (P). Ventura County: Pine Creek near Sespe, March 24, 1917, *B. W. Everman* (CA). Santa Barbara County: Figueroa Mountain, May 31, 1929, *Ralph Hoffmann* (SBM); Dutch Flat, San Rafael Mountains, June 8, 1929, *Ralph Hoffmann* (SBM); trail to Zaca Peak, June 19–30, 1906, *Alice Eastwood 585* (CA). Monterey County: north of Parkfield, March 24, 1925, *P. A. Munz 9186* (P).

Coreopsis Bigelovii was described by Gray as having the annulus of the disc corollas beardless. A similar interpretation was given by Hall and also by Jepson (Man. Fl. Pl. Calif. 1084, 1085. 1925) who uses the beardless annulus as one of the characters distinguishing *C. Bigelovii* from *C. calliopsidea.* Blake, after an examination of the type of *C. Bigelovii,* states (*op. cit.,* p. 341): "The annulus of the disk-flowers, in the types and other specimens examined, is very distinctly bearded, not glabrous as originally described and as repeated in the Synoptic Flora and by Hall." The specimens cited above verify this observation of Blake's, though in some of the specimens the ring of hairs is not complete.

2. **Coreopsis hamiltonii** (Elmer) comb. nov. *Leptosyne hamiltonii* Elmer, Bot. Gaz. 41: 323. 1906.

Erect, essentially glabrous annual with several (1–30, mostly 8–10) scapose stems from a taproot: cotyledons linear, 1.5 cm. long, 1 mm. wide, flattened, spreading: scapes reddish, somewhat leafy below and occasionally branching near base, sometimes with a small, appressed bract above the leaves, monocephalous, 6–25 (mostly 10–15) cm. tall: leaves 1–5 cm. long, alternate, basally clustered, fleshy, flattened and lightly grooved above, rounded below, glaucous, spreading; blade triangular ovate, 0.5–2 cm. long, often as wide, twice pinnate into linear, obtuse and sometimes callous tipped lobes 1 mm. wide; petiole 1–3 cm. long, 2 mm. wide, strongly grooved above, expanded at base: heads erect, 7–10 mm. high, 10–20 mm. wide: involucre glabrous, cylindric or somewhat barrel shaped, with sharply truncate base; bracts of outer series 4–7, linear, 3–6 mm. long, always shorter than inner series, obtuse, dark green occasionally splotched with red, glaucous to shining, slightly fleshy, appressed to inner bracts and spreading only near tips; bracts of inner series 6–8, broadly lanceolate or narrowly ovate, 5–8 mm. long, 2–3 mm. wide, acute with apical tuft of hyaline hairs, greenish yellow, shining, thin, many nerved, narrowly scarious margined, appressed or sometimes with tips spreading, reflexed in fruit: ray florets 5–8, pistillate, fertile; ligule golden yellow, oblong to obovate, 3–8 mm. long, 2–5 mm. wide, obscurely 3-toothed at the truncate apex, strongly reflexed; tube 1.5–2 mm. long with incomplete ring of short, yellowish, glandular capitate hairs near apex; style branches linear, obtuse: disc florets 20–30, perfect, golden yellow, central ones sterile; tube 1–2 mm. long, annulus glandular pubescent; throat expanded, 1.5–2 mm. long; corolla lobes triangular ovate, acute, glandular papillate, spreading; anther tips ovate cordate; style tips triangular acute, glandular papillate; pollen grains spherical, with short spines: receptacular bracts linear, 5–6 mm. long, 1 mm. broad, obtuse, hyaline, falling separately from disc achenes: ray achenes obcompressed, meniscoid, obovate, 5 mm. long, 3 mm. wide, dark brown or tan splotched with brown, smooth, glabrous and shining, rounded on back, flat on inner face with slight central keel epappose; marginal wing thin, smooth, tan marbled with brown: disc achenes obcompressed, narrowly obovoid, 5–6 mm. long, 1.5–2 mm. broad, smooth, tan marbled with brown, truncate at base with slight callous, rounded on both sides, the inner face with slight central ridge or keel, both faces covered (sometimes sparsely so) with persistent, upwardly directed, silky, white, two-celled cilia 1 mm. long, which are microscopically bidentate at apex and often swollen at base, the marginal cilia thicker, more spreading, and up to 1.5 mm. long; pappus palea of two, persistent, obovoid, triquetrous, triangular acute, hyaline, denticulate membranes 1 mm. long.

Range. Exposed, dry rocky slopes of Santa Clara County in the Mount Hamilton Range of the inner South Coast Ranges of California, altitude 600–1295 meters.

Type. Mount Hamilton, Santa Clara County, California, April, 1900, *A. D. E. Elmer 2328.* The collector comments as follows: "It was in fine flower and fruit, and grew in dry gravelly soil on a steep slope a few hundred yards below the observatory. Since then I have failed to find it either in this same place or elsewhere."

Specimens examined. Santa Clara County: Mount Hamilton, April 29, 1923, *Alice Eastwood 11671,* topotype (CA); Copernicus Peak, highest point of Mount Hamilton, altitude 4250 feet, April 15, 1934, *H. K. Sharsmith 914,* topotype, representative of the species (UC); April 28, 1935, *H. K. Sharsmith 1839,* topotype (UC); Mount Hamilton-Livermore road, April 28, 1925, *Alice Eastwood 12468* (CA); eight miles from Mount Hamilton on road to San Antonio Valley, April 6, 1930, *J. T. Howell 4665* (CA), April 6, 1930, *E. K. Crum 602* (UC); San Antonio Valley, March 23, 1932, *H. E. Wieser* (SU); Arroyo Bayo, March 30, 1935, *H. K. Sharsmith 1709,* April 2, 1936, *3489,* April 25, 1936, *3628* (UC).

Coreopsis hamiltonii has been overlooked as a specific entity ever since Elmer's description of it in 1906. The only recent reference occurs in Blake's paper (*op. cit.,* p. 341), in which the original combination (*Leptosyne hamiltonii* Elmer) is given as a synonym under *C. Bigelovii;* no specimens are cited and no locality is mentioned. Elmer's original description of *C. hamiltonii* is detailed in content and presents, in general, an adequate picture of the species. It is in error, however, regarding the achenes, which are described as "ciliate on the edges, pubescent on the sides, brown and glabrous when mature: pappus of two caducous hyaline finely ciliate membranes." Actually, the achenes are dimorphic, those of the ray differing strongly from those of the disc.

3. Coreopsis calliopsidea (DC.) Gray, Bot. Mex. Bound. 90. 1859. *Agarista calliopsidea* DC. Prod. 5: 569. 1836. *Pugiopappus calliopsidea* Gray, Proc. Am. Acad. 8: 660. 1873. *Leptosyne calliopsidea* Gray, Syn. Fl. 1, pt. 2: 300. 1884. *L. calliopsidea* var. *nana* Gray, loc. cit.

Erect, essentially glabrous, usually rather stout annual with several (1–30 or more, mostly 4–6) stems from a taproot: stems yellowish green to stramineous, usually leafy to the middle or even above, sometimes almost naked, sometimes branching near the base, occasionally branching above, monocephalous, 8–55 (mostly 20–30) cm. tall: leaves 4–8 cm. long near base, reduced above, alternate, somewhat clustered at base or quite scattered on stems, only slightly fleshy, lightly grooved above, rounded beneath, somewhat glaucous, spreading; blade ovate, 1–5 cm. long, once or twice pinnate into linear, obtuse, divergent lobes 0.5–2 mm. wide and often callous tipped, rachis as wide as lobes or up to 5 mm. wide, upper leaves sometimes simple; petiole 1–5 cm. long, 0.5–5 mm. wide, channelled, expanded at base: heads erect, showy, 1–2 cm. high, 2–9 cm. wide: involucre campanulate, united at base into a disc 3–10 mm. across, this disc glabrous or with a few, scattered glandular hairs; bracts of outer series 5 (occasionally 4 or 6), deltoid ovate with a broad base, 3–8 mm. long, almost as wide to wider, acute and sometimes callous tipped, green, glaucous, flat, not fleshy, margined occasionally with short glandular capitate hairs, somewhat spreading; bracts of inner series mostly 8 (occasionally 6 or 7), ovate with a broad base, 8–10 mm. long, exceeding the outer series, acute with a minute, apical tuft of hyaline hairs, greenish yellow, shining, thin, narrowly scarious margined, many nerved, somewhat spreading: ray florets mostly 8 (occasionally 6 or 7), pistillate, fertile or often sterile; ligule golden yellow, obovate, 10–35 mm. long, 5–18 mm. broad, with truncate erose apex, spreading horizontally; tube 3 mm. long, essentially glabrous; style branches linear, obtuse: disc florets 15–50, perfect, golden yellow, usually all fertile; tube 2 mm. long, with scattered glandular hairs; annulus heavily bearded with glandular hairs; throat funnelform, 2 mm. long; corolla lobes lanceolate, 1 mm. long, acute, glandular papillate, spreading; anther tips lanceolate cordate; style tips triangular acuminate, glandular papillate; pollen grains spherical, with short spines; receptacular bracts lanceolate to oblanceolate, 6–7 mm. long, 1–1.5 mm. wide, acuminate to apiculate, hyaline, the midrib callous thickened, scale equalling or scarcely exceeding body of disc achene, closely adhering to its dorsal surface and persistently attached to its base: ray achenes (if developed) obcompressed, oval, 5–6 mm. long, 3–4 mm. wide, glabrous, epappose; body tan or brown, smooth or sometimes almost covered with a rough, tan callous, flat or somewhat ridged on inner face, rounded on back; marginal wing smooth, stramineous, flat: disc achenes obcompressed, linear to oblanceolate, 6–7 mm. long, 1.5 mm. wide; body dark brown, shining, microscopically latticed, rounded at base with an evident callous; inner face flat, covered with upwardly directed, silky, white or tawny, two-celled cilia 1 mm. long and microscopically bidentate at apex; back somewhat rounded, completely glabrous, covered with the persistent receptacular bract; marginal cilia thicker, 2–3 mm. long; pappus palea of two, persistent, lanceolate, triquetrous, acuminate, hyaline, denticulate membranes 2.5–5 (mostly 4) mm. long.

Range. Western portion of the Mohave Desert in San Bernardino County and Kern County; west to eastern San Luis Obispo County; north on extreme eastern side of inner South Coast Ranges to Corral Hollow, Mount Hamilton Range, Alameda County, altitude 210–1070 meters.

Type. "In California legit cl. Douglas."

Specimens examined. San Bernardino County: Mohave Desert, May, 1882, *C. G. Pringle,* isotype of *C. calliopsidea* var. *nana* Gray (UC); Crutts Post Office, May 14, 1922, *I. M. Johnson 6475* (UC); Fremont's Peak, May 6, 1906, *H. M. Hall and H. P. Chandler 6868, 6869* (UC); near Palmdale, March 28, 1931, *F. A. MacFadden 2574* (UC). Kern County: Mohave Station, June 3, 1915, *S. B. Parish 9771* (UC); Randsburg, April 5, 1927, *Craig, Newsom, Hilend 129* (P); Bakersfield, April 4, 1893, *Alice Eastwood* (UC). Los Angeles County: 3 miles west of Muroc, Mohave Desert, April 2, 1932, *H. L. Mason 6895* (UC). Santa Barbara County: Cuyama, White Hills, May 2, 1896, *Alice Eastwood* (UC). San Luis Obispo County: Carrizo Plains, April 1, 1934, *E. Armstrong 1102* (VTM). Fresno County: Alcalde, April, 1891, *T. S. Brandegee* (UC); Panoche Creek, April 1, 1932, *C. H. Quibell 2799a* (P). Stanislaus County: Arroyo del Puerto, Mount Hamilton Range, altitude 730 feet, March 29, 1935, *H. K. Sharsmith 1593* (UC). Alameda County: Tesla, April 11, 1935, *J. T. Howell 12598* (CA); Corral Hollow, April 21, 1935, *A. M. Carter 777* (UC).

Coreopsis calliopsidea is the only one of the annual species here treated in which the stems are always somewhat leafy. Basal clustering of the leaves may be quite absent, and the stems may be clothed with scattered leaves for their greater length, or the upper half or two-thirds of the stems may be essentially naked. *Coreopsis calliopsidea* var. *nana* Gray was based on small plants in which the leaves are somewhat basally crowded, and the stems more scapose than usual. In Hall's treatment (*op. cit.,* p. 141) the outer disc achenes are described as being like those of the ray, oval, flat, and glabrous, the central disc achenes as being narrow with long cilia. The dimorphism, however, is sharply defined between achenes of ray and disc, in this species as in the other members of the section *Pugiopappus.* Only the ray achenes are glabrous, and all of the disc achenes are ciliate.

4. **Coreopsis californica** (Nutt.) comb. nov. *Leptosyne californica* Nutt. Trans. Am. Phil. Soc. n. ser. 7: 363. 1841. *L. Newberryi* Gray, Proc. Am. Acad. 7: 358. 1868. *L. Douglasii* of

Gray and other authors, not *L. Douglasii* DC. *Coreopsis Douglasii* Hall, Univ. Calif. Publ. Bot. 3: 140. 1907 (misapplied).

Erect, essentially glabrous annual with several (1–20, mostly about 5) scapose stems from a slender taproot: cotyledons linear filiform, 3–4 cm. long, obtuse with a conspicuous red callous tip, fleshy, terete or slightly flattened above, erect: scapes slightly reddish, somewhat leafy and occasionally branching near base, often with a small, appressed bract above the leaves, monocephalous, 5–45 (often 20–25) cm. tall: leaves basally clustered, erect, linear filiform, 2–10 (or 15) cm. long, 0.5 mm. wide, obtuse with a conspicuous red callous tip, fleshy, terete or slightly flattened above, mostly entire, occasionally with 1–2 small, linear pinnae, glabrous except for an occasional, short, glandular capitate hair: heads erect and solitary, 6–10 mm. high, 10–35 mm. broad: involucre barrel shaped with rounded base; bracts of outer series 2–7, pale green, sometimes blotched with red, prominently bearded at gibbous base with yellow or red glandular papillae, slightly fleshy, narrowly lanceolate, 4–7 mm. long, 1 mm. wide, obtuse with a red callous tip, spreading; bracts of inner series 5–8 (or 10), broadly lanceolate to narrowly obovate, 6–10 mm. long, 2–4 mm. wide, acute with tuft of apical hyaline hairs, yellow green often blotched with red, thin, many nerved, narrowly scarious margined, constricted at middle with upper half spreading in anthesis, connivent in early fruit, spreading in age: ray florets 5–12, pistillate, fertile; ligule yellow, sometimes paler near apex, narrowly to broadly obovoid, 5–15 mm. long, 3–8 mm. wide, strongly 3-toothed at apex, spreading horizontally; tube 1–1.5 mm. long with apical ring of brownish or yellowish glandular papillae; style branches linear, obtuse: disc florets 10–30, perfect, yellow, central ones often sterile; tube 1–2 mm. long; annulus glandular pubescent with yellowish or brownish hairs; throat expanded, 2 mm. long; corolla lobes broadly ovate, acute, spreading; anther tips ovate cordate; style tips triangular, attenuate, glandular papillate; pollen grains spherical, with short spines; receptacular bracts linear to spatulate, 4–55 mm. long, 1–1.5 mm. broad, obtuse, hyaline, lightly nerved, not falling with disc achenes and often more tardily deciduous: achenes monomorphic, obcompressed, obovate, 2.5–5 mm. long, dull and microscopically papillate, roughened with short, hyaline, two-celled, clavellate or capitate hairs on wing and body, rusty-tan to light brown, tardily deciduous; pappus reduced to a cupule; marginal wing of achene colored like body or slightly lighter, strongly and irregularly corky thickened and spongy, microscopically foveolate, with marginal row of hyaline, two-celled, clavellate or capitate hairs and often with row of 1 to several red spots on inner edge; body of achene rounded on back, inner face with a well developed, central corky ridge; central sterile achenes varying to thin, smooth, somewhat shining, only sparsely hairy, usually with clavellate hairs forming an obvious marginal fringe on the wing, light tan or stramineous, often with conspicuous and numerous red spots along inner edge of wing.

Range. Cismontane southern California, Mohave Desert and Colorado Desert, from southeastern Santa Barbara County to San Diego County, altitude 30–600 meters; south to northwest Lower California, east to southern Arizona.

Type. "Near San Diego. Upper California," *Nuttall.*

Specimens examined. CALIFORNIA. Santa Barbara County: Le Cumbre Club, *R. C. and J. Robbins* in 1921 (SBM). Los Angeles County: Little Rock, April 26, 1926, *H. L. Mason 3003* (UC); Lancaster, April 1, 1932, *H. L. Mason 6872* (UC); Pasadena, May 2, 1882, *Marcus E. Jones 3361 pro parte, 3373* (P); Claremont, May 20, 1909, *L. Abrams 5325* (SU); Cobal Canyon, March 16, 1925, *P. A. Munz 9357* (P); near Santa Ana Canyon, March 10, 1926, *M. E. Jones* (P); Altadena, April, 1902, *G. B. Grant 681* (UC); Verdugo Hills, April 6, 1901, *L. Abrams 1387* (SU). Orange County: Santa Ana Mountains, April, 1904, *H. D. Geis 732* (SU). Kern County: El Paso Range, May 1, 1927, *L. R. Abrams 11915* (P); 10 miles east of Mohave, April 2, 1932, *H. L. Mason 6906* (UC); between Rosamund and Mohave, April 30, 1927, *L. R. Abrams 11788* (P, SU); between Coso Hot Springs and Coso Junction, April 30, 1928, *R. S. Ferris 7466* (P). San Bernardino County: north of Box S Ranch, April 21, 1932, *P. A. Munz 12415* (P, UC); between Warren's Well and Coyote Well, April 18, 1930, *J. A. Ewan 3057* (UC); 20 miles northwest of Barstow, May 5, 1906, *H. M. Hall and H. P. Chandler 6850* (UC); west of 29 Palms, April 10, 1935, *P. A. Munz 13774* (P); summit Cajon Pass, April 12, 1919, *S. B. Parish 19237* (UC). Riverside County: Riverside, April 4, 1902, *H. M. Hall 2960* (UC); se. of White Tanks, April 9, 1932, *P. A. Munz and C. L. Hitchcock 12224* (P, UC). Imperial County: Coyote Canyon, April, 1902, *H. M. Hall 2859* (UC, SU). San Diego County: San Diego, April 21, 1903, *H. M. Hall 3860* (UC); Del Mar, March 28, 1894, *T. S. Brandegee* (UC); Point Loma, April 6, 1913, *Alice Eastwood 2533* (CA); Jacumba Springs, April 11–16, 1924, *W. W. Eggleston 19748* (P). ARIZONA. Arnett Canyon, Pinal County, March 19, 1932, *J. W. Gillespie 5420* (UC); Apache Trail, March 6, 1929, *Mrs. C. W. McKelvey* (CA). MEXICO. Baja California: Northwest corner Baja California, April, 1903, *H. M. Hall 3973* (UC); San Quintin, February 15, 1935, *C. Epling and W. Robison* (UCLA); Todos Santos Bay, April 10, 1882, *M. E. Jones* (SU).

From the time of Gray to the present, the southern Californian species described above as *C. californica* has been known, first, as *Leptosyne Douglasii,* and later, as *Coreopsis Douglasii.* Soon after beginning the present study it became evident that there are two species among the plants recognized as *C. Douglasii,* the most outstanding differences being in the fruits. Through the courtesy of Sir Arthur Hill, two fruits from the type of *Leptosyne Douglasii* DC. were sent for comparison from the Royal Botanic Gardens at Kew. Though somewhat immature, these fruits belong unquestionably, not to the widely spread and well known southern California unit under consideration, but to the relatively restricted and hitherto unrecognized unit of the inner South Coast Ranges. The name *C. Douglasii* must be transferred, then, from its old and well-known association with the southern Californian species, to the South Coast Range species. It follows that *Leptosyne californica* must be reestablished as the type of the southern Californian species.

According to Nuttall's description of *Leptosyne californica,* the ray achenes are imperfectly developed and almost smooth, but the disc achenes are scabrous with short, glandular hairs, and have, as well, thick, spongy margins and often a similarly enlarged center. *Leptosyne Newberryi* Gray, described from material collected by Newberry at Sitgreaves Pass, Arizona, and by Palmer at Camp Grant, Arizona, represents a phase in which the achenes are only sparsely clad with clavellate hairs. These minor achenal differences give evidence of the variations to be expected in the achenes of *C. californica.* If only the extremes are considered, the differences are striking. The variation is not, however, one of regional significance, but seems, rather, to be related to fertility within the individual head. The central disc florets of this species are more or less sterile and vary from the fertile ray and outer disc achenes in the manner indicated in the description of the species. Both extremes may be present in the same head, or the more fertile type may be quite lacking.

When there is taken into consideration the wide range of climatic and edaphic factors to which *C. californica* is exposed, the size variation which occurs within the species is not surprising. The species is sufficiently plastic to adapt itself to habitat conditions as diverse as the Mohave Desert and the seacoast mesas of San Diego County. The maritime form often has the basal leaves thickly clustered, and the scapes stout and rather low with large and showy heads.

5. Coreopsis Douglasii (DC.) Hall, Univ. Calif. Publ. Bot. 3: 140. 1907 (as to name but not as to description). *Leptosyne Douglasii* DC. Prod. 5: 531. 1836. *C. Stillmanii* var. *Jonesii* Sherff, Bot. Gaz. 97: 605. 1936.

Erect, essentially glabrous, glaucous annual with several (1–12, mostly 2–5) stems from a slender taproot: cotyledons linear, 2–5 cm. long, obtuse with an inconspicuous red callous tip, fleshy, rounded beneath, flattened and lightly grooved above, spreading: stems reddish, scapose, somewhat leafy and occasionally branching near base, sometimes with a small, appressed bract above basal leaves, monocephalous, 5–25 (mostly 15) cm. tall, glabrous or with an occasional, short, glandular capitate hair: leaves alternate, basally clustered, spreading when young, suberect to erect with age, linear, 2–8 cm. long, 1 mm. wide, obtuse with an inconspicuous red callous tip, fleshy, rounded beneath, flattened and lightly grooved above, entire or with 1–2 linear pinnae 3–10 mm. long, glabrous except for lateral rows of widely scattered, short, glandular-capitate hairs: heads often nodding in bud, erect in flower, 6–10 mm. high, 10–25 mm. broad; involucre barrel shaped with rounded base; bracts of outer series 2–7, pale green, inconspicuously bearded with short, yellowish glandular papillae at gibbous base, slightly fleshy, narrowly lanceolate, 4–7 mm. long, 1 mm. wide, obtuse, spreading; bracts of inner series 5–8, obovate, 6–10 mm. long, 3–4 mm. wide, acute with apical tuft of hyaline hairs, pale green to yellowish or reddish green, thin, many nerved, narrowly scarious margined, constricted at middle with upper half spreading in anthesis, connivent in early fruit, spreading in mature fruiting heads: ray florets 5–8, pistillate, fertile; ligule golden yellow, sometimes paler near apex, oval, 5–8 mm. long, 3–5 mm. wide, weakly 3-toothed at apex, spreading horizontally, tube 1.5–2 mm. long with hairy ring of glandular hairs at apex; style branches linear, obtuse: disc florets 10–30, perfect, golden yellow, central ones often sterile; tube 1.5–2 mm. long; annulus glandular pubescent; throat expanded, 2 mm. long; corolla lobes broadly ovate, acute, glandular papillate, spreading; anther tips ovate cordate; style tips triangular, attenuate: pollen grains spherical, with short spines: receptacular bracts linear, 4–5 mm. long, 1–2 mm. wide, obtuse, hyaline, lightly nerved, falling separately from disc achenes: achenes monomorphic, obcompressed, obovate, meniscoid, 2.5–5 mm. long, essentially glabrous, smooth, somewhat tardily deciduous; pappus reduced to a cupule; marginal wing yellowish to stramineous, occasionally tan or brownish, 1 mm. wide, somewhat corky but scarcely thickened, microscopically foveolate, glabrous (very rarely with a hair or two), without red spots (very rarely with one or two) on inner margin; body of achene dark brown, shining, microscopically latticed, rounded on back, smooth on inner face or with a few, small, central or scattered, inconspicuous, callous papillae, and occasionally with some small, appressed, two-celled, scarcely clavellate or capitate hairs; central sterile achenes similar to but smaller than fertile ones.

Range. Dry rocky slopes of the inner South Coast Ranges of California, Santa Clara County to western and central Santa Barbara County, altitude 150–600 meters; Mount Hamilton Range, San Carlos Range, southern Gabilan Range, southeastern Santa Lucia Mountains, western San Rafael Mountains.

Type. "In California legit cl. Douglas."

Specimens examined. California, *Douglas 8,* achenes from type at Herb. Kew. (UC). Santa Clara County: Arroyo Bayo, Mount Hamilton Range, altitude 2000 feet, April 2, 1936, *H. K. Sharsmith 3490,* flowering specimens typical (UC), April 25, 1936, *H. K. Sharsmith 3627,* achenes typical (UC), May 15, 1937, *H. K. Sharsmith 3944, 3946* (UC). San Benito County: Hernandez Valley, May 1, 1933, *Roxanna S. Ferris 8394* (UC, SU). Monterey County: Priest Valley, May 13, 1893, *Alice Eastwood* (UC); Jolon, Bradley road near Bryson road junction, May 2, 1933, *Roxanna S. Ferris 8454* (UC, SU); Bradley-Jolon road near Pleyto road junction, May 3, 1933, *D. D. Keck 2098* (P); Jolon, *T. S. Brandegee* in 1876 (UC); top of Jolon grade, March 24, 1935, *Alice Eastwood and J. T. Howell 1966* (CA); summit of Mustang grade, March 26, 1935, *Alice Eastwood and J. T. Howell 2085* (CA); Mansfield Ranch, King City, April 1, 1915, *Alice Eastwood 4022* (CA). San Luis Obispo County: Paso Robles, May 4, 1926, *Alice Eastwood 13858* (CA). Santa Barbara County: Lompoc, April 16, 1932, *Ralph Hoffmann* (SBM); Zaca Mountain, March 25, 1935, *D. Axelrod 143,* immature (VTM).

The identification of De Candolle's type of *Leptosyne Douglasii* with the South Coast Range species under consideration, and the necessary transfer to this species of the name *C. Douglasii,* previously misapplied to *C. californica,* has been discussed under the latter species. The exact locality in California from which Douglas collected the type of *Leptosyne Douglasii* is unknown, but a number of Douglas' collections indicate that he penetrated the inner South Coast Ranges, and it is probable that he obtained it either east of Monterey or north and east of Santa Barbara. The description of *C. Douglasii* as given above has been based upon living plants from the Mount Hamilton Range.

Because of its close alliance with the far more abundant *C. californica, C. Douglasii* has remained unnoticed by the very few California botanists who have collected it. It is important to realize that the vegetative features which help to distinguish this species are to be adequately recognized only in the living plants. In herbarium specimens only the achenal characters stand out as distinctive (*H. K. Sharsmith 3946*). It should be noted also that the younger living plants show the characteristic leaf position, shape, and glaucous cast far more clearly, the leaves becoming more terete and flaccid with maturity. To a certain degree the quite young plants maintain their vegetative characters even when pressed (*Ferris 8394,* SU).

Coreopsis Stillmanii var. *Jonesii* was based on a collection made May 2, 1882, at Pasadena, California (*Marcus E. Jones 3361 pro parte*). Although the wings of some of the achenes do show a certain amount of corky and rugose thickening suggestive of *C. Stillmanii,* varietal relationship to this species is not indicated.

On the basis of leaf and floral characters, *C. Stillmanii* var. *Jonesii* is referable either to *C. californica* or to *C. Douglasii;* the achenes are those of *C. Douglasii.* Pasadena is far removed from the range of *C. Douglasii* as otherwise known. A suspected error in locality is partially confirmed by the inter-mixture of specimens of *C. californica* on the two duplicate sheets (P, CA) of the type collection. Another collection of the same locality and date (*Jones 3373,* P) consists of one plant of *C. californica.* The suspected error is further confirmed by examination of available Los Angeles County specimens of the section *Euleptosyne;* all are found to belong, on the basis of achenal characters, to *C. californica.* In a region as well known botanically as the area about Pasadena, it is significant that none of the many local collectors has ever reported any species which would correspond to *C. Douglasii.* Mr. Frank W. Peirson, who has made a special study of the Pasadena flora, states that he has never collected any *Coreopsis* with such achenal characters. In consideration of these facts, it seems necessary to conclude that these Jones Pasadena specimens do not represent a part of the geographic range of *C. Douglasii.*

6. Coreopsis Stillmanii (Gray) Blake, Proc. Am. Acad. 49: 342. 1913. *Leptosyne Stillmanii* Gray, Bot. Mex. Bound. 92. 1859.

Erect, essentially glabrous annual with several (1–15, mostly 3–5) stems from a tap root: cotyledons 1 cm. long, spatulate, flattened, only slightly fleshy, spreading: stems yellowish green to stramineous, leafy on lower half or scapose, sometimes branched, occasionally with a small, appressed bract on upper portion, monocephalous, 5–30 (mostly 10–15) cm. tall: leaves 2–10 cm. long, alternate, clustered at base or mostly cauline, only slightly fleshy, flat, spreading; blade triangular, 0.5–5 cm. long, often as wide, once or twice pinnate into spatulate, obtuse lobes 1–3 mm. wide and often inconspicuously callous tipped, terminal spatulate lobe usually broader than the lateral pinnae, blade simple in depauperate plants; petiole 1–5 cm. long, 1–2 mm. wide, channelled, sometimes margined with scattered glandular capitate hairs, expanded at base: heads erect, 7–20 mm. high, 1–3.5 mm. wide: involucre barrel shaped, rounded at base; bracts of outer series 4–8, linear to spatulate, 3–10 cm. long, 1–2.5 (mostly 1.5) mm. wide, obtuse, green or reddish green, flat, not fleshy, somewhat spreading, angled but not gibbous at base, prominently bearded at base with long (1 mm.), brownish glandular hairs, similar but shorter hairs scattered along margins; bracts of inner series 5–10, ovate, 5–10 mm. long, 2–5 mm. wide, often lightly angled on midrib, acute with apical tuft of hyaline hairs, greenish yellow, shining, thin, many nerved, narrowly scarious margined, constricted two-thirds from base, tips spreading in anthesis, connivent in early fruit, spreading in age: ray florets 5–8, pistillate, fertile; ligule orange yellow, obovate, 5–15 mm. long 3–8 mm. broad, deeply 3-toothed at apex, spreading horizontally; tube 1–1.5 mm. long, glabrous or with a few, scattered glandular hairs; style branches linear, obtuse: disc florets 10–40, perfect, orange yellow, usually all fertile; tube 1.5 mm. long; annulus glabrous or with a few glandular hairs; throat expanded, 1.5 mm. long; corolla lobes triangular ovate, acute, glandular papillate, spreading; anther tips ovate cordate; style tips triangular acute, glandular papillate; pollen grains spherical, with short spines: receptacular bracts lanceolate, 5–6 mm. long, 2 mm. broad, obtuse or subacute, hyaline, caducous, not falling attached to disc achenes: achenes monomorphic, obcompressed, obovate, 2.5–5 mm. long, 1.5–2.5 mm. wide; pappus reduced to a cupule or occasionally with 1–2 short, rigid awns from rim of cupule; marginal wing stramineous, glabrous, corky thickened, rugose, microscopically foveolate, erose margined; body of achene dark brown, smooth but usually not shining, microscopically foveolate, back rounded and glabrous or with short, scattered, two-celled, not obviously clavellate hairs which often arise from callous papillae, inner face with a usually well developed central row of callous papillae, also with smaller, scattered papillae bearing short hairs.

Range. Arid foothills on either side of the Sacramento Valley and San Joaquin Valley, altitude 30–900 meters; western slope of the Sierra Nevada from Butte County to Tulare County, eastern side of the inner South Coast Ranges in Contra Costa County, Santa Clara County, and Stanislaus County.

Type. "In the Valley of the Upper Sacramento," *Stillman.*

Specimens examined. Butte County: Iron Canyon, May, 1897, *Mrs. C. C. Bruce 1987* (P). Placer County: Auburn, April 10, 1865, *W. H. Brewer 4520* (UC). Tuolumne County: Coulterville, March 21, 1936, *H. L. Mason 11019* (P, UCLA, UC); Chinese Camp, 1937, *C. W. Belshaw 2782* (UC). Mariposa County: Mariposa, April 2, 1893, *J. W. Congdon* (UC). Madera County: Raymond, May 9, 1925, *Alice Eastwood 12604* (CA); 8 miles west of Chowchilla, March 21, 1936, *R. F. Hoover 821* (UCLA). Tulare County: April, 1897, *J. B. Davy,* achenes awned (UC). Contra Costa County: Antioch, April, 1889, *T. S. Brandegee* (UC). Santa Clara County: Seeboy Ridge, May 3, 1935, *H. K. Sharsmith 1959* (UC), May 5, 1935, *H. K. Sharsmith 3054,* achenes awned in some heads (UC); San Antonio Creek, March 28, 1895, *E. I. Applegate 259* (SU). Stanislaus County: Arroyo del Puerto, Red Mountains, March 30, 1935, *H. K. Sharsmith 1689,* April 21, 1935, *H. K. Sharsmith 1818* (UC); Adobe Valley, April 22, 1936, *H. K. Sharsmith 3536* (UC).

Plants of some colonies of *C. Stillmanii* have leaves entirely or quite basal, and scapes unbranched and naked (*H. K. Sharsmith 3536*), while others show the basal leaves less densely clustered, and the lower part of the scapes with a few cauline leaves. The extreme of this latter condition is indicated when there is no basal cluster of leaves, and the branched scapes are strongly leafy up to half their length or more (*Belshaw 2782*). These variations appear, however, not to have any particular geographic significance. The condition of leafy stems has been used to differentiate *C. Stillmanii* from *C. californica* which has scapose stems, but this distinction does not hold.

7. Coreopsis maritima (Nutt.) Hook. Curtis Bot. Mag. t. 6241. 1876. *Tuckermannia maritima* Nutt. Trans. Am. Phil. Soc. n. ser. 7: 363. 1841. *Leptosyne maritima* Gray, Proc. Am. Acad. 7: 358. 1868.

Erect, robust, glabrous perennial 3–8 dm. high: stems stout, hollow, spreading from a thick woody base, much branched above: leaves alternate, fleshy, 5–25 cm. long, 2–3 times pinnate into often remote, linear, obtuse, flattened divisions 5–50 mm. long, 1–4 (mostly 2–3) mm. wide; rachis scarcely wider than divisions, flattened, extending into a petiole 2–15 cm. long and 2–3 mm. wide at base: heads few (2–3 at ends of branches), 1.5–2 cm. high, 6–9 cm. wide, erect on essentially naked peduncles 15–50 cm. long: involucre campanulate, rounded and fused at base into a disc 1 cm. across; bracts of outer series 6–10, oblong or oblong-ovate, 10–25 mm. long, 4–8 mm. wide, obtuse, green, flat, spreading to reflexed; bracts of inner series 10–15, ovate, 12–15 mm. long, subacute, thin, yellowish, many nerved, erect or with tips spreading: ray florets 15–20, pistillate, fertile; ligule golden yellow, elliptic to narrowly obovate, 25–40 cm. long, subentire to irregularly 3-toothed at apex, spreading horizontally; tube 3–4 mm. long, glabrous; style branches linear, obtuse; disc florets many, perfect, golden yellow, all fertile or central ones sterile, tube 2.5 mm. long; annulus glabrous or only weakly bearded with glandular papillae; throat funnelform, 3 mm. long; corolla lobes ovate, acuminate, thinly glandular papillate within; anther tips ovate, subcordate at base; style tips triangular acute, glandular papillate; pollen grains spherical, with short spines; receptacular bracts linear to oblanceolate, 8–12 mm. long, 1.5–3 mm. wide, subacute, midrib slightly callous thickened, falling separately from disc achenes: achenes monomorphic, obcompressed, oblong to obovate, 6–7 mm. long, 2–3 mm. wide, plane or slightly meniscoid, dark brown, smooth or often with microscopic surface papillae, seemingly glabrous but often with microscopic, hyaline hairs, inner face with slight central ridge, back rounded; marginal wing up to 1 mm. broad, thin, light brown to dark brown, smooth, microscopically latticed.

Range. Seacoast of southern California in San Diego

County; south along coast to northern Baja California and adjacent islands, altitude 3–60 meters.

Type. "On shelving rocks, near the sea at St. Diego, in Upper California." *Nuttall.*

Specimens examined. San Diego County: Del Mar, March 28, 1894, *T. S. Brandegee* (UC); La Jolla, April 16, 1904, *H. P. Chandler 5123* (UC); Point Loma, March 4, 1896, *T. S. Brandegee* (UC); Soledad, March 29, 1882, *M. E. Jones 3134* (P); San Diego, March, 1895, *T. S. Brandegee* (UC); Cardiff, May 9, 1924, *P. A. Munz 7955* (P). Baja California: Salado Cañon, April 27, 1893, *T. S. Brandegee* (UC); San Martin Island, March–June, 1897, *A. W. Anthony 216* (UC).

8. Coreopsis gigantea (Kellogg) Hall, Univ. Calif. Publ. Bot. 3: 142. 1907. *Leptosyne gigantea* Kellogg, Proc. Calif. Acad. Sci. 4: 198. 1873.

Erect, robust, glabrous perennial with a thick, fleshy main trunk 3–30 (mostly about 12) dm. high, up to 1 dm. thick; primary branches remote, club-like: leaves alternate, clustered at apices of branches, 3–25 cm. long, 3–4 times pinnate into many linear to linear filiform, apically truncate divisions 10–50 mm. long and 0.5–1.5 mm. wide which are lightly grooved above and rounded beneath; rachis stout, terete, lightly grooved above, extending into a petiole 30–70 mm. long and 3–5 mm. thick: heads 1–2 cm. high, 4–8 cm. wide, erect, numerous, cymosely clustered on somewhat leafy peduncles 6–20 cm. long at the ends of branches: involucre campanulate, rounded at base; bracts of outer series 5–12, lanceolate to oblong, 5–20 (mostly 8–10) mm. long, 2–4 mm. wide, obtuse, flat, green, spreading to reflexed; bracts of inner series 10–15, oblong ovate, 10–15 mm. long, 4–8 mm. wide, subacute, thin, yellowish, erect, many nerved with midrib often callous thickened below: ray florets 10–16, pistillate, fertile; ligule golden yellow, elliptic to narrowly obovate, 20–30 mm. long, 5–8 mm. wide, obtuse or subacute with entire or minutely and irregularly 3-toothed apex, spreading horizontally; tube 3–4 mm. long, glabrous; style branches linear, obtuse; disc florets many, perfect, golden yellow, all fertile, or central ones usually sterile; tube 2.5 mm. long; annulus glabrous or only weakly bearded with glandular papillae; throat funnelform, 3 mm. long; corolla lobes triangular acute, thinly glandular papillate within; anther tips narrowly ovate cordate; style tips triangular acute, glandular papillate; pollen grains spherical, with short spines: receptacular bracts linear, 8–10 mm. long, 1.5–2 mm. wide, midrib somewhat callous thickened on lower half, falling separately from disc achenes: achenes monomorphic, obcompressed, oblong to obovate, plane or slightly meniscoid, 5–6 mm. long, 2–3 mm. wide, glabrous or with a very few microscopic hairs, epappose; body dark brown, smooth, shining, microscopically latticed, inner face with slight central ridge, back rounded;

marginal wing narrow, thin, smooth, microscopically latticed, light-brown or dark brown.

Range. Seacoast of southern California from San Luis Obispo County to Los Angeles County, both on mainland and adjacent islands, altitude 15–60 meters.

Type. "Cuyler Harbor, San Miguel Island, about 40 miles off the coast of Santa Barbara, Cal.," *W. G. W. Harford.*

Specimens examined. Mainland. San Luis Obispo County: Oso Flaco Lake, March 17, 1936, *H. C. Lee 514* (VTM). Santa Barbara County: Point Sal, April 11, 1936, *Annetta Carter 1095* (UC); five miles south of Surf, April 14, 1929, *R. S. Ferris 7572* (P, UC). Ventura County: foothills east of Hueneme, *W. G. Wright* in 1894 (UC); near Point Mugu, May 14, 1931, *C. B. Wolf 2052* (P, UC). Los Angeles County: Malibu Hills, April 26, 1926, *M. E. Jones* (P); Point Duma, March 7, 1898, *J. H. Barber 372* (UC). Islands. Santa Rosa Island: April, 1901, *P. M. Jones* (UC); April 9, 1930, *P. A. Munz and E. Crow 11750* (P). Santa Cruz Island: May 12–15, 1929, *L. Ellison* (UC); vicinity of Prisoner's Harbor, April 26, 1930, *L. R. Abrams and I. L. Wiggins 129* (P, UC). Anacapa Island: May 12–15, 1929, *L. Ellison* (UCLA). Catalina Island: Bird Rock, January 22, 1920, *C. F. Millspaugh 4630* (UC); March 27, 1911, *I. J. Condit* (UC). San Nicolas Island: March 13, 1932, *J. T. Howell 8220* (P). San Miguel Island: April 10, 1930, *P. A. Munz and J. Voss 11877* (P). A specimen from Del Monte, Monterey County (May 24, 1923, *Eric Walther,* CA) is probably an escape from cultivation.

Discussion

Section Pugiopappus. Although there is a close degree of relationship among the three species of this section, specific characters are abundant and obvious, and intergradation is quite lacking, despite the fact that *C. Bigelovii* and *C. calliopsidea* occupy a common geographic territory.

Coreopsis Bigelovii and *C. hamiltonii* agree in such characters as scapose stems, basally clustered leaves, and cylindric, truncate involucre with a variable number of linear outer bracts. *Coreopsis calliopsidea* stands quite apart with stems leafy, lower leaves obviously clustered, and campanulate involucre with five ovate outer bracts. When achenes are considered, however, the relationships are reversed. In *C. Bigelovii* and *C. calliopsidea* the pappus paleae are lanceolate acuminate and the disc achenes have permanently attached receptacular bracts with calloused midribs (more obvious in *C. calliopsidea*). The pappus paleae of *C. hamiltonii* are obovate with triangular-acute apices and the receptacular bracts, which lack the calloused midrib, fall separately from the disc achenes. All three species contrast in size of pappus palea, and in distribution and length of cilia on the disc achenes (pl. XXXII, figs. 1–17). A striking feature of *C.*

hamiltonii, not shared by *C. Bigelovii* or *C. calliopsidea,* or, indeed, by any of the Californian species of *Coreopsis,* is the strongly reflexed ligules. The ligules are usually horizontal in the subgenus *Leptosyne.*

When all of the features of similarity and difference between the three species of the section *Pugiopappus* are considered, *C. Bigelovii* is seen to occupy a position between *C. calliopsidea* on one hand and *C. hamiltonii* on the other. Phylogenetically *C. Bigelovii,* or an ancestral type from which it was derived, would appear to be primitive for this particular unit, *C. calliopsidea* and *C. hamiltonii* having diverged from it in opposite directions.

Section Euleptosyne. There is much similarity in habit between the three species of this section, but a closer relationship is indicated between *C. californica* and *C. Douglasii.* In these two species the stems are always scapose, and the leaves basally clustered, while in *C. Stillmanii* there may be great variation in these characters. *Coreopsis Stillmanii* may even equal *C. calliopsidea* of the section *Pugiopappus* in leafiness and branching of the stems. *Coreopsis californica* and *C. Douglasii* agree, also, in their fleshy, linear, entire or once pinnate leaves, while *C. Stillmanii* has distinctive, flat, spatulate, once or twice pinnate leaves. Less obvious but no less characteristic leaf differences occur, however, between *C. californica* and *C. Douglasii,* for *C. californica* has the leaves erect, linear filiform, terete, and light green, while in *C. Douglasii* they are spreading (becoming erect with age), linear, flattened, and somewhat glaucous. As has already been mentioned, the leaf distinctions of *C. Douglasii* can be observed with certainty only in young living plants.

The general nature of the barrel shaped involucre is common to all three species, but in *C. californica* and *C. Douglasii* the outer bracts are fleshy, narrowly lanceolate, and gibbous at the base, while in *C. Stillmanii* they are flat, linear to spatulate, and merely angled at the base. Sherff relied in part on an extreme variation in the number of outer involucral bracts for the establishment of *C. Stillmanii* var. *Jonesii.* The number of these bracts, however, is inconstant in all the annual Californian species except *C. calliopsidea,* and this character does not seem to be of taxonomic significance.

Explanation of the Figures

Plate XXXII. Fig. 1. Head of *C. Stillmanii,* ×1.5. Fig. 2. Inner face of achene of *C. Stillmanii,* ×5. Fig. 3. Head of *C. californica,* ×1.5. Fig. 4. Inner face of achene of *C. californica,* ×5. Fig. 5. Head of *C. Douglasii,* ×1.5. Fig. 6. Inner face of achene of *C. Douglasii,* ×5. Fig. 7. Hair from achene of *C. californica,* ×175. Fig. 8. Head of *C. Bigelovii,* ×1.5. Fig. 9. Inner face of disc achene of *C. Bigelovii,* ×5. Fig. 10. Inner face of ray achene of *C. Bigelovii,* ×5. Fig. 11. Hair from disc achene of *C. Bigelovii,* ×35. Fig. 12. Inner face of ray achene of *C. hamiltonii,* ×5. Fig. 13. Inner face of disc achene of *C. hamiltonii,* ×5. Fig. 14. Head of *C. hamiltonii,* ×1.5. Fig. 15. Head of *C. calliopsidea,* ×1.5. Fig. 16. Inner face of ray achene of *C. calliopsidea,* ×5. Fig. 17. Inner face of disc achene of *C. calliopsidea,* ×5.

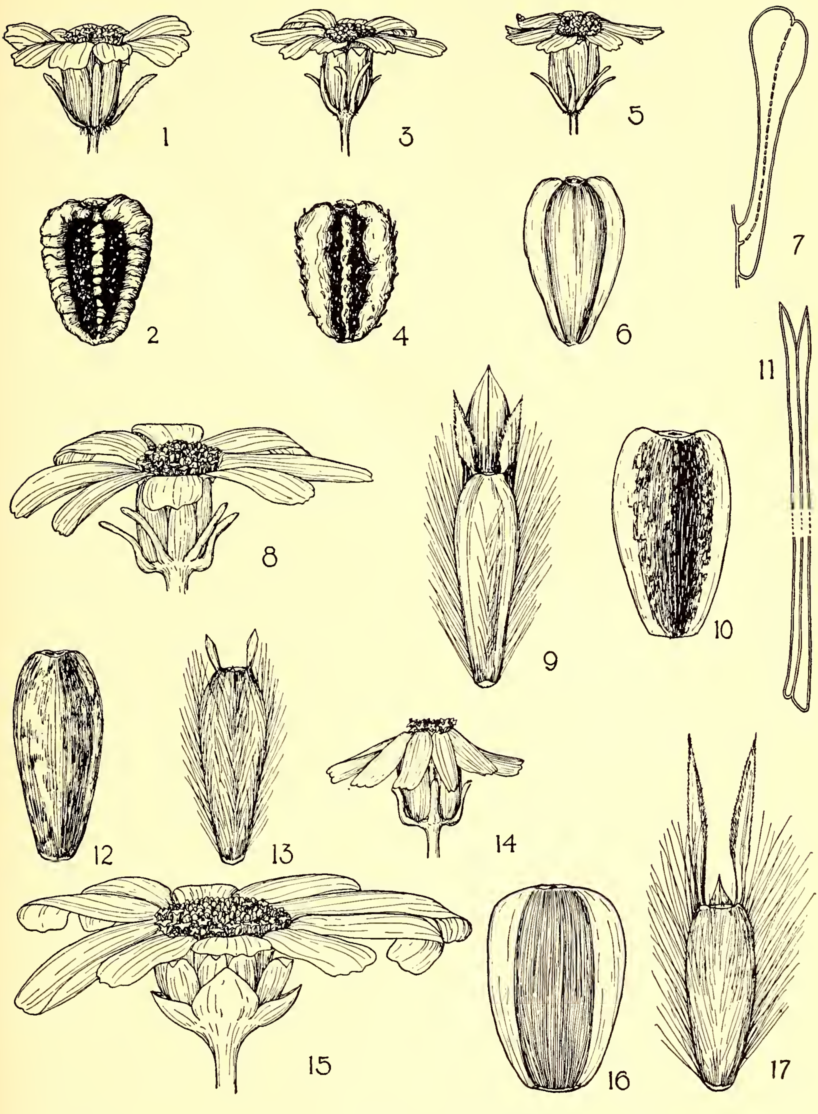


PLATE XXXII. NATIVE ANNUAL CALIFORNIAN SPECIES OF COREOPSIS.
(See explanation of figures on page 228.)

Coreopsis californica and *C. Douglasii* have the annulus of the disc corollas obviously bearded, while in *C. Stillmanii* it is characteristically glabrate. *Coreopsis Stillmanii* is the only annual California species of *Coreopsis* which lacks a distinctly bearded annulus.

Achenal differences play an important part in species differentiation within the section *Euleptosyne* as well as in the section *Pugiopappus*. One feature is sufficent to distinguish the achenes of *C. californica*, the presence of conspicuous, two-celled, clavellate or capitate hairs on body and wing. Even in immature achenes, with adequate magnification, these minuscule clubs or stalked knobs stand out clearly along the margin of the wing. Other characters which aid in distinguishing the achenes of *C. californica* are the dull, rough, tan to reddish surface, and the irregularly thickened, corky wing and central ridge of the mature and fertile achenes. *C. Douglasii* is marked by the glabrous nature of the immature achenes, and the smooth, shining, usually glabrous, brown body and thin, yellow or stramineous wing of the mature achenes. Even though the inner face occasionally bears some callous papillae or two-celled hairs, the hairs are smaller and scarcely clavellate or capitate, and almost never (one or two at most) occur on the wing. The sparsely hairy, smooth, central sterile achenes of *C. californica*, often with conspicuous red spots ("oil glands"), are quite different from the achenes of *C. Douglasii*, and are easily distinguished.

The question of specific relationships within this section is somewhat difficult to visualize. The specific delimitation of *C. Stillmanii* is obvious, even though this species transgresses the separate geographic ranges of both *C. californica* and *C. Douglasii*. Less obvious, however, is the specific differentiation of *C. californica* and *C. Douglasii*. With the use of herbarium specimens alone, there is but a single, clear basis for their separation, that of the achenes, a reliable criterion even when the achenes are immature. Only in young, living plants are the other differentiating characters adequately seen. A study of simultaneous garden cultures of *C. californica* and *C. Douglasii*, as well as field observations, gave convincing evidence that additional differences exist which justify a specific segregation. Another factor of significance is that the two species occupy distinct geographic territories. The western limit of *C. californica* is in very close approximation to the southern limit of *C. Douglasii*, but, unless the Pasadena locality of Jones' specimens should ever be validated, no specimens are on record which show an overlapping between the ranges of the two species.

One experiment was performed, which though yielding insufficient evidence to be significant in itself, may point the way to a convincing proof of the relationship of *C. californica* and *C. Douglasii*. A reciprocal cross was made between these two species by removing the unopened, perfect disc florets from a young head of each, and leaving only the pistillate ray florets. The heads were then cross pollinated. A control was similarly treated and self pollinated. The heads were protected from insects and allowed to mature. Fully developed and apparently fertile ray achenes were obtained from the control, but only imperfect and partially developed ray achenes were obtained from the reciprocal cross.

Coreopsis californica predominates in the area which may be considered the center of diversity for the subgenus *Leptosyne* in California, cismontane and desert southern California. Considering this fact as well as its wider range and greater abundance, *C. californica* may be thought of as a unit ancestral to *C. Douglasii.* Whether *C. californica* or *C. Stillmanii* should be considered as primitive in the section *Euleptosyne* is questionable. On the basis of distribution, *C. californica* may rank as the most primitive member of the section, but the center of diversity may differ from the center of origin which often proves of greater significance in establishing relationships. The occasional occurrence of one or two smooth, straight awns upon the cupule of *C. Stillmanii* may indicate that this species is primitive in the section.

Section Tuckermannia. In their perennial habit and maritime habitat, the two members of this section are highly distinctive among the Californian species of *Coreopsis.* They differ particularly in the arrangement and number of the heads, those of *C. gigantea* being numerous and cymosely clustered on short, leafy peduncles, those of *C. maritima* being few in number on long, essentially naked peduncles.

University of California,
Berkeley, July 6, 1937.

COLOR VARIATION IN DELPHINIUM CARDINALE HOOK.

Charles O. Blodgett and G. L. Mehlquist

Conspicuous variation in flower color within a species in its natural habitat is of some scientific interest. We wish, therefore, to record an observation which to the best of our knowledge has not heretofore been reported.

About four miles southeast of Lompoc, in the northwestern part of Santa Barbara County, California, there exists an extensive natural colony of *Delphinium cardinale* Hook. Through the kindness of Mr. Ian Sinclair of Bodgers Seed Company we were privileged to see this colony on July 17, 1937. The field of approximately eighty acres was on the north slope of a rather steep, thin-soiled hill, covered with loose calcareous rock from low cliffs above. The hillside bore a sparse cover of typical Coast Range chaparral, the shrubs ranging from two to five feet tall. Scattered among these were many plants of the brilliant scarlet larkspur, varying in height from three to six feet or more. The plants were evidently completely at home in this dry sunny location, sheltered from the stiff cool coast breezes so prevalent in the valley, for there were many magnificent specimens. Interspersed among the plants bearing the typical cardinal colored flowers were a conspicuous number with flowers of paler hue, ranging through several shades of orange-red, orange-yellow, and buff to a clear lemon-yellow with only a trace of cardinal in the spurs. The color-variant forms were of course in the minority, no doubt less than ten percent of the total number of plants, while the pure yellows, though noticeable, were very few. No other consistent differences, such as height, habit, or leaf variations, could be distinguished in the plants.

Similar color variations have been recorded in *Delphinium nudicaule* Torr. & Gray, a closely allied Californian species. In "Delphinium," the book of the American Delphinium Society for 1936, Mr. Carl Purdy (p. 37) mentions such color variations, and Major N. F. Vanderbilt (p. 65) states that he has "described various forms and variations in *D. nudicaule* in a wide range." Neither author indicates whether or not the variations were found in wild plants or in those resulting from garden manipulation.

Division of Genetics, University of California,
Berkeley, October 25, 1937.

GLAUCOCARPUM, A NEW GENUS IN THE CRUCIFERAE

Reed C. Rollins

The discovery, through recent exploration, of a new genus of plants in the continental United States is rare enough, it seems to me, to merit special consideration. It is not surprising that the more remote parts of the west should yield new species of plants, but it must be conceded that nearly, if not quite, all the native genera are known. Thus when a year ago, Dr. E. H. Graham transmitted to me for identification, specimens of a strange cruciferous plant which he had collected in the Uinta Basin of eastern Utah, the possibility of their belonging to an undescribed genus seemed remote indeed. An exhaustive study at the time, showed that these plants possessed a broad relationship with certain species of "Great Basin" crucifers which have been variously considered to belong to *Thelypodium, Thelypodiopsis* or *Sisymbrium.* Graham's specimens, though only in flower or in some cases possessing a few immature fruits, revealed distinctive characteristics which indicated that their disposition in any of the known genera was unsatisfactory and at best could be only temporary. Mature fruiting specimens were necessary for a complete analysis of this anomalous species, hence a trip into the Uinta Basin to make collections and detailed field observations was planned. On June 15, 1937, I visited the site of Graham's collecting and found the plants growing on a narrow (20 feet) highly calcareous stratum of shale of the Green River formation. The caespitose plants growing in clumps of from two to six inches across and deployed along this single stratum in a highly perplexing fashion, were traced along the face of a high bluff, known locally as Big Pack Mountain, for more than three miles.

This close adaptation to a specific stratum combined with the fact that the plant's discovery was so very recent, gives some indication that we are probably dealing with a highly localized endemic. Further substantiation of this view is evidenced by the more or less restricted ranges of the species found in association with it. These include: *Yucca Herrimaniae* Trel., *Linum leptopoda* A. Nels., *Mentzelia* sp., *Gilia polycladon* Torr., *Cryptantha nana* (Eastw.) Payson, *Cryptantha Grahamii* Johnston, *Cryptantha* sp., *Erigeron argentatus* Gray and *Hymenopappus lugens* Greene. Of these species, *Cryptantha Grahamii* is known only from the immediate vicinity, *Cryptantha* sp. and *Mentzelia* sp. are apparently new to science and the collection of *Linum leptopoda* appears to be the second for this rare species. The type collection of the latter was made in southern Nevada. The other species listed are typically "Great Basin" and are found most frequently in eastern Utah and adjacent Colorado. The deployed distribution and paucity of individuals of all species in the limited area under consideration, gives evidence of the extremely dry conditions under which they survive. The area is in the Upper Sonoran Life-Zone and would ordinarily be placed in the mixed desert shrub type, although the actual site more nearly approaches a "bad land" type of habitat.

Glaucocarpum gen. nov. Perenne suffruticosum glabrum et glaucum; caulibus gracilibus simplicibus; foliis alternis integris vel sparse dentatis; inflorescentiis racemosis; sepalis oblongis non saccatis; petalis flavis spathulatis integris; pedicellis erectis rigidis; siliquis sessilibus vel stipitatis glabris et glaucis; stylis robustis; stigmate integro; loculis 4–8-ovulatis; seminibus oblongis exalatis uniseriatis; cotyledonibus incumbentibus.

Glaucocarpum suffrutescens (Rollins) comb. nov. Species typica. *Thelypodium suffrutescens* Rollins ex Graham in Ann. Carneg. Mus. 26: 224. 1937. The known collections are from the Uinta Basin of eastern Utah and include the following: west of Willow Creek, Thorne's Ranch, eastern slope of Big Pack Mountain, Uintah County, May 23, 1935, *Graham 8950* (type in Gray Herb., isotypes in Carnegie Mus. Herb.); June 15, 1937, *Rollins 1700* (Gray Herb.).

The study of a large series of fruiting plants both in the field and as specimens, make advisable certain minor changes and additions to the original description of *G. suffrutescens.* Plants caespitose, 1–2.5 dm. high (average 2 dm.) root strong, deep and with a pithy texture; radical leaves absent; leaves entire or sparsely and remotely dentate, petiolate or sessile by a narrow base, elliptical to broadly oblanceolate; paired stamens united at base or appearing as a single stamen as a result of the uniting of filaments and anthers by their entire length; siliques 1–2 cm. long, 2–3 mm. broad, slightly flattened parallel to the septum, sessile or with a short, stout gynophore less than 1 mm. long; valves strongly nerved from base to apex; style stout, 1–2 mm. long; stigma circular, entire and unexpanded; ovules 4–8 in each cell; seeds uniseriate, oblong, plump, 1.5–2 mm. long, 1–1.5 mm. broad, mucilaginous when wetted; funiculus free, stout, less than 1 mm. long; septum with a median band of cells slightly elongated parallel to replum; cotyledons incumbent.

Glaucocarpum is most closely related to certain species of *Thelypodium,* which in the broader sense includes species placed in *Thelypodiopsis* by Rydberg (Bull. Torr. Bot. Club 34: 432. 1907) and by O. E. Schulz (Engler, Pflanzenfam. $17b^2$: 582. 1936) and in *Sisymbrium* by Payson (Univ. Wyo. Publ. Sci. 1^1: 11–13. 1922). However, the natural relationship is not sufficiently close to allow the inclusion of the new plant in any of these genera. In order to avoid confusion in making a comparison, the broadly defined "Thelypodium" *sensu* Robinson (Syn. Fl. N. Am. 1^1: 173. 1895) and Jepson (Fl. Calif. 2: 35. 1936) is adopted for the present discussion, but it is not necessarily accepted as the most natural treatment. At the outset, *Glaucocarpum* and *Thelypodium* are dissimilar in field aspect. Except for being more caespitose and of lower stature, the new genus has a closer resemblance to *Stanleya* in habit and general appearance than to any species of *Thelypodium.* Distinctive features of *Glaucocarpum* are: the deep, strongly perennial, woody root; branching multicipital caudex; slender, wiry, simple and leafy stems; absence of radical leaves; numerous petiolate or narrowly sessile, entire cauline leaves; narrow, strict and elongated but lax inflorescence; greenish-yellow petals and young sepals; united long stamens; slightly developed nectar glands; strongly nerved, broad, rather short siliques and stout evident styles. Opposing characteristics typical of the genus *Thelypodium* include: a biennial or short-lived perennial habit; simple caudex; stout branching or more rarely simple stems; well-differentiated radical leaves; cauline leaves which are sessile and auriculate or if petiolate, then divided; broad and usually very congested inflorescence; purple to white or rarely yellowish flowers; long narrow often apiculate anthers with free filaments; well-developed nectar glands; long narrow and nerveless or nerved siliques with a short or obsolete style. In the aggregate, these characters effectively demonstrate the generic distinctiveness of *Glaucocarpum.*

Gray Herbarium, Harvard University,
February 18, 1938.

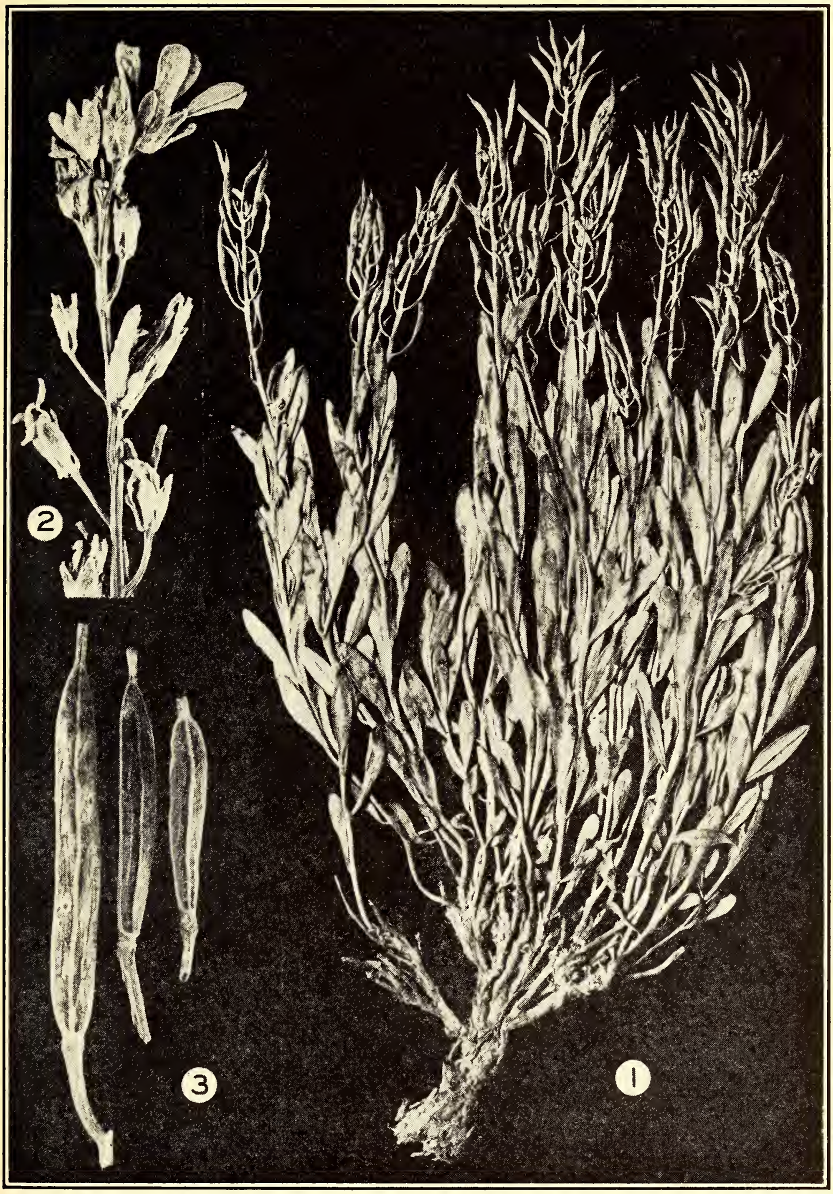


Plate XXXIII. Glaucocarpum suffrutescens Rollins. Fig. 1. Fruiting plant $\times \frac{2}{3}$ (*Rollins 1700*). Fig. 2. Flowering raceme from the type $\times 2$ (*Graham 8950*). Fig. 3. Siliques $\times 3$ (*Rollins 1700*).

REVIEWS

Tübatulabal Ethnography. By Erminie W. Voegelin. Anthropological Records. Volume II, Number 1. Pp. 1–84 with 6 plates and 16 text figures. University of California Press. March 9, 1938. $1.00.

Mrs. Voegelin has made an ethnographic study of the Kern River Indians of California during which extensive observations were made of the use by these primitive peoples of the native plants at their disposal. Specimens were made of the plants used and the collection deposited at the University of California Herbarium. Of 220 plant species collected by the author, 130 are reported to be used as food or medicine or are applied in some way in the primitive handcraft of the Indians. The native names for most of the plants are recorded. Considerable space in the published report is devoted to an account of the tending and the preparation for use of native tobacco. Both *Nicotiana Bigelovii* Wats. and *N. attenuata* Torr. were used. A summary of the reported use of tobacco by several Indian tribes is made. Another section deals with the collection, preparation and storage of plant foods. Acorns and piñon nuts are among the most important of these. In addition to the ethnobotany that is definitely organized, there is much casual reference to plants and plant uses that would interest the botanist searching for such information. The literary style is telegraphic. The printing is in photolithography. It is gratifying to see that such information is being gathered and preserved before it becomes lost.—Herbert L. Mason.

Species Lupinorum. By C. P. Smith. Privately published by the author, Route 1, Box 24, Saratoga, California. Signature 1, pp. 1–16, April, 1938. Signature 2, pp. 17–32, May, 1938.

Botanists will welcome the first two numbers of the "Species Lupinorum" by Charles Piper Smith. The projected work is the culmination of the author's years of experience with the difficult genus *Lupinus* and will include the lupines of the world. Signature one of April, 1938, comprising a part of paper one, includes besides the introduction, a "Catalog of the published names proposed for species," a "Catalog of names of authors describing one or more species or varieties," and the beginning of a "Chronological catalog of species and varieties" closing with the year 1910. The second signature, May, 1938, continues the chronological catalog to the year 1937, thus closing paper one. Paper two of May, 1938, also included in the second signature, is "A preliminary catalog of the lupines of Baja California and Sonora." The species and varieties and their synonyms, the type collections, bibliographic references, and the citations of a few specimens calculated to indicate the range are listed. No descriptions occur except for new species and varieties. Where necessary, critical notes are included to clarify taxonomic problems. *Lupinus Mearnsii* C. P. Smith, *L. albifrons* var. *Brandegeei* C. P. Smith, *L. latifolius* var. *Wigginsii* C. P. Smith are described as new. The paper closes with a key to the species included. It is to be hoped that nothing will stand in the way of the completion of this very worth while series of papers. The printing is in photolithography. Copies may be had by making a contribution to the publishing fund. A minimum contribution of one dollar entitles the donor to five signatures.—HERBERT L. MASON.

Plants of the Lava Beds National Monument, California. By ELMER I. APPLEGATE. The American Midland Naturalist. Volume XIX, Number 2. Pp. 334–368. March, 1938.

So little has been written of the western extension of the Great Basin flora into the Pacific Coast states, that this capable treatment of one such area is extremely valuable. The Lava Beds National Monument comprises about seventy-two square miles of northeastern Siskiyou County and adjacent Modoc County. The numerous cinder-cones, lava flows and deposits of pumice, which support a rather sparse vegetation, clearly mark it as a region of recent volcanic activity. The author lists ten species of trees, thirty three of shrubs, one hundred and fifty of herbs, and two of ferns, many of which are typical of the Great Basin, although some are evidently derived from the Sierra-Cascade and Klamath (Siskiyou) areas. A well written, popular account of the "life zone" concept, and terse keys to the families, genera and species should make the paper helpful to interested amateurs as well as to professional botanists.—LINCOLN CONSTANCE.

NOTES AND NEWS

BATTAREA PHALLOIDES (DICKS.) PERS. IN SANTA BARBARA. This stalked puffball, although widely distributed, has not heretofore been reported from Santa Barbara. It was observed in rocky soil near the seashore, January, 1938. Dimensions noted below exceed those usually given in descriptions of this species: stem hollow, woody, shining straw color, 25 cm. long, 2.5 to 3.5 cm. in diameter, tapering toward the cap; stem scales conspicuous, pendulous, 5 to 10 mm. wide, 10 to 25 mm. long; volva subterranean, 10 cm. in diameter with loose ragged edge; cap bell-shaped, 7 cm. in diameter, 5 cm. in depth, with smooth, white skin-like peridium which at maturity splits horizontally along the edge and is gradually pushed off; exposed mass of red-brown spores gradually disappearing, the stem standing for several months.—RUTH HARTWELL, Museum of Natural History, Santa Barbara, California.

Dr. W. H. Long, Senior Pathologist, retired, United States Forest Pathology Field Office, Albuquerque, New Mexico, was a visitor, during May and June, to the herbaria at Stanford University and the University of California, Berkeley. Dr. Long was especially interested in studying the collections of gasteromycetes and rusts, particularly *Ravenelia.*

The members of the Second Expedition of the University of California Botanical Garden to South America will sail from San Francisco for Peru on July 20, 1938. The staff, under the direction of Dr. T. H. Goodspeed, will include Dr. H. E. Storck, Carleton College, C. R. Worth, Rutgers University, A. A. Beetle, Rocky Mountain Herbarium, W. J. Eyerdam, Seattle, Washington, J. L. Morrison and O. B. Horton, University of California, Berkeley. The expedition was organized for the purpose of collecting plants suitable for garden culture as well as for obtaining herbarium specimens. On reaching Peru, the members of the expedition will divide into several parties, one covering the higher portions of Peru and Bolivia, another, the Peruvian and Chilean coasts, and a third, southern Patagonia and Tierra del Fuego.

Miss Sarah C. Dyal, on leave from the Herbarium, Department of Botany, Cornell University, has been making a field study of the Valerianaceae, mainly *Plectritis,* during the past year. Most of April and May, 1938, were spent in central California, where in addition to taking numerous field trips, she visited the herbaria at Stanford University, California Academy of Sciences and University of California. After leaving Berkeley, Miss Dyal went north along the coast, stopping in Eureka to consult the private herbarium of Joseph P. Tracy.

Of especial interest to western American botanists is the recent appearance of the "Flora of the Aleutian Islands and westernmost Alaska peninsula with notes on the flora of the Commander Islands," by Eric Hultén (pp. 1–397. Stockholm, 1937), Curator of the Herbarium at the Botanical Museum of the University of Lund, Sweden. The introduction deals with the history of botanical collecting as well as the geological history and phytogeography of the area. The taxonomic portion of the volume consists of 298 pages of discussion, literature citations, and ranges. Descriptions are given only for new species and varieties. Geographical ranges of the 477 species treated in the flora are summarized in a series of maps at the end of the volume.

Mrs. Ynez Mexia has recently returned from Mexico where she has been collecting in the States of Guerrero and Oaxaca since last October. In the latter state she worked in the vicinity of Mitla and Yaveo, a region little known to botanists.

Dr. Carl Epling, Department of Botany, University of California at Los Angeles, made a trip up the Redwood Highway of California during June in order to study the Labiatae in that region.

The following recent publications are of interest to botanists of western North America.

"Notes on the Flora of the Charleston Mountains, Clark County, Nevada," by Ira W. Clokey (Bull. So. Calif. Acad. Sci. 37: 1–11. 1938). Mr. Clokey, who has been making extensive collections in the Charleston Mountains for several years, describes six new entities in this paper: *Calochortus rhodothecus, Aquilegia scopulorum* subsp. *perplexans, Potentilla cryptocaulis, Ditaxis diversiflora, Angelica scabrida* Clokey and Mathias, *Senecio Andersonii.*

"Studies in Penstemon VI. The section Aurator" by David D. Keck (Bull. Torrey Bot. Club 65: 233–255. 1938). In this paper, the section *Aurator* is erected and the following subspecies and varieties are proposed as new: *Penstemon Jamesii* subsp. *breviculus, P. eriantherus* var. *grandis* Pennell and Keck, *P. eriantherus* var. *redactus* Pennell and Keck, *P. Whitedii* subsp. *tristis* Pennell and Keck.

"Plants of Rock Creek Lake Basin, Inyo County, California, a check list" by Frank W. Peirson, privately published by the author, 1938. Mr. Peirson has collected and studied the plants of this region intensively for a number of years. The remarkably complete annotated list contains over 320 species and varieties found above 10,500 feet elevation in this area on the east side of the Sierran crest.

PROCEEDINGS OF THE CALIFORNIA BOTANICAL SOCIETY

The California Botanical Society celebrated its Silver Jubilee on the evening of April 23, 1938, on the occasion of the annual dinner. This was held in the Berkeley Women's City Club and was attended by about 130 members and friends of the Society. Special effort was made to reach as many as possible of the remaining 205 charter members of the Society, for the Silver Jubilee was planned to honor them and particularly the founder of the Society, Professor W. L. Jepson.

The entire second floor of the club house was at the disposal of the Society for the evening and many old acquaintances were renewed as friends came together who had become active in other than botanical lines in recent years. Amateur and professional botanists were there in equal numbers.

Professor W. W. Robbins, of the University of California Agricultural Experiment Station at Davis, presided ably as toastmaster following the dinner. He was introduced by the President of the Society, Professor H. E. McMinn. Dr. Robbins called for short speeches from several persons including Mr. James B. Smith and Mrs. Adeline Frederick, charter members, who combined early reminiscences with tributes to the founder; Professor W. W. Mackie, who discussed some of the early field trips of the Society and the interesting personalities who attended and inspired them; and Professor George J. Peirce, past president of the Society, who read a series of communications from charter members who were unable to attend the banquet, yet who wished to recall the inspirational leadership, good comradeship and steady progress that had marked the organization since its founding. Dr. Peirce then announced the election of Dr. Jepson to life membership in the Society and called upon him as the last speaker.

Dr. Jepson, in addressing the large group of friends and early associates, emphasized the ideals upon which the California Botanical Society was founded and which guided its early leaders. He concluded with an exhortation to the coming ranks to adhere to the ideals of the Society in making new advances. After touching upon the early meetings and the labors of many to insure the success of the organization, the speaker related the historical background of the founding of the Society. One of the functions of the California Botanical Society as visualized by its founder was realized during the first year of the organization, when the members of the Second International Phytogeographic Excursion were entertained at dinner at the Hotel Oakland, Sept. 12, 1913. This occasion brought together perhaps the most notable assemblage of world-renowned botanists in the history of the state.

The history of Madroño was related by the speaker together with the reasons for its name and format. The journal has always been edited as an inviting magazine to the reader, with diversity of content, accuracy and dignity.

Dr. Jepson then suggested means by which the needs of West Coast botanists may be more fully met by the Society. These included the organization of long distance field trips to outstanding botanical localities, such as the Mohave Desert and the "White Plains" or pine barrens of the Mendocino coast. He pointed out the desirability of preparedness to aid in preserving and conserving our botanical heritage when such occasions arise, as when, for example, the largest known individuals of our tree species are threatened with destruction.

After the address the gathering lingered for social intercourse and the opportunity to greet the founder. A suitably inscribed herbarium sheet was passed around for "annotating" and the entire party enrolled thereon, following which the document was presented to Professor Jepson.—D. D. Keck.

VOLUME IV NUMBER 8

MADROÑO

A WEST AMERICAN JOURNAL OF BOTANY

Contents

Published at North Queen Street and McGovern Avenue, Lancaster, Pennsylvania

October, 1938

MADROÑO

A WEST AMERICAN JOURNAL OF BOTANY

Entered as second-class matter October 1, 1935, at the post office at Lancaster, Pa., under the act of March 3, 1879.

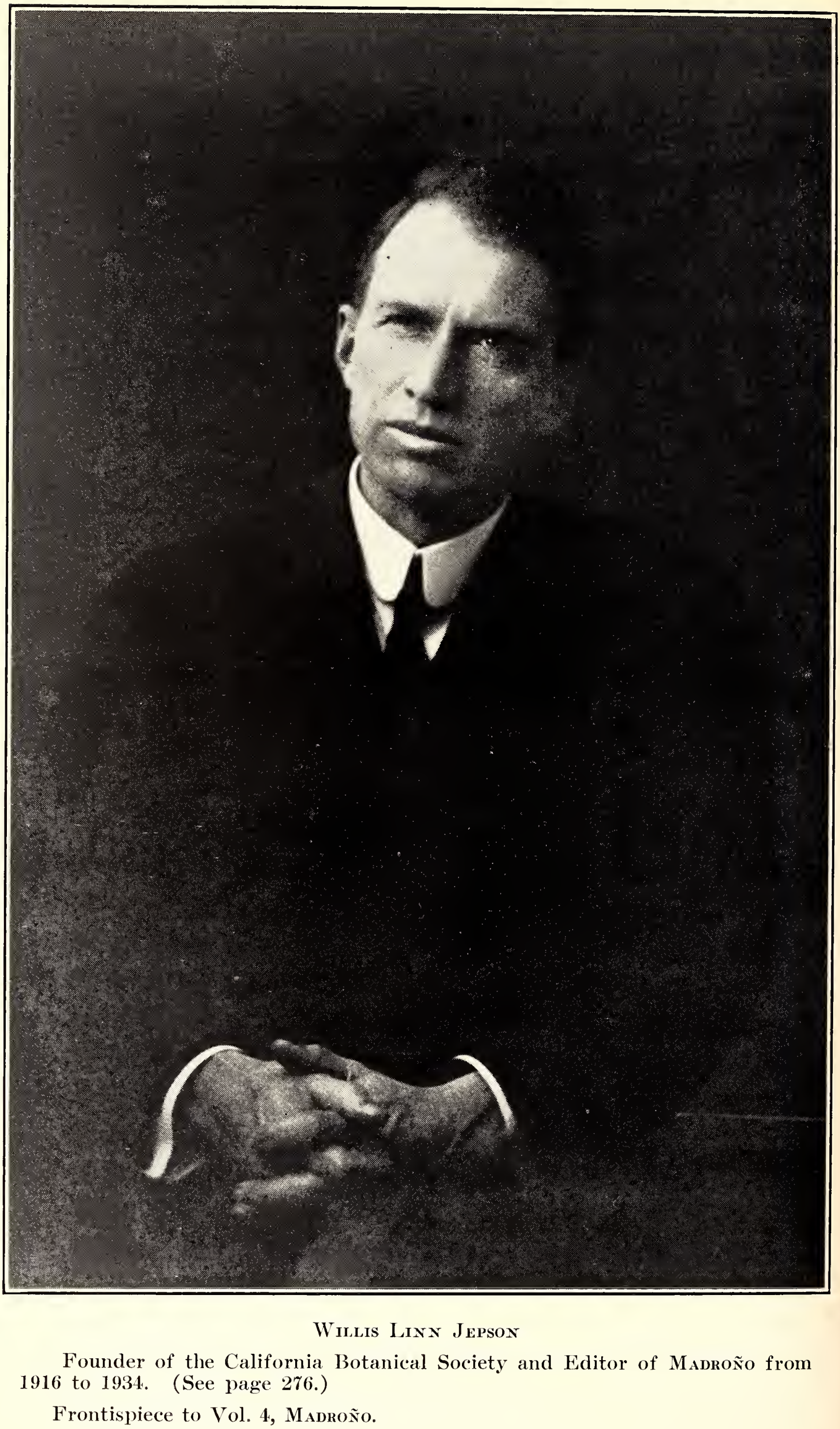
Established 1916. Published quarterly. Subscription Price $2.50 per year. Volume I, Numbers 1 to 17, complete, $5.00. Volume II, Numbers 1 to 17, complete, $5.00. Volume III, Numbers 1 to 8, complete, $5.00. Single numbers $0.75.

Papers up to 15 or 20 pages are acceptable. Longer contributions may be accepted if the excess costs of printing and illustration are borne by the contributor. Range extensions and similar notes will be published in condensed form with a suitable title under the general heading "Notes and News." Articles may be submitted to any member of the editorial board. Manuscripts may be included in the forthcoming issue provided that the contributor pay the cost of the pages added to the issue to accommodate his article. Reprints of any article are furnished at a cost of 4 pages, 50 copies $3.70; 100 copies $4.10; additional 100's .75¢; 8 pages, 50 copies $5.40; 100 copies $6.00, additional 100's $1.20. Covers, 50 for $2.50; additional covers at $1.50 per hundred. Reprints should be ordered when page proofs are returned.

Published at North Queen Street and McGovern Avenue, Lancaster, Pennsylvania, for the

CALIFORNIA BOTANICAL SOCIETY, INC.

Annual membership dues of the California Botanincal Society are $2.50, $2.00 of which is for a year's subscription to Madroño. Dues should be remitted to the Treasurer. General correspondence and applications for membership should be addressed to the Secretary.



Willis Linn Jepson

Founder of the California Botanical Society and Editor of Madroño from 1916 to 1934. (See page 276.)

Frontispiece to Vol. 4, Madroño.

THE FLOWERING OF WOLFFIELLA LINGULATA (HEGELM.) HEGELM.

Herbert L. Mason

The occurrence of flowering in the Lemnaceae has been a subject of great interest during the past ten years. Most of these reduced aquatic plants either flower rarely, or more probably because of their minuteness and obscurity, the flowers are easily overlooked. Flowers in certain species of *Lemna* and *Wolffia,* in some localities at least, are not infrequently observed, while those of *Spirodella* are rarely encountered. Until 1935 flowers of *Wolffiella* were unknown although members of this genus are widespread throughout the warmer parts of the earth and most of the species have been known for approximately seventy years. Because of the failure to find any flowering specimens during this long period, *Wolffiella* has been regarded by some as the most specialized member of the family, having lost completely its capacity to flower. It was supposed that sexual reproduction did not exist and the plants were regarded as being dependent upon vegetative budding as a means of reproduction. Hicks (6) in dealing with this subject states (p. 116–117), "The ability to produce flowers apparently has been so completely lost that probably they are never produced by plants in nature. In *Wolffiella floridana,* at least, it is doubtful as to whether the flowering potentiality could be made to find expression as the result of favorable physiological condition." That *Wolffiella* still retains the capacity to flower is borne out by the finding of flowering material of *W. oblonga* (Phil.) Hegelm. in Argentina and of *W. lingulata* (Hegelm.) Hegelm. in California.

The first species of *Wolffiella* to be reported flowering was *W. oblonga,* a species ranging from South America to North America. Flowers of this species were observed by Giardelli (1) in a lagoon near the town of Dolores, Province of Buenos Aires, Argentina. Careful dissections were made and a very complete diagnosis of the floral characters was drawn up. Illustrations were presented to supplement the descriptions.

In June, 1937, flowering specimens of *W. lingulata* were found in a slough of the marshes of Roberts Island in the delta of the San Joaquin River near Holt, California. On January 11, 1938, a collection of sterile plants was made in Trapper's slough on Roberts Island. These were brought into the laboratory and grown in an aquarium. In three weeks flowers began to appear, and blooming continued over a period of six weeks. In June, 1938, flowering plants were encountered in great abundance at the Roberts Island locality. From these plants seeds developed which germinated freely. On August 26, 1938, many plants were still flowering, although not in such abundance as in June.

Madroño, vol. 4, pp. 241–308. October 31, 1938.

Wolffiella lingulata occurs in quiet water of sloughs in clearings among tules (mostly *Scirpus acutus*). The sloughs are largely the result of excavation for materials to build the dikes which withhold the waters of the San Joaquin river from the rich agricultural delta lands. They have no outlet and obtain their water through seepage from the diked lands as well as from the river. The underlying soil is an immense peat deposit. Associated with the *Wolffiella* were *Riccia fluitans, Typha latifolia, T. angustifolia, Scirpus acutus, Spirodella polyrhiza, Lemna minor, L. cyclostasia, Ceratophyllum demersum, Myriophyllum hippurioides,* and *Jussiaea californica.* Both species of *Lemna* were flowering throughout the summer months.

Wolffiella lingulata was described by Hegelmaier (3) from material collected by Hahn near Mexico City in 1868. A very complete and revised description is given by Thompson (9) which, in certain details, is at variance with the observations recorded here. The vegetative organography has been very ably discussed by Goebel (2). In general this species possesses a very simple rootless thalloid plant body (frond) with a triangular vegetative reproductive pouch at the basal end (pl. XXXVI, fig. 2). The plants are free floating in water at or below the surface but usually do not break through the surface tension layer until the time of flowering. Field observations throughout the entire period of growth and reproduction demonstrate considerable seasonal variation in the size and shape of the fronds as well as in the behavior of the plants. There appear to be two well marked phases of the plant depending upon whether it is in the vegetative or the flowering condition. As in other members of the Lemnaceae the flowering phase in *Wolffiella* is smaller than the vegetative phase (pl. XXXVI, fig. 3). In *Wolffiella,* moreover, it is accompanied by an asymmetrical widening of the basal portion of the frond to accommodate the floral cavity in which the inflorescence is produced. Apparently a reduction in the size of the daughter fronds produced takes place quite generally in the colony just prior to the time of flowering. That there is a connection between flowering and size of the fronds is indicated by the fact that in material growing in the laboratory as well as that in the field, the average size of fronds in colonies producing flowers is much smaller than in those reproducing only vegetatively.

The frond varies from broadly oblong to linear and may range from apparently symmetrical to strongly falciform. There is great variation in proportion of length to width. The length ranges from 1.5 times the width to as much as 7 times the width. Often those that are short have the greatest actual width. The maximum width occurs on vegetative plants. They range from 3.5 millimeters to as much as 5 millimeters wide. Fronds with lengths of 8 or 9 millimeters are not uncommon. Flowering fronds however may be from 3 to 5 millimeters long and as narrow as 1 to 1.5 millimeters. Much of this variation in size and shape is seasonal, and descriptions based on a collection taken at any particular season may be very misleading, particularly when applied to a plant from the same locality collected at another season of the year. Except in the flowering condition all of the plants are concave dorsally by virtue of the turning up of the lateral margins. In addition the ends of the fronds are projected downward and only a small portion of the surface area of the plant ever breaks through the surface layer of the water. This curvature of the frond causes it to appear as though it were a "segment of a band." Some of the fronds may also be twisted so as to appear somewhat spiral. The vegetative phase seems to be at its highest development in California during the winter months. At this time the fronds are of maximum size and show the greatest variation.

The most common type of reproduction encountered in *Wolffiella* is vegetative and is accomplished by budding of the meristematic tissue at the inner angle of the reproductive pouch. The young bud is at first strictly symmetrical and is attached to the parent by means of a stipe (pl. XXXV, figs. 7, 8). Goebel regards this as a very degenerate vascular strand. The length to which the stipe will develop shows great variation when correlated with season. Early in the ontogeny of the bud, tissue differentiation takes place and there is formed at one side of its stipe axis a triangular reproductive pouch with its opening facing the parent frond (pl. XXXV, fig. 7). This pouch causes an asymmetrical development of the new frond with respect to its axis as indicated by the position and direction of the stipe. The pouch lies either to the right or the left of the axis. As the frond continues to grow it assumes an apparently symmetrical form, but morphologically the axis is diagonal and follows along one margin of the reproductive pouch. In plants with short stipes the growth of the daughter frond soon causes it to break away from the parent. A definite abscission layer made up of several layers of transverse cells forms across the stipe (pl. XXXV, fig. 8). During the winter months, however, the stipes are very long and often the daughter fronds remain attached to the parent, forming what have been termed family colonies (pl. XXXV, figs. 4, 5). This is contrary to the observations of Thompson who states that in *W. lingulata* family colonies never occur. In material observed during January as many as ten pairs of fronds were seen attached in a family colony each with its stipe sufficiently elongated to accommodate it to colonial existence. Thompson's failure to observe colonies may well be due to the fact that he was dealing with a single seasonal variant with short broad fronds of large proportion. Such size and shape is a definite obstacle to the formation of family colonies. Of this short, broad type of frond not more than five were noted in one family and these families were rare.

The position of the stipe scar on the frond has been used as a diagnostic character for this species of *Wolffiella*. Careful observation of large numbers of plants demonstrates that the stipe scar may be either on the lower margin of the reproductive pouch to the right or to the left of the median axis of the frond or it may be in the exact right or left corner of the frond (pl. XXXV, figs. 9, 10). Both dextral and sinistral fronds are observable in the photograph.

The tissue of the frond is very simple in its structure. It is only two cells thick at the distal end, whereas at the basal end in the region of large intercellular spaces it is several cell layers thick. Such intercellular spaces are characteristic of members of the Lemnaceae. In *Wolffiella lingulata* they occupy only the basal third or half of the frond (pl. XXXVI, fig. 2). The epidermal layers are beset with scattered dense cells which have been termed pigment cells. Upon drying these become red brown. The few stomata (pl. XXXV, fig. 6) that have been observed were on flowering specimens and only on that portion of the frond that is emersed. Goebel reports his inability to see stomata. Hegelmaier noted one or two near the margin of a frond. Although search was made no stomata were seen on strictly vegetative plants. This coincides with the findings reported by Giardelli for *W. oblonga*. Whether or not the development of stomata precedes the emergence of the frond from water has not been observed. In any event just prior to flowering the fronds break through the tension layer of the water surface and soon the development of the inflorescence becomes evident.

The inflorescence occurs in a floral cavity and makes its appearance first as a double colorless spot composed of a dense mass of very small cells on the side of the reproductive pouch that bears the stipe of the frond (pl. XXXVI, fig. 3). Soon it loses its double aspect and appears as a single oblong mass in a floral cavity lying in a plane essentially parallel to the side of the vegetative pouch. Next a slit-like opening occurs in the surface of the frond above the cavity; this is followed by the emergence of the single flask-shaped pistillate flower. Flowering is thus protoginous. When the stigma becomes receptive a small globule of liquid is exuded (pl. XXXVI, fig. 4) which assumes a spheroid form and completely covers the concave stigmatic surface; presumably this is a trap to catch insect or wind borne pollen. With the disappearance of the globule of liquid from the stigma, the staminate flower, composed of a single stamen, begins to emerge. The stamen, lying back of the pistillate flower away from the base of the frond, is made up of a subspheroid two-lobed anther on a stout filament. During its development the stamen usually tears the aperture of the cavity. Soon after emergence it dehisces its dry white powdery pollen and appears as a conspicuous glistening white spot on the surface of the frond

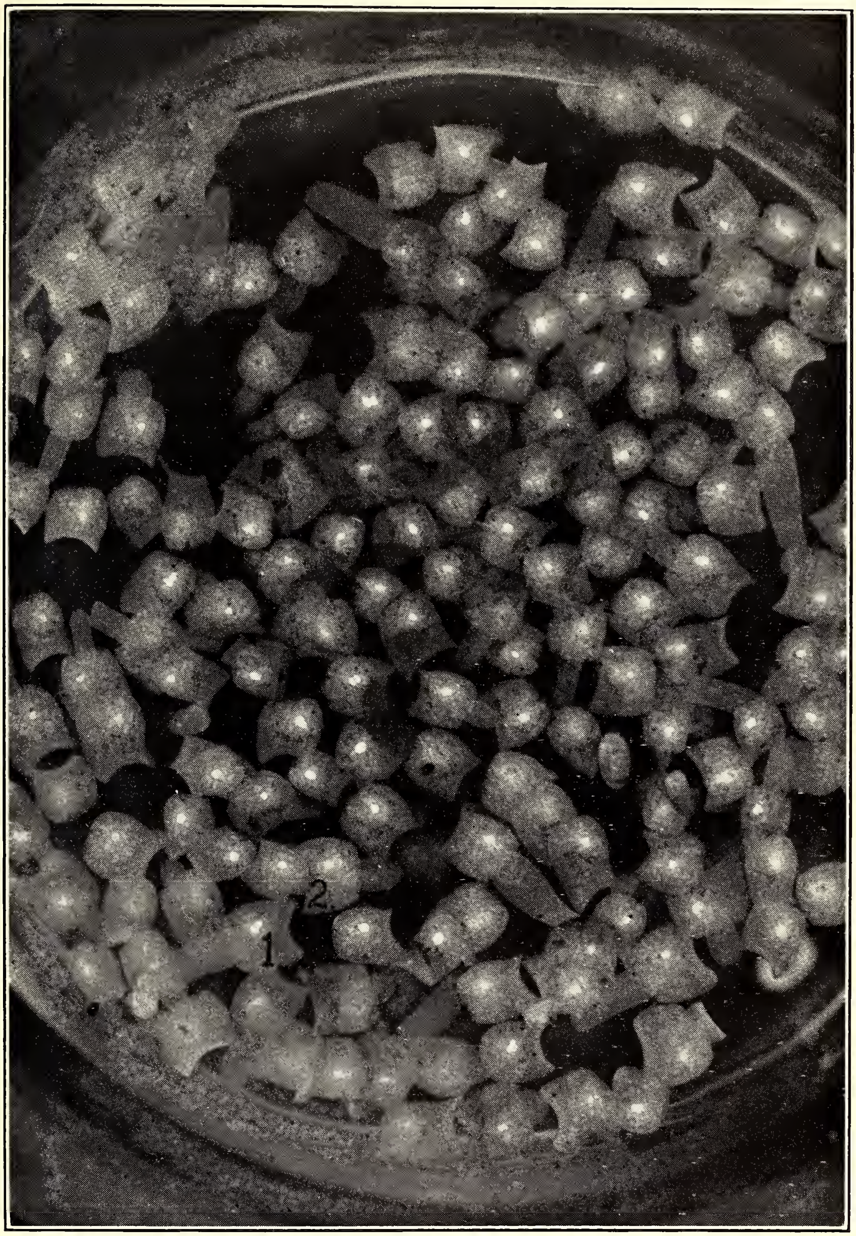


PLATE XXXIV. WOLFFIELLA LINGULATA (Hegelm.) Hegelm. Group of flowering plants, ×5. The shaded portions of the fronds are immersed, the lighter portions bearing the flowers are emersed. (1) Sinistral frond bearing a dehiscing stamen; (2) dextral frond with the pistillate flower in anthesis (dextral and sinistral fronds being interpreted on the basis of the position of the stipe scar rather than the position of the flower).

(pl. XXXIV). It then withers and disappears. There is no evidence of a spathe surrounding the inflorescence.

The young fruit develops asymmetrically into an indehiscent utricle with a single ellipsoid seed and a persistent style (pl. XXXVI, fig. 9). In all plants observed the ripening of the fruit is accompanied by the death of the parent frond, which remains floating with the fruit in place in the ruptured floral cavity (pl. XXXVI, fig. 12). Soon the seed begins to germinate. The ovary wall collapses and disintegrates. The minute brown conical operculum of the testa begins to push out, attached to the hypocotyl (pl. XXXVI, figs. 13–18). As the hypocotyl further enlarges, the operculum becomes increasingly lateral in its position and an irregular slit appears separating the hypocotyl from the cotyledonary sheath. From this slit, the young vegetative frond makes its appearance, the distal end of the frond emerging first. The cotyledon remains within the testa. When fully formed the young plant breaks away from the hypocotyl and other remaining embryo tissues and is a free floating plant with the next vegetative generation already formed in its pouch (pl. XXXVI, fig. 18). At the lower margin of the vegetative pouch the minute stipe by which the young plant was attached to the hypocotyl is clearly visible. A formal description of the inflorescence and flowers of this species follows.

Wolffiella lingulata (Hegelm.) Hegelm. in Engler, Bot. Jahrb. 21: 303. 1895. *Wolffia lingulata* Hegelm. Monogr. Lemnac. 132. 1868. *Wolffiella oblonga* of California authors, *non Wolffiella oblonga* (Phil.) Hegelm. 1857.

Fronds monoecious, protoginous; inflorescence without spathe, borne in floral cavity in dorsal side at basal end of frond, dextrally or sinistrally to vegetative pouch; staminate flower posterior to pistillate flower, stamen one, filament stout, .74–.76 mm. long, anther subspheroid, two lobed, white; pollen white, subspheroid 20–23 microns in diameter, minutely mucronulate; pistillate flower, solitary, pistil flask shaped, .47–.48 mm. high, ovary .13–.20 mm. wide, one-celled, style short, thick, abruptly expanding to a concave circular stigma; ovule solitary, suberect, becoming tilted; fruit a utricle, bladdery, asymmetrical, indehiscent, style persistent; seed ellipsoid ovoid, .41–.44 mm. long, .29 mm. wide, glistening white, operculum of testa lying in a cavity at end of seed (pl. XXXVI, fig. 11).

Specimens from the Missouri Botanical Garden (M) and from the Herbarium of the University of California (UC) were examined.

Mexico. Near Mexico City, *L. Hahn* (type collection, M). California. Kern County: near Bakersfield, Oct. 7, 1895, *C. H. Thompson* (M). San Joaquin County: one-half mile southwest of Holt, *H. L. Mason 11,548* (UC); Trappers Slough, Roberts Island, *H. L. Mason 11,850, 12,072* (UC). San Bernardino

County: near San Bernardino, *Parish 4581* (UC); San Bernardino Valley, *Parish 4586* (UC). Orange County: San Juan Capistrano, *Abrams 4200* (UC). San Luis Obispo County: Oceano, Nov. 14, 1908, *I. J. Condit* (UC). Monterey County: 2 miles south of Pajaro, Sept. 27, 1903, *C. H. Thompson* (M). Santa Clara County: Alviso, Sept. 9, 1903, *C. H. Thompson* (M).

Comparing the above description with that given by Giardelli for *Wolffiella oblonga* the two species are strikingly alike in flower characters. Only two points of difference are outstanding; a third may or may not be significant. For *W. oblonga* there is reported pollen 11 to 15 microns in diameter whereas in *W. lingulata* the pollen is 20 to 23 microns in diameter. In *W. oblonga* the pollen is covered with minute wrinkles whereas in *W. lingulata* it is turgid and minutely mucronulate. In general the size of all the flower parts in *W. lingulata* exceeds that in *W. oblonga.* This is consistent with the larger plant body. The following is a detailed comparison of *W. oblonga* with *W. lingulata* as to points in which measurements were recorded by Giardelli. Except as noted above and in the following table, the flowers agree in other characters. The size of the frond was computed from the magnification cited on Giardelli's illustration.

	W. oblonga	*W. lingulata*
Pollen	11–15 mu	20–23 mu
Pistil	.4 mm. high	.47–.48 mm. high
	.2 mm. wide	.13–.20 mm. wide
Fruit	.45– .55 mm. long	.58–.77 mm. long
	.37– .46 mm. wide	.45–.50 mm. wide
Seed	.35– .40 mm. high	.41–.44 mm. high
	.25– .29 mm. wide	.29 mm. wide
Frond	2.8 –3.5 mm. long	5–8 mm. long

Wolffiella oblonga was first described in 1857 as a species of *Lemna* by Philippi (7) from material collected near Santiago, Chile. Hegelmaier (3) in 1868 in his classical monograph of the Lemnaceae transferred the species to the genus *Wolffia* and erected the subgenus *Wolffiella* to include it and several related species. He expressed the belief that this subgenus should really be considered a distinct genus but was not prepared at that time to make such a disposition of it. However, Hegelmaier (5) later (1895) raised the subgenus *Wolffiella* to generic status and made the combination *Wolffiella oblonga* (Phil.) Hegelm.

The following material of *Wolffiella oblonga* (Phil.) Hegelm. was studied. Chile: Santiago, May, 1857, *Philippi* (type collection, M). Argentina: Cordoba, May 9, 1898, *Stuckert* (M). Uruguay: Montevideo, Pocitas, *Herter 150: 70512* (M, UC).

Wolffiella oblonga (Phil.) Hegelm. has been reported from California, an occurrence based upon two collections from near San Bernardino, by Parish. A careful study of this material and comparison with the type of *W. oblonga* eliminates that species from consideration in the California flora. These plants are clearly small individuals of *W. lingulata.* It is a matter of interest to note that a single specimen of the Parish collection shows an immature flower in a very early stage of development.

Wolffiella lingulata was described as a *Wolffia,* subgenus *Wolffiella,* by Hegelmaier in 1868. To this in 1878 he added the variety *W. lingulata* var. *minor.* In 1898 Thompson (10) reduced this variety to synonomy with *W. oblonga* (Phil.) Hegelm. When the subgenus *Wolffiella* was raised to generic rank by Hegelmaier in 1896 the combination *Wolffiella lingulata* (Hegelm.) Hegelm. was made.

Wolffiella lingulata, as differentiated from *W. oblonga* by Hegelmaier, was based largely upon size characters. His measure ments for fronds of *W. lingulata* ranged from 4.7 to 6.1 millimeters in length and from 1.8 to 2.4 millimeters in width. For *W. oblonga* he reported for the frond a length of 1.7 to 3 millimeters and a width of .6 to .85 millimeters. Later in describing *W. lingulata* var. *minor* he noted that the size character between the two species broke down, causing him to express doubt as to the specific status of *W. lingulata* as distinct from *W. oblonga.* Hegelmaier noted and figured the difference in the extent of the air cavities in the fronds of the two species but made no particular point of this difference in his diagnosis. This character was given emphasis, however, by J. D. Smith (8) and its importance has been corroborated in the present investigation.

Thompson (9) largely on the basis of field and culture studies of material collected near Bakersfield, California, and supplemented with specimen studies of material from Mexico and South America, laid aside the doubts of Hegelmaier and rediagnosed *W. lingulata,* calling attention to what appeared to him to be the constant position of the stipe scar on the lower lip of the pouch to the right of the median line of the frond. He stated that in *W. oblonga* this scar occurs at the angle of the pouch to the right of the frond. This, he maintained, consistently characterized the small forms of *W. lingulata* as well as the large, while *W. lingulata* var. *minor* on the other hand is in this respect identical with *W. oblonga* and must be regarded as an elongated form of that species. This character, he points out, serves as a ready means of distinguishing these two species. The above observations of Thompson's relative to the position of the stipe scar have not been substantiated in the investigations of the writer. As noted above, both dextral and sinistral fronds have been observed and the position of the stipe scar on the pouch is not a constant character. The dextral and sinistral position of the stipe in all probability is the result of genetic variation within the species and probably only occurs as a result of sexual reproduction. In vegetative reproduction, as has been pointed out by Hegelmaier, the stipe and costa of the daughter frond always develop on the side of the parent pouch opposite to the position of these organs on the parent (pl. XXXV, figs. 7, 11). Since the base of the daughter frond faces the opposite direction from the base of the parent frond, this necessitates that a dextral frond must produce dextral offspring and likewise sinistral fronds must produce sinistral offspring. This could account for the uniformity of the plants reported by Thompson from a sterile colony. They probably owed their origin asexually to a single migrant individual. The position of the stipe scar on the lower lip of the pouch or on its right hand corner has been found to vary within a family colony, every member of which descended asexually from a single individual. Figures 9 and 10 of plate XXXV are mother and daughter fronds. In figure 10 the stipe scar is on the lower margin of the frond, whereas figure 9 illustrates an individual with the stipe scar at the corner of the pouch. Figure 9 has the characters attributed to *W. oblonga* in this respect. Since it can be demonstrated that the size and shape of the frond is so dependent on local and seasonal conditions the broad short character of the frond attributed to *W. lingulata* by Thompson must be discarded as a basis for differentiating the two species. Likewise the "saber shaped" character attributed to *W. oblonga* by modern writers does not hold. The great majority of the collections of *W. lingulata* through most of the year are saber shaped. Figure 1 of plate XXXV is typical of *W. lingulata* according to the interpretation of Thompson. It is a flowering specimen. Figures 2, 4, and 5 are of the saber shaped type. Flowers were found on both types and no differences other than shape of the fronds were noted between them. The differences between the two species as observed by the writer (pl. XXXVI, figs. 1, 2) will perhaps be best illustrated by a key.

Plants 1.5 to 4 mm. long; angle of vegetative pouch 40 to 50 degrees, the tip somewhat attenuate, the lips strongly rounded; air chambers almost throughout the frond; pollen 11 to 15 microns in diameter, surface minutely wrinkled (*fide Giardelli*) .... *W. oblonga*

Plants 4 to 9 mm. long; angle of vegetative pouch 60 to 90 degrees, the tip not attenuate; air chambers occupying not more than half the frond; pollen 20 to 23 microns in diameter, the surface muriculate .... *W. lingulata*

Since two species have been found flowering it would seem that some information should now be forthcoming relative to the generic status of *Wolffiella*. Most writers have made their particular disposition of the group "pending the finding of flowers." In a plant so reduced in the structure of its vegetative and reproductive parts it is scarcely to be expected that conclusive data will be available to serve as a basis for descriptive differentiation. Hegelmaier differentiated *Wolffiella* from *Wolffia* primarily on the position of the axis of the vegetative shoot with respect to the vegetative pouch. In *Wolffia* this shoot lies at the base of the

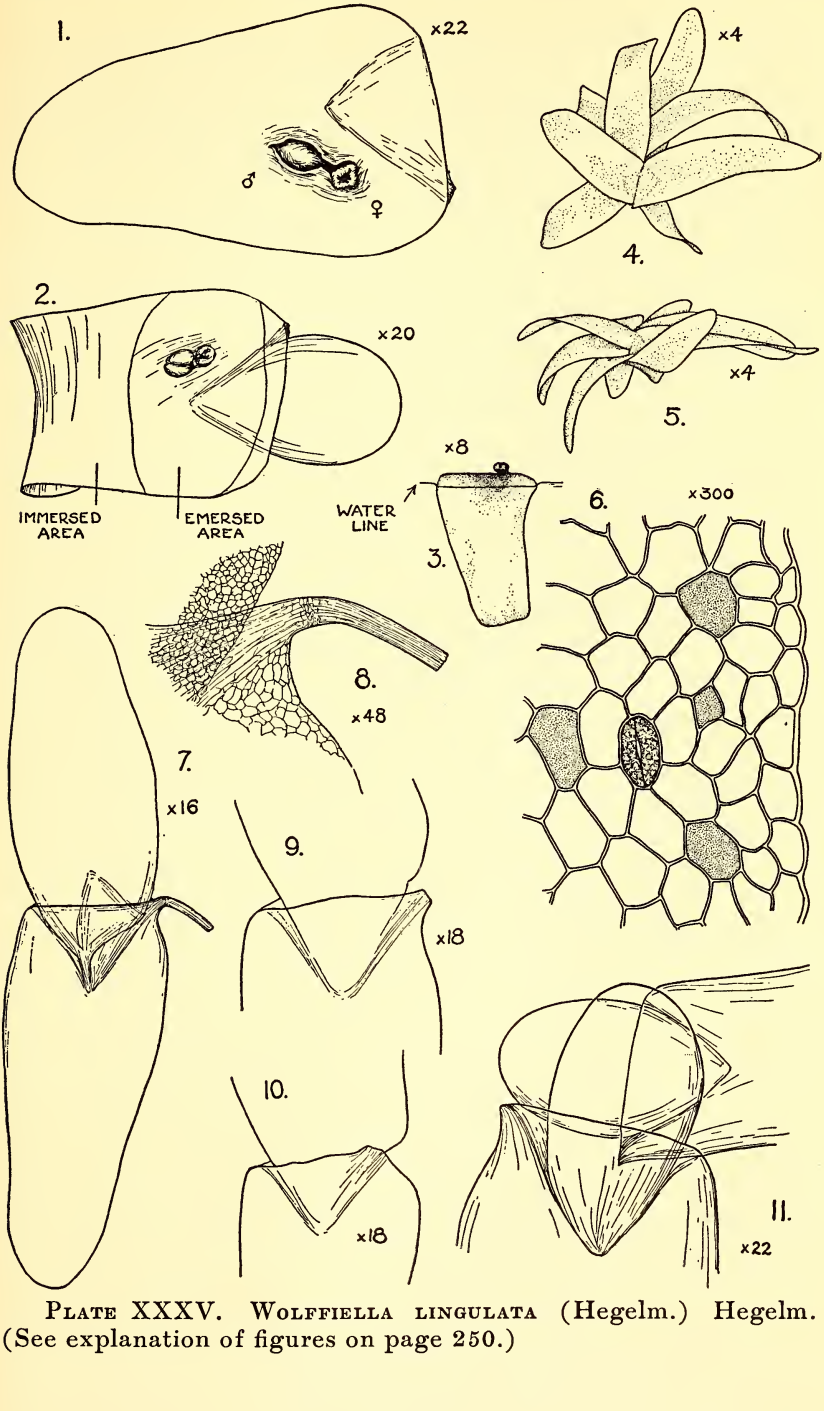


PLATE XXXV. WOLFFIELLA LINGULATA (Hegelm.) Hegelm. (See explanation of figures on page 250.)

reproductive pouch whereas in *Wolffiella* it lies at or near one side of the pouch. There is thus a tendency toward bilateral symmetry in *Wolffia* and toward asymmetry in *Wolffiella.* The discovery of flowers adds nothing more conclusive than this vegetative character for separating the two genera. Although the flowers vary in minor details that could scarcely have generic significance, they are in all essential features alike.

University of California,
Berkeley, September, 1938.

Literature Cited

1. Giardelli, M. L. Las flores de Wolffiella oblonga. Revista Argentina de Agronomia 2: 17–20. 1935.
2. Goebel, K. Zur Organographie der Lemnaceen. Flora 114: 278–305. 1921.
3. Hegelmaier, F. von. Die Lemnaceen, ein Monographische Untersuchung. Leipzig. 1868.
4. ————. Lemnaceae, in Martius, Flora Brasiliensis 3^2: 1–23. 1878.
5. ————. Systematische Ubersicht der Lemnaceen. Engler's Bot. Jahrb. 21: 268–305. 1895.
6. Hicks, L. E. Flower production in the Lemnaceae. Ohio Journ. Sci. 32: 115–131. 1932.
7. Philippi, R. A. Plantarum novarum Chilensium, centuria quarta. Linnaea 29: 1–47. 1857.
8. Smith, J. D. Wolffia (Wolffiella) gladiata Hegelm. Bull. Torrey Bot. Club 7: 64–65. 1880.
9. Thompson, C. H. The ligulate Wolffias of the United States. Missouri Bot. Gard., 7th Ann. Rept. 101–111. 1896.
10. ————. Revision of the American Lemnaceae occurring north of Mexico. Missouri Bot. Gard., 9th Ann. Rept. 1–42. 1898.

Explanation of the Figures

Plate XXXV. *Wolffiella lingulata* (Hegelm.) Hegelm. Fig. 1. Ligulate type of frond showing floral cavity with pistillate flower in anthesis. Fig. 2. Frond showing position of flower with respect to immersed area of plant. Fig. 3. Profile view of staminate flower showing its position relative to water surface. Figs. 4, 5. Family colonies of saber shaped fronds. Fig. 6. Upper epidermis of flowering frond showing pigment cells and stoma. Fig. 7. Parent and daughter frond showing position of daughter stipe and pouch with respect to the parent. Fig. 8. Stipe of frond of the colony stage. Note abscission layer. Figs. 9, 10. Daughter and parent fronds showing variation in position of stipe scar in a single family. Fig. 11. Separation of parent and daughter frond.

Plate XXXVI. Fig. 1. Frond of *Wolffiella oblonga* from type collection. Note extent of air chambers in tissue of frond. Fig. 2. Frond of *Woffiella lingulata.* Note extent of air chambers. Figs. 3–18. *Wolffiella lingulata.* Fig. 3. Mature daughter frond still attached to parent. Note flower bud and reduced size of flowering frond as compared to size of parent. Figs. 4–8. Stages in flowering and fruiting: 4, pistillate flower in anthesis, staminate flower not yet emerged; 5, emergence of staminate flower; 6, dehiscence of stamen; 7, degeneration of stamen and development of fruit; 8, mature fruit. Fig. 9. Mature fruit with persistent style. Fig. 10. Pollen grains, × 500. Fig. 11. Two seeds, left hand one showing cavity in which lies the operculum of the testa. Fig. 12. Mature fruit in dead parent frond. Figs. 13–18. Stages in development of seedling. Terminology of fig. 17 adapted from Goebel (2).

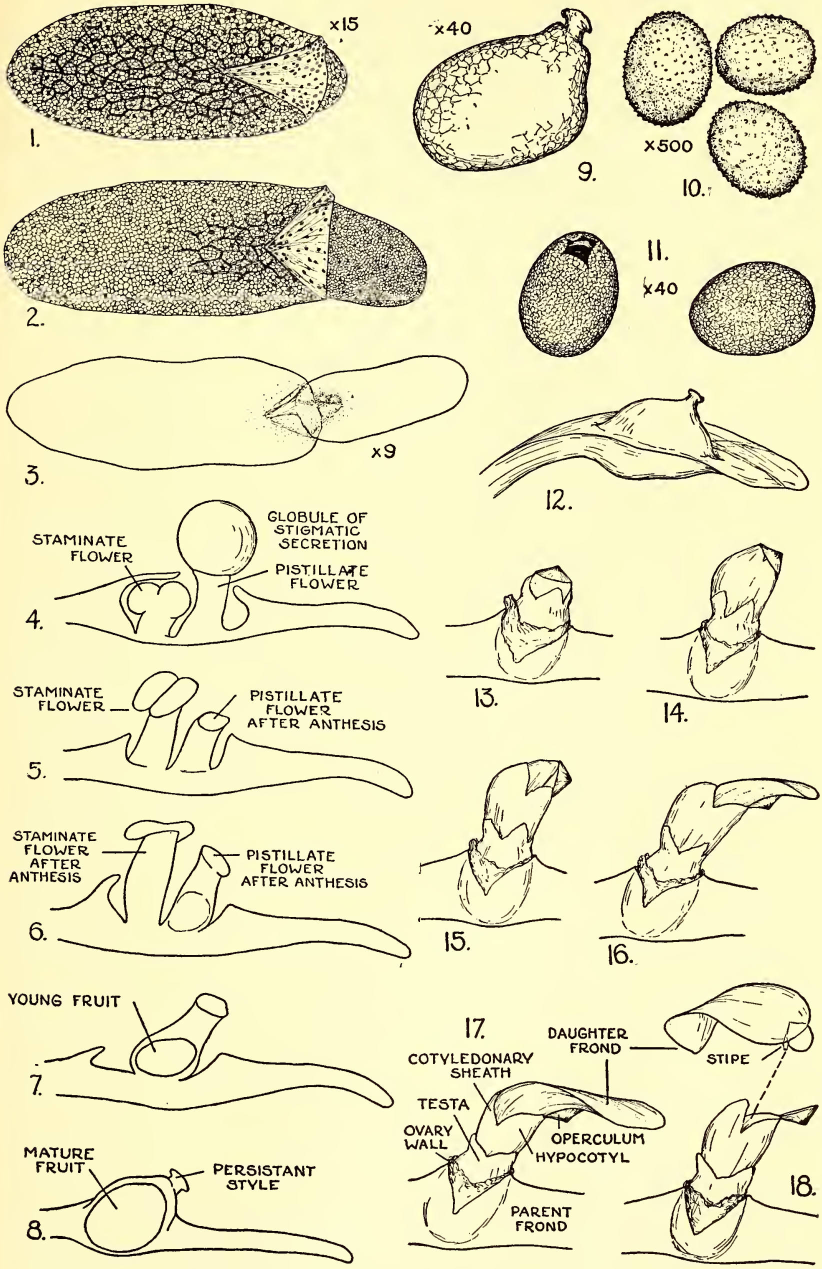


Plate XXXVI. Wolffiella. (See explanation of figures on page 250.)

THE WESTERN AMERICAN SPECIES OF PAEONIA

G. Ledyard Stebbins, Jr.

In all recent treatments of the genus *Paeonia* in the western United States, only one species has been recognized, *P. Brownii* Dougl. The range of this "species," however, is most unusual. *Paeonia* occurs commonly in cismontane southern California at low altitudes. It is rare in central California, but reappears as a frequent or common plant at medium altitudes, in the northern part of the North Coast Ranges and in the northern Sierra Nevada, and from there extends northward to British Columbia and eastward to Wyoming.

Struck by this remarkable discontinuity in range, several systematists have maintained that the peony of southern and south central California is specifically distinct from that of the northwest. Nuttall, whose manuscript description is quoted by Torrey and Gray (8), described the southern form as *Paeonia californica,* which, he stated could be distinguished from the northern *P. Brownii* by its "smaller, less divided leaves, which are deep green on both sides, and the leaflets bifid or trifid, never pinnatifid," as well as by possessing three rather than five carpels. Nuttall's type of *P. californica* was collected near Santa Barbara; Douglas' type of *P. Brownii* in Oregon, "near the confines of perpetual snow on the alpine range of Mt. Hood." Unfortunately, additional material of both species revealed that, with the exception of green rather than glaucous leaves, all of the characteristics mentioned by Nuttall occur also in the northern *P. Brownii.* Many plants of this species have leaves smaller than those of typical *P. californica;* in some specimens of *P. Brownii* the leaves are not more dissected than are those of the southern plant; the number of carpels varies from two to five in both. Probably recognizing these facts, Gray (2) as well as Brewer and Watson (1) considered *P. californica* a synonym of *P. Brownii.* The authors of recent California floras, Jepson (4, p. 373) and Munz (6, p. 170) have also recognized only *P. Brownii,* and have not even mentioned *P. californica* as a synonym.

The strongest case for recognizing *Paeonia californica* as a distinct species was presented by E. L. Greene (3). He drew a graphic picture of the ecological differences separating the two but failed to give any valid diagnostic characters to distinguish between them, except leaf color and shape of leaf segments. Using these characteristics, Lynch (5) recognized *P. californica* as a variety of *P. Brownii.*

The writer became interested in this species problem through cytological and systematic studies of the Old World species of the genus. Upon examining herbarium specimens, it was found that after a little study one could tell almost at a glance, without looking at the label, whether a specimen was from southern California

TABLE 1.—Comparison of *Paeonia Brownii* and *P. californica*

	P. Brownii	*P. californica*
HABIT		
Number of flowering stems per plant	1–16	5–30
Height of flowering stems	2–4 dm.	3.5–7.5 dm.
Number of leaves per stem	5–8 (av. 6–7)	7–12 (av. 9–10)
Character of branching	stems usually simple, sometimes with 1 or 2 short branches	stems always branched or with rudiments of branches in axils of upper leaves; in luxuriant plants the larger primary branches bear secondary branches
CATAPHYLLS		
Apex	obtuse	acute
LEAVES		
Color	glaucous	green
Texture	thick, usually somewhat fleshy	thin, easily wilting
Base of primary segments	abruptly contracted, petiolulate	cuneate, sessile or with short, alate petiolules
Terminal secondary segment of middle cauline leaf, length	3.5–6.0 cm.	2.8–7.5 cm.
Terminal secondary segment of middle cauline leaf, width	2.5–5.5 cm.	1.1–4.5 cm.
Ratio of length to width	0.8–1.4	1.5–3.0
Number of ultimate lobes on terminal primary segment of middle cauline leaf	13–44	10–17
Shape of ultimate lobes	elliptic, usually obtuse	lanceolate or narrowly elliptic, usually acute
FLOWERS		
Petals	rotund to orbicular	elliptic
Length of largest petal	8–13 mm. (av. 9–11)	15–25 mm. (av. 19–21)
Width of largest petal	10–15 mm.	11–18 mm.
Ratio of length to width	0.7–1.0	1.1–1.6
Petal, color of center	maroon or bronze	deep blackish red
Petal, color of margin	yellowish or greenish	pink (sometimes a narrow yellowish margin at the apex)
Length of longest filaments	4.2–5.5 mm.	6.0–8.5 mm.
Length of longest anthers	3.3–5 mm.	3.5–7 mm.

or from the north. The exact differences between the two, however, were not easily defined, largely because the leaves of *Paeonia* are rarely well spread out in the preparation of specimens, the bulky flowers are usually crushed in such a manner that little can be told of their fresh condition, and there are rarely enough flowers on a specimen to permit dissection.

For this reason, the writer has paid particular attention to *Paeonia* on collecting trips. Several collections of *P. Brownii* were made during the seasons of 1936 and 1937 in Nevada, Sierra, Lassen, and Shasta counties in northeastern California, and a small colony was discovered on the northeast side of Mount Hamilton, Santa Clara County, in the Coast Range. This is a southerly extension of the known range of typical *P. Brownii;* the nearest known locality to the northward is in Lake County, about 150 miles distant by air line. The southern plant was studied and collected in 1937 at the type locality near Santa Barbara, as well as near San Luis Obispo and at the foot of Cajon Pass, San Bernardino County; in 1938 its most northerly known locality, Pine Canyon, west of King City, Monterey County, was visited. In making each collection, a number of flowers were dissected before pressing as described elsewhere (Stebbins, 7).

On the basis of these observations, the existence of a number of real distinctions between *P. Brownii* and *P. californica* was established. These are stated in Table 1 and the most important summarized in the following key:

Stems 2–4 dm. high, bearing 5–8 leaves; leaves more or less glaucous, their primary divisions abruptly contracted at the base to distinct, often elongate petiolules, the ultimate lobes elliptic; petals rotund or orbicular, mostly broader than long, the larger 0.8–1.3 cm. long when fully spread out, definitely shorter than the inner sepals ..... 1. *P. Brownii*

Stems 3.5–7.5 dm. high, bearing 7–12 leaves; leaves green, not glaucous, their primary divisions cuneate at the base, often sessile, the ultimate lobes lanceolate or narrowly elliptic; petals elliptic, longer than broad when fully spread out, the larger 1.5–2.5 cm. long, slightly longer than the inner sepals .... 2. *P. californica*

1. Paeonia Brownii Dougl. ex Hook. Fl. Bor. Am. 1: 27. 1829; Torr. & Gray, Fl. N. Am. 1: 41. 1838. Illustrations: Bot. Reg. 25, t. 30. 1839; Journ. Royal Hort. Soc. Lond. 12: 433. fig. 24, 1890. (pl. XXXVII, figs. f–n.)

Northern California, from Santa Clara and Tuolumne counties north to British Columbia, east to Wyoming. In California mostly at altitudes of 3000 to 6000 feet. (900 to 1800 meters). The following specimens in the herbarium of the University of California (UC) and in the Dudley Herbarium, Stanford University (DS), are typical. Idaho: Silver City, Owyhee County, *Macbride 943* (UC, DS). Washington: Swauk Creek, Wenatchee Mts., *Quick 1042, 1054* (UC). Oregon: Rock Creek, Morrow County, alt. 1040 m., *Leiberg 95* (UC). California: Quartz Valley, Siskiyou County, Butler *1229* (UC, DS); Jameson Creek, Plumas County, *Hall 9307* (UC); Bartlett Mt., Lake

County, *Abrams 12416* (DS); Mount Hamilton, Santa Clara County, *H. K. Sharsmith 3947* (UC).

The exact eastern limits of *Paeonia Brownii* are uncertain. Rydberg (Rocky Mt. Flora, p. 315) includes Utah in the range; Tidestrom (Fl. Utah and Nevada, p. 202) questions its occurrence there but includes Alberta, which Rydberg does not. In answer to requests by the writer, Dr. Ellsworth P. Killip of the United States National Herbarium (US), Mr. C. A. Weatherby of Gray Herbarium (G) and Dr. H. A. Gleason of the New York Botanical Garden (NY), have examined the material of this species in their collections and report no specimens of *P. Brownii* from either Utah or Alberta. One collection is reported from Wyoming: Jackson's Hole, Lincoln County, *Payson & Payson 2196* (G, NY).

2. Paeonia californica Nutt. ex Torr. & Gray, Fl. N. Am. 1: 41. 1838. Greene, Garden and Forest 3: 356. 1890. (*P. Brownii* var. *californica* Lynch. Journ. Royal Hort. Soc. Lond. 12: 433. 1890). Illustrations: Lynch. l.c. fig. 25, leaf; Parsons, Wild Fl. Calif. 341. 1897; Davidson, California Plants in their Homes, fig. 31, 1898; Armstrong, Field Book West. Wild Fl. 139. 1915; Pickwell et al., Spring Wild Flowers of the Open Field, Western Nature Study 2: fig. 31. 1931; Munz, Man. S. Cal. Bot. 170, fig. 76, 1935; Thurston, Wild Fl. So. Cal. 326, fig. 511, 1936. (pl. XXXVII, figs. a–e.)

Southern and south central California, from Monterey to San Diego County, from sea level to 4000 feet (1212 meters) (*fide* Munz, 1935). The following specimens are typical. California: east of Bryson, Monterey County, *Ferris 8450* (UC, DS); Santa Ynez Mts., Santa Barbara County, *Elmer 3786* (UC, DS); Santa Monica Mts., Los Angeles County, alt. 425 m., *Clokey & Templeton 4447* (UC); San Bernardino Valley, San Bernardino County, alt. 360—400 m., *Parish 6820, 11713* (UC); Encinitas, San Diego County, *Brandegee* in 1884 (UC).

As will be seen from the table, most of the differences between the two species are associated with the greater luxuriance of growth in *Paeonia californica.* This species is larger and better developed in all of its parts than *P. Brownii,* except that no significant differences between the two could be found in the outer sepals, the carpels at anthesis, the mature follicles, and the seeds. *Paeonia californica,* judging from its range, is not hardy, and is a mesophyte. Although the climate of its habitat is semiarid so far as the season as a whole is concerned, *P. californica* completes its active growth during the rainy season, when the ground is more or less moist, and lies dormant during the dry season, depending on food stored in its thick roots. Its leaves and stems wilt very readily.

Paeonia Brownii, on the other hand, is definitely hardy, since its shoots sometimes push their way up through banks of snow. It is also semi-xerophytic; at least the latter part of its seasonal growth takes place after precipitation has almost or entirely ceased, and the ground has become quite dry. Its fleshy leaves retain their turgor for many hours after the stem is broken.

On the basis of these facts, the question arises as to whether or not the differences between *Paeonia Brownii* and *P. californica* are due to the direct stimulus of the environment, and whether they could be transformed one into the other by transplanting. The critical experiments to test this point have not yet been performed, but all available evidence indicates that such transformation would not take place. Many experimenters, notably Turesson (9), have shown that the large majority of adaptations to different habitats within the same or closely related species are genetically conditioned.

Within each of these two species of *Paeonia* variation in the characters by which they differ from each other is not noticeably correlated with differences in habitat. Plants of *P. californica* in Monterey County, central California, are practically indistinguishable from those of the same species occurring about San Diego, 350 miles farther south, which receive about half as much rainfall. Those of *P. Brownii* growing in central California, on Mount Hamilton, are very similar to those found in the Wenatchee Mountains of Washington, 750 miles to the north. Furthermore, *P. Brownii* shows evident "conservatism" in the southern part of its range. It is rare in the Coast Ranges of California and is apparently retreating with the advent of a warmer climate. Many of the plants in the Mount Hamilton colony, the southernmost known locality, produce only small, abortive buds and no flowers, an indication that the species is there dying out. All evidence points to the assumption that plants of *P. Brownii* are not only unable to adapt themselves to a warmer climate, but in addition that they cannot, either by segregation or by mutation, produce offspring that can tolerate a warmer climate. *Paeonia californica,* on the other hand, shows every sign of advancing with the increasing warmth of the climate. It is a rather common plant in suitable spots up to the northern limit of its range, and at its northernmost known station is abundant and very luxuriant. It has not, however, been able to colonize the localities within its range which have a climate corresponding to that required by *P. Brownii.* In the higher mountains of southern California, which have a climate and flora similar to that of the northern Sierra Nevada where *P. Brownii* is abundant, there is no *Paeonia* at all. At present, therefore, all evidence warrants the assumption that neither by physiological nor by genetical change can either of these species become transformed into the other.

Another possible explanation is that the two forms represent geographic variations—varieties, subspecies, or ecotypes (Turesson, 10) of a single species. The crucial test of this, hybridization of the two, would be a long-time proposition since most species of *Paeonia* do not flower until they are four or five years old. Furthermore, the significance of hybridization tests would be complicated by the fact that both species normally have 60 to 70 per cent of pollen sterility, due to their anomalous cytological condition (Stebbins and Ellerton, in press). At present, however, the facts that no intermediates exist and that hybrids could not be produced except under highly artificial conditions of cultivation, speak strongly in favor of maintaining *Paeonia Brownii* and *P. californica* as distinct species.

Paeonia californica is a relatively constant species. Within *P. Brownii,* on the other hand, there is a considerable range of variation, particularly in the amount of dissection of the leaves and in the shape of the segments. In the northern Sierra Nevada a form occurs with leaves much dissected, and frequently with smaller flowers than are typical for the species. Since, however, plants with leaves and flowers of the normal type occur within the range of this Sierran variant, the writer does not consider it well enough marked for recognition as a distinct variety or subspecies.

The phylogenetic relationship between the two species is best determined by comparing them with the Old World species of *Paeonia. Paeonia Brownii* and *P. californica* constitute a distinct subgenus, *Onaepia* (Lynch, 5), which is characterized by small petals; a very prominent disk, usually divided into separate segments; and cylindrical rather than ovoid seeds. The Eurasian species are segregated into two subgenera, *Moutan* comprising the shrubby, and *Paeon,* the herbaceous species. In spite of the shrubby habit, *Moutan* is nearer to *Onaepia* than is *Paeon.* The "tree peonies" of China have, like the American species, a very prominent disk, and both have large seeds with dull coarsely rugose surfaces; the seeds of *Paeon* are smaller, relatively smooth, and often shining. Furthermore, one of the two species of subgenus *Moutan, P. Delavayi* Franch. of southwestern China, has petals almost as small as those of *P. californica,* and in the typical form of *P. Delavayi* they are of a similar reddish color. *Paeonia Delavayi* resembles *P. californica* also in its sepals and carpels and in the shape of its leaves, although those of the Chinese species are much larger and more dissected. In some specimens of *P. californica* the disk segments are relatively thin and are partly fused with each other, recalling the conspicuous, continuous disk of *P. Delavayi.* Both species are characterized by rather indefinite branching, the branches generally bearing well developed leaves as well as a terminal flower bud. In all other species of *Paeonia* (except occasional luxuriant individuals of *P. Brownii*), the side branches bear only a terminal bud, with sometimes a reduced leaf below it. Since *P. Delavayi* must be considered the most primitive species of *Paeonia* extant, (Stebbins, 7) the line which gave rise to *P. californica* and *P. Brownii* must have branched off from the rest of the genus very early in its history.

The fact that the closest connection between the Old and the New World species of *Paeonia* is through species endemic to such remote and different regions as southern California and southwestern China suggests that this connection is very ancient. The Old World species, *P. albiflora* Pall. of Manchuria, from which the well known cultivated peony is derived, is geographically nearest to *P. Brownii* and occupies a somewhat similar habitat, but it is obviously very remotely related to both *P. Brownii* and *P. californica.* In all of the most important morphological characters by which *P. Brownii* differs from *P. californica,* it diverges also from all of the Old World species. In shape and texture of leaves, shape and color of petals, and in habit *P. Brownii* is quite unique. It represents, therefore, an offshoot which has diverged more in morphological characters from the common ancestor of the American peonies than has *P. californica.* The latter species, however, shows more ecological divergence from other species of the genus, since it is the only peony that is not frost-hardy. The most likely hypothesis as to the course of evolution of the two species is that their common ancestor was mesophytic and frost-hardy, as are all Old World species, and resembled morphologically *P. Delavayi* and *P. californica.* This ancestor probably was present in California in Mesozoic or early Tertiary time, and gave rise to a considerable number of ecological and morphological types. Of these all that were mesophytic and frost-hardy perished when the climate of California became warmer and more arid. *Paeonia californica* persisted in southern California by evolving a change in its period of dormancy from the cold winter to the dry summer, but retained most of the morphological characters of its original ancestor. *Paeonia Brownii,* on the other hand, retained its frost-hardiness and winter period of dormancy, but became adapted to dry summers by evolving a series of morphological specializations. Both species, therefore, are derived types, but morphologically *P. californica* is undoubtedly the more primitive.

Division of Genetics,
University of California, Berkeley, April, 1938.

Explanation of the Figures. Plate XXXVII

Figs. *a–e, Paeonia californica* (Santa Ynez Valley, California, *Stebbins 2090*): *a,* terminal primary segment of median cauline leaf, × ½; *b,* the three innermost sepals, × 1; *c,* the largest and smallest petals, × 1; *d,* two stamens, × 1; *e,* disk and follicles at anthesis, × 1.

Figs. *f–i, Paeonia Brownii* (Wenatchee Mts., Washington, *Quick 1042*): *f,* terminal primary segment of median cauline leaf, × ½; *g,* the largest petal, × 1; *h,* two stamens, × 1; *i,* disk and follicles at anthesis, × 1.

Figs. *j–n, Paeonia Brownii* (Sierra County, California, *Stebbins & Jenkins 2157*): *j,* terminal primary segment of median cauline leaf, × ½; *k,* the five innermost sepals, × 1; *l,* the largest and smallest petal, × 1; *m,* two stamens, × 1; *n,* disk and follicles, × 1.

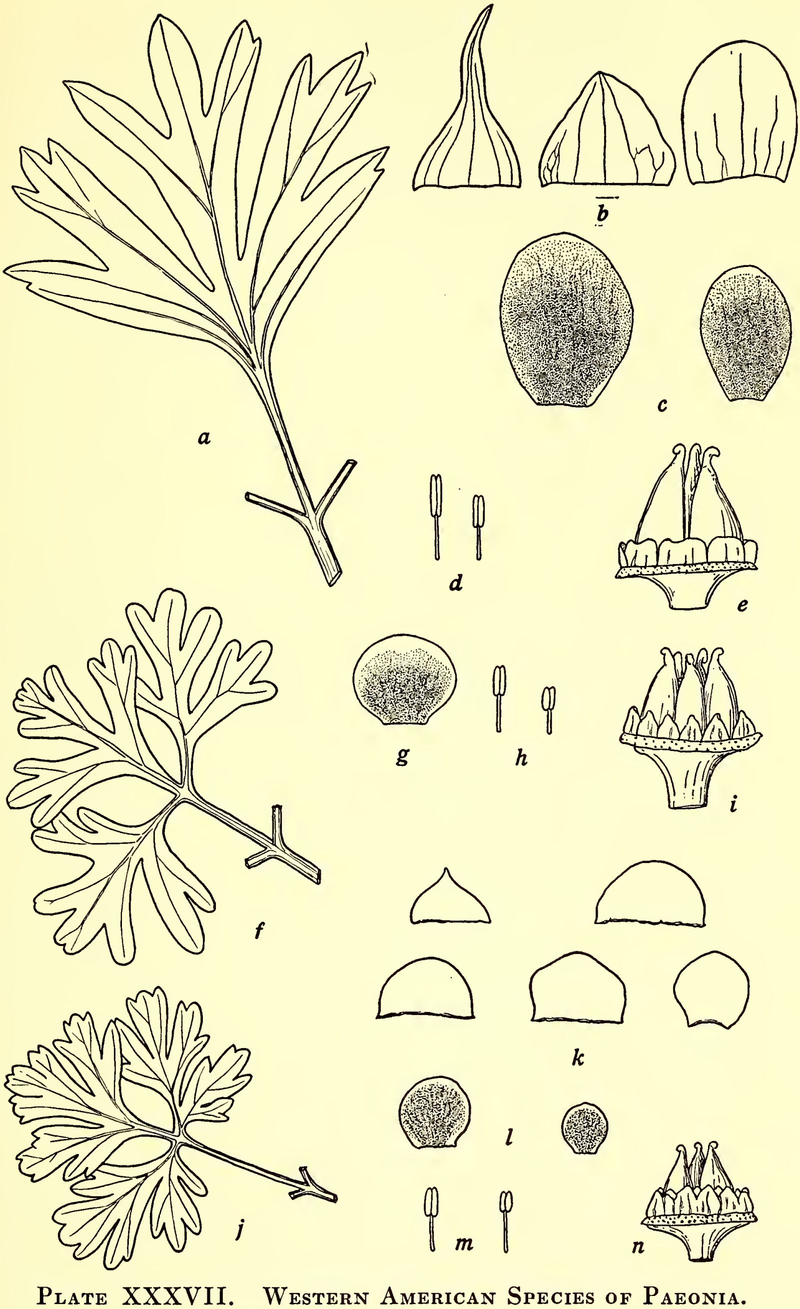


Plate XXXVII. Western American Species of Paeonia.

Literature Cited

1. Brewer, W. H., and S. Watson. Paeonia L., in Botany of California 1: 13. 1876.
2. Gray, A. Paeonia L., in Synoptic Flora of North America 1(1): 56. 1875.
3. Greene, E. L. The California Paeonias. Garden and Forest 3: 356. 1896.
4. Jepson, W. L. A Manual of the Flowering Plants of California. 1925.
5. Lynch, R. I. A New Classification of the Genus Paeonia. Journ. Royal Hort. Soc. Lond. 12: 428–445. 1890.
6. Munz, P. A. Manual of Southern California Botany. 1935.
7. Stebbins, G. L., Jr. Notes on the systematic relationships of the Old World species and of some horticultural forms of the genus Paeonia. Univ. Calif. Publ. Bot. (in press).
8. Torrey, J., and A. Gray. Paeonia L., in Flora of North America 1: 41. 1838.
9. Turesson, G. The plant species in relation to habitat and climate. Hereditas 6: 147–236. 1925.
10. ————. Zur Natur und Begrenzung der Arteinheiten. Hereditas 12: 324–334. 1929.

HANGING GARDENS OF THE CANARY ISLAND DATE PALM

Ira L. Wiggins

The practice of trimming the older leaves from the trunks of palms used in ornamental plantings provides a temporary arboreal habitat for a number of plants that normally grow only on the ground. The row of Canary Island date palms on either side of Palm Drive on the campus of Stanford University, California, annually supports a total population of many hundred individual plants and a surprisingly large number of species. The relationships between these plants that are normally ground-dwellers and their arboreal supporters, the fluctuations in the "hanging gardens" from year to year, and the variations in the tenacity of such wanderers marooned above their normal sphere are sources of considerable interest.

Many palms growing under wild conditions retain their leaves over a period of years, thus forming a close thatch that shades out any seedlings that may, upon rare occasions, begin growth on their trunks. But even in such trees, the functional leaves, extending upward at sharp angles, provide catchment basins in the bases of their petioles for decaying organic matter and a small quantity of dust. In cultivated trees a considerable portion of this material remains in the fissures between the basal parts of the petioles after the bulk of the leaves has been pruned from the trunk. The functional leaves above form a natural drainage system that directs much of the intercepted rainwater into the basal parts of the petioles. Some of this water is retained in the cups formed by the petiolar bases, some of it trickles over the rims to enter those below and fill the lower reservoirs. Thus, during the course of a heavy rain the entire trunk of one of these date palms may become a series of miniature reservoirs, each containing a small quantity of decayed organic matter and rainwater.

Seeds lodged in these pockets find conditions favorable for germination and rapid growth, with the result that many of the palms become decorated with various annual and perennial seedlings. Many of the herbaceous annuals contributing to these hanging gardens live through their entire life cycles before the water supply fails. Such plants reseed the petiolar cups for the next season's growth so the gardens flourish year after year. Even the perennials survive for a surprisingly long time, though few, if any, live long enough in this habitat of limited supplies to produce fruit. Ferns furnish an exception among the perennials, for they produce fertile fronds regularly.

Casual observations made over a period of ten years or more indicate that there are four principal agencies that are effective in sowing seeds in the petiolar bases of the palms. They are: 1, gravity; 2, wind; 3, animal and bird carriers; 4, direct deposition of seed by annuals growing against the trunks of the trees.

Gravity is responsible for the presence of numerous specimens of young palms in the petiolar cups of the parent trees. Falling fruits lodge among the leaf-bases in great numbers and some of their seeds grow. Occasionally seeds of *Acacia* and acorns from the oaks fall among the leaves of the palms. Although *Eucalyptus* trees tower above the palms at a number of places and some of the seeds shattering from the capsules must lodge in the petiolar cups, no seedlings of *Eucalyptus* appear in the arboreal habitat. Their absence is doubtless to be attributed to some factor in the petiolar gardens that is unfavorable to the germination of the seeds of *Eucalyptus* rather than to the failure of the force of gravity!

Birds and small rodents carry acorns, pine nuts, seeds of some species and berries of others from the parent plants to the leaf-bases of the palms before the outer parts of the leaves are removed, or, in the cases of woodpeckers, jays, and squirrels, may hide seeds and nuts among the petiolar bases some distance below the leaf-crown. Robins drop fruit of *Photinia, Pyracantha,* and *Cotoneaster* among the leaves. Waxwings carry these fruits, as well as those of *Schinus molle,* from fruiting plants to other localities, and the purple house finch after eating the berries of *Sambucus,* frequently takes refuge in the palm trees. The habit of wiping beaks on the perches doubtless results in the deposition of some seeds in the crevices among the petiolar bases.

The wind carries seeds of such species as *Ailanthus glandulosa* and *Sonchus oleraceus* to the arboreal habitats, and the same agency is responsible for the presence of *Polypodium* and *Dryopteris* on the sides of palm trunks high above one's head. It is difficult to explain the absence of such seedlings as those of *Ulmus, Platanus, Senecio* and others with wind-borne seeds.

The most interesting group, however, is made up of those species that do not have wind-blown seeds, do not seem to be used extensively as food by birds and animals, and grow on the ground below the trunks on which some of their number appear season after season. Periodic observations have shown that such annuals as *Stellaria media, Anagallis arvensis, Festuca megalura, Silene gallica, Montia perfoliata,* and *Bromus rigidus* slowly climb higher and higher from one year to another until they occur from the ground to the leaf-crown. An occasional plant of one of these weedy species missed by the gardener's hoe grows against the base of the tree. Its seed capsules or fruiting spikes drop a few seeds into the crevices between the petiolar bases a short distance above the soil and the plant is on its way upward. The plants resulting from the seeds thus sown also grow in close contact with the tree-trunk, mature fruit, and deposit more seeds a few inches higher up the trunk of the supporting palm tree. This progressive ascent may account for the presence of an almost solid growth of annuals from the ground to the leaf-crown on some trees, the almost total absence of them on other trees in the same row.

There is a noticeable lack of hanging gardens on the trunks of fan palms. The attachment of the petioles to the trunk of *Washingtonia filifera,* for example, is such that water is not held in the bases of the petioles. The basal part of the petiole bifurcates, each branch running diagonally downward and about one fifth of the way around the trunk before the main vascular supply enters the trunk of the tree. The increase in diameter of the trunk after the initial departure of the young leaf-traces further splits the base of the petiole and tears the tissue between many of the smaller vascular strands running into the trunk. Thus a considerable portion of the petiolar base is unattached to the trunk of the tree, so water running down from the leaves above percolates through the fibrous strands enwrapping the trunk to enter the soil at the base of the tree. Therefore the trunk of the tree and the crevices between the petiole bases dry out too rapidly to permit the growth of even the short lived annuals.

Some perennials survive in the crevices among the petiolar bases on the date palms for several years. Seedlings of *Pinus radiata* five years old, of *Pinus Sabiniana* three years old, and of *Quercus agrifolia* nine years of age are not infrequent on the trunks of date palms along the drive on the Stanford campus. Plants of *Polypodium californicum* and of *Dryopteris arguta* are now under observation for the sixth successive year. A specimen of *Eriobotrya japonica* (loquat) that started as a seedling in a petiolar base of a date palm in front of the Museum Building reached the leaf-crown of the palm, nearly twenty feet above its roots, before being removed by the gardeners. However, this seedling started only a couple of feet above the ground, so its roots soon found their way into the soil, and its period of dependence on the scanty supply of soil and moisture in the petiolar cups was comparatively short.

It would be interesting to know something about the fluctuations in the available moisture in these cups, and whether the perennials die on account of water shortage or through the exhaustion of the essential mineral elements entrapped in the petiolar crevices.

The following list includes only those species observed growing on the date palms on the Stanford campus and in park ways near my home. A more extensive survey might expand this list considerably.

Acacia retinodes Schlecht.
Ailanthus glandulosa Desf.
Anagallis arvensis L.
Avena fatua L.
Bromus mollis L.
Bromus rigidus Roth.
Cupressus Macnabiana Murr.
Cupressus macrocarpa Hartw.
Dryopteris arguta (Kaulf.) Watt.
Eriobotrya japonica Lindl.
Echinocystis fabacea Naud.
Festuca megalura Nutt.
Festuca myuros L.
Hordeum murinum L.
Montia perfoliata (Donn) Howell
Phoenix canariensis Hort.
Pinus radiata Don
Pinus Sabiniana Dougl.
Prunus communis L.
Prunus ilicifolia Walp.
Polypodium californicum Kaulf.
Quercus agrifolia Née
Pyracantha sp.
Sambucus glauca Nutt.
Silene gallica L.
Solanum nigrum L.
Sonchus oleraceus L.
Stellaria media (L.) Cyr.
Thuya orientalis L.
Verbena prostrata R. Br.

Dudley Herbarium,
Stanford University, July, 1938.

ADDITIONS TO OUR KNOWLEDGE OF THE FLORA OF MOUNT BAKER, WASHINGTON

W. C. Muenscher

Mount Baker, with its cap of perpetual ice and snow, attaining a height of 10,750 feet above sea level, dominates the landscape of Whatcom County, Washington, the northwest corner of the United States. In 1929 St. John and Hardin (3) published a flora of this area reporting its known flora as consisting of 334 species and varieties.

As a result of the writer's botanical explorations of Mount Baker, made between 1910 and 1937, its flora is well represented in the herbarium of Cornell University. The present list of vascular plants consisting of additions to the known flora of the Mount Baker region, as delimited by St. John and Hardin, is largely based upon the writer's observations and collections. A record of the occurrence of a few of these species has been published previously (1, 2). Mr. J. W. Thompson of Seattle, Washington, has published records of seven species (4, 5, 6) and has communicated recently by letter the occurrence of 18 additional species. With the exception of Mr. Thompson's records, the present list is based entirely upon collections deposited in the herbarium of Cornell University. Introduced as well as native species are included.

The present list increases the known plants of the region, as published by St. John and Hardin, by 13 families, 90 genera and 228 species, an increase by 68 per cent of the previously reported flora. At least forty weeds occur, most of which have been introduced in openings along the lower trails and few roads that penetrate the area. The presence of so many introduced species indicates that the flora of the region, although still mostly in a primitive state, is no longer as isolated as formerly, even though it is located in a national forest.

Acknowledgment is due to Professor K. M. Wiegand for assistance in the determinations in several critical genera and to Dr. R. T. Clausen who determined the species of *Botrychium*.

Polypodiaceae

Asplenium Trichomanes L. Rocky slopes in lower forest.
Asplenium viride L. Moist ledges near timber line.
Cheilanthes gracillima D. C. Eaton. Mt. Hermann, *J. W. Thompson.*
Cryptogramma densa (Brack.) Diels. Rocky ledges near timber line.
Dryopteris Phegopteris (L.) C. Chr. At base of Panorama Dome, *J. W. Thompson.*
Polystichum Lemmonii Underw. Rocky ledges above timber line.
Pteridium aquilinum (L.) Kuhn. var. lanuginosum (Bong.) Fern. Common on lower slopes.
Woodsia scopulina D. C. Eaton. Mt. Hermann, *J. W. Thompson.*

Ophioglossaceae

Botrychium lanceolatum (Gmel.) Angstr. Alpine meadows.
Botrychium Lunaria (L.) Swartz. Alpine meadows.
Botrychium multifidum (Gmel.) Rupr. subsp. silaifolium (Presl) Claus. Moist banks about mountain meadows.

Equisetaceae

Equisetum hyemale L. Springy slopes in lower forest.
Equisetum limosum L. Marshy banks of streams and ponds.

Lycopodiaceae

Lycopodium annotinum L. Moist slopes in the lower forest.
Lycopodium obscurum L. Dry exposed ridge, Sulphur Creek.
Lycopodium Selago L. Among mosses in lower forest.

Selaginellaceae

Selaginella Wallacei Hier. Dry rocky slopes near timber line.

Isoetaceae

Isoetes echinospora Dur. var. Braunii (Dur.) Englm. In shallow water, Baker Lake.

Pinaceae

Picea sitchensis (Bong.) Traut. and Mey. Infrequent in lower forest along Baker River and Swift Creek.

Pinus contorta Dougl. Dry burned over slope near Sulphur Creek.

Typhaceae

Typha latifolia L. Marshy shores of Baker Lake.

Sparganiaceae

Sparganium multipedunculatum (Morong) Rydb. Baker Lake; Baker River.

Potamogetonaceae

Potamogeton americanus Cham. and Schlecht. Baker River near Baker Lake.

Potamogeton epihydrus Raf. Baker Lake; Baker River.

Potamogeton tenuifolius Raf. Baker Lake; Baker River.

Gramineae

Agropyron trachycaulum (Link) Steud. Dry meadows, Skyline Ridge.

Agrostis Thurberiana Hitchc. Alpine meadows, *J. W. Thompson.*

Aira caryophyllea L. Common on dry soil in openings in the lower forests.

Bromus ciliatus L. Moist banks.

Bromus tectorum L. A weed about Glacier.

Calamagrostis canadensis (Michx.) Beauv. var. scabra (Presl) Hitchc. Wet meadows.

Dactylis glomerata L. Introduced along roads, *J. W. Thompson.*

Elymus glaucus Buckl. Meadow on Skyline Ridge.

Festuca rubra L. Dry slopes.

Festuca subulata Trin. Baker Lake region.

Festuca supina Schur. Alpine meadows.

Glyceria elata (Nash) Hitchc. Swampy ground along lower streams.

Holcus lanatus L. A weed along the lower roads and trails.

Muhlenbergia filiformis (Thurb.) Rydb. Near Austin Pass, *J. W. Thompson.*

Phleum pratense L. Introduced along roads and trails, *J. W. Thompson.*

Poa alpina L. On ledges in alpine meadows.

Poa annua L. Baker Lake region.

Poa arctica R. Br. Heliotrope Ridge, *J. W. Thompson.*

Poa epilis Scribn. Among rocky ledges, Skyline Ridge.

Poa gracillima Vasey. Common in alpine meadows.

Poa palustris L. Introduced along roads, *J. W. Thompson.*

Poa pratensis L. Introduced along roads, *J. W. Thompson.*

Poa secunda Presl. Rocky alpine slopes, *J. W. Thompson.*

Trisetum cernuum Trin. In moist forests.

Cyperaceae

Carex ablata Bailey. Wet meadows.

Carex arcta Boott. Open areas in the lower forest.

Carex festivella Mack. Marshes and wet meadows.

Carex laeviculmis Meinsh. Wet meadows and along streams.

Carex leporinella Mack. Alpine meadow, Heliotrope Ridge.

Carex leptopeda Mack. Marshy places in lower forests.

Carex Piperi Mack. Grassy slopes.

Carex Rossii Boott. Meadows near timberline, *J. W. Thompson.*

Carex rostrata Stokes var. utriculata (Boott) Bailey. In shallow water, Baker Lake.

Carex sitchensis Bailey. Sloughs and wet banks of lower streams.
Carex vesicaria L. var. major Boott. Marshes about Baker Lake.
Dulichium arundinaceum (L.) Britt. Marshes about Baker Lake.
Eleocharis obtusa (Willd.) Schultes. Meadow near Glacier, *J. W. Thompson.*
Scirpus microcarpus Presl. Common in wet places in the lower forest.

Juncaceae

Juncus bufonius L. Along the lower trails.
Juncus macer S. F. Gray. Baker Lake region.
Luzula campestre (L.) DC. In open places in lower forests.

Liliaceae

Camassia quamash (Pursh) Greene. Rare on grassy slopes.
Disporum oreganum (Wats.) Benth. and Hook. Lower forest.
Disporum Smithii (Hook.) Piper. Baker Lake region.
Fritillaria lanceolata Pursh. Alpine meadows.
Lloydia serotina (L.) Sweet. Moist ledges near timber line.

Orchidaceae

Corallorhiza maculata Raf. Lower forest.
Habenaria dilatata Pursh. In swamp about Baker Lake.

Salicaceae

Populus tremuloides Michx. Lower slopes.
Populus trichocarpa Torr. and Gray. Baker Lake and along banks of larger streams.
Salix artica Pall. var. subcordata (And.) Schn. Skyline Ridge, *J. W. Thompson.*
Salix canadensis Cock. Alpine meadows, 6000–7000 feet elevation.
Salix lasiandra Benth. var. Lyallii Sarg. Baker Lake region.
Salix nivalis Hook. Skyline Ridge, *J. W. Thompson.*
Salix petrophila Rydb. var. caespitosa (Kenn.) Schn. Skyline Ridge, *J. W. Thompson.*
Salix Scouleriana Barr. Lower slopes.
Salix sitchensis Sanson. Open forests.

Betulaceae

Betula occidentalis Hook. Common on lower slopes.

Loranthaceae

Arceuthobium campylopodum var. Tsugensis (Rosendahl) Gill. Forming "witches brooms" associated with *Tsuga heterophylla* (Raf.) Sarg. and *T. mertensiana* (Bong.) Sarg.

Polygonaceae

Polygonum aviculare L. A weed along the lower trails.
Polygonum Convolvulus L. A weed above the village of Glacier.
Polygonum Douglasii Greene. Dry slopes.
Polygonum Hydropiper L. Along ditch banks.
Polygonum Persicaria L. A weed along the lower roads.
Polygonum viviparum L. Alpine meadows above 6000 ft. elevation on Skyline Ridge. Also reported by *J. W. Thompson.*
Rumex crispus L. A weed in the lower grassy places.

Chenopodiaceae

Chenopodium album L. A weed about Glacier.

Amaranthaceae

Amaranthus retroflexus L. A weed about Glacier.

Caryophyllaceae

Arenaria macrophylla Hook. Open places in lower forest.
Arenaria serpyllifolia L. On sandy stream banks.
Cerastium viscosum L. Grassy banks, lower forest.
Cerastium vulgatum L. Grassy slopes, lower forest.
Silene noctiflora L. A roadside weed about Glacier.
Spergula arvensis L. A weed along lower roads.
Spergularia rubra (L.) Presl. Baker Lake.
Stellaria media (L.) Cyrill. A common weed about Glacier.

Ranunculaceae

Anemone Lyallii Britt. On wooded ridges near timber line.
Delphinium Menziesii DC. Grassy slopes in lower meadows.
Ranunculus acris L. Roadside weed near Glacier.
Ranunculus aquatilis L. var. capillaceus DC. Submerged in Baker Lake.
Ranunculus Bongardii Greene. Lower forests.
Ranunculus Macounii Britt. Shore of Baker Lake.
Ranunculus orthorhynchus Hook. Table Mountain, *J. W. Thompson 9738.*
Ranunculus repens L. A weed along roads and trails.
Ranunculus reptans L. var. ovalis (Bigel.) Torr. and Gray. Shore of Baker Lake.
Thalictrum occidentale Gray. Common on moist slopes in meadows.

Berberidaceae

Achlys triphylla (Smith) DC. Common in lower forests.
Berberis aquifolia Pursh. Gravelly slopes above Glacier.

Cruciferae

Arabis glabra (L.) Bernh. Near Glacier, *J. W. Thompson.*
Barbarea orthoceros var. dolicarpa Fern. Boggy places along streams.
Brassica campestris L. A weed.
Capsella Bursa-pastoris L. A weed along lower roads.
Draba prealta Greene. Skyline Ridge, *J. W. Thompson.*
Draba stenoloba Ledeb. High ridges and grassy ledges.
Erysimum cheiranthoides L. A weed along lower roads and trails.
Lepidium medium Greene. Shore of Baker Lake.
Roripa hispida (Desv.) Britt. var. glabrata Lunell. Wet banks along lower streams and ponds.
Sisymbrium altissimum L. A weed.
Sisymbrium officinale Scop. A weed.
Smelowskia ovalis Jones. Heliotrope Ridge, *J. W. Thompson.*
Subularia aquatica L. Submerged in Baker Lake and Baker River.

Crassulaceae

Sedum integrifolium (Raf.) A. Nels. Moist ledges, 6000–7000 feet elevation, Skyline Ridge, Heliotrope Ridge.

Saxifragaceae

Philadelphus Gordonianus Lindl. Open areas in lower forest.
Ribes sanguineum Pursh. Burned-over lower slopes.
Saxifraga oppositifolia L. Skyline Ridge, *J. W. Thompson.*
Saxifraga rivularis L. Skyline Ridge, *J. W. Thompson.*
Suksdorfia ranunculifolia (Hook.) Engler. Moist cliffs, *J. W. Thompson.*
Tiarella laciniata Hook. Lower forests of Baker Lake region. Perhaps this is only a form of *T. trifoliata* with deeply cleft leaves.

Rosaceae

Fragaria vesca L. Grassy slopes near Glacier.
Malus fusca (Raf.) Schneid. Swamps along lower streams.
Physocarpus opulifolius (L.) Maxim. Baker Lake.

Potentilla glaucophylla Lehm. Alpine meadows.
Potentilla norvegica L. var. hirsuta (Michx.) Lehm. Grassy slopes.
Potentilla palustris L. Marsh about Baker Lake.
Prunus avium L. Escaped on burned-over slopes above Glacier.
Rosa gymnocarpa Nutt. Common in open forests.
Rosa nutkana Presl. Baker Lake.
Rubus nivalis Dougl. On slopes in lower forest.
Spiraea Douglasii Hook. Baker Lake region.
Spiraea lucida Dougl. On gravelly slopes near Glacier.
Spiraea roseata Rydb. Springy bank, below Austin Pass.

Leguminosae

Lathyrus palustris L. var. myrtifolius (Muhl.) Gray. Common on burned-over slopes.
Lupinus Lyallii Gray. Exposed ridges about 7000 feet elevation.
Medicago Lupulina L. Escaped along the lower roads and trails.
Trifolium dubium Smith. Escaped along the lower roads and trails.
Trifolium hybridum L. Escaped along the lower roads and trails.
Trifolium pratense L. Escaped along the lower roads and trails.
Trifolium repens L. Escaped along the lower roads and trails.
Vicia americana Muhl. Baker Lake region.

Geraniaceae

Erodium cicutarium (L.) L'Her. Along trails about Glacier.
Geranium molle L. Grassy places along lower roads.

Callitrichaceae

Callitriche palustris L. Baker Lake.

Aceraceae

Acer glabrum Torr. var. Douglasii Hook. Moist slopes and edges of lower meadows.

Rhamnaceae

Rhamnus Purshiana DC. Open lower forest.

Halorrhagidaceae

Hippurus vulgaris L. Baker Lake; Baker River.

Onagraceae

Epilobium minutum Lindl. Dry slopes and lower meadows.
Epilobium paniculatum Nutt. Open places, Baker Lake.

Umbelliferae

Cicuta occidentalis Greene. In marshes along lower streams.
Daucus Carota L. Roadside above Glacier.
Oenanthe sarmentosa Presl. Common in marshes in lower forest.
Osmorrhiza obtusa (Coult. and Rose) Fern. Moist banks.
Pastinaca sativa L. Along roadside, Glacier.
Sanicula septentrionalis Greene. Rocky slopes in meadows.

Ericaceae

Gaultheria humifusa (Graham) Rydb. Rocky slope on Table Mountain.
Moneses uniflora (L.) Gray. Lower forest.
Monotropa uniflora L. Lower forest.
Pyrola chlorantha Swartz. Lower forest.

Primulaceae

Lysimachia thyrsiflora L. Marshes about Baker Lake.

Gentianaceae

Gentiana Amarella L. Grassy slopes in meadows.
Menyanthes trifoliata L. Marshes about Baker Lake.

Polemoniaceae

Collomia heterophylla Hook. Dry banks in lower forest.
Collomia linearis Nutt. Open places in lower meadows.
Microsteris gracilis (Dougl.) Greene. Dry slopes.

Hydrophyllaceae

Nemophila parviflora Dougl. Along stream banks in lower forest.

Labiatae

Galeopsis Tetrahit L. Baker Lake region.
Lycopus uniflorus Michx. Shores of Baker Lake.
Mentha arvensis L. var. canadensis (L.) Briq. Marshy places in lower forest.
Mentha arvensis L. var. glabrata (Benth.) Fern. Shores of Baker River.
Nepeta hederacea (L.) Trev. Baker Lake region.
Scutellaria lateriflora L. In marshes along the lower streams and lakes.
Stachys ciliata Dougl. In swamps in the lower forests.

Scrophulariaceae

Collinsia parviflora Dougl. Open places in lower forests.
Digitalis purpurea L. Naturalized along the lower roads and trails.
Mimulus guttatus DC. In marshes along Baker Lake.
Mimulus moschatus Dougl. Moist stream banks.
Verbascum Thapsus L. A weed along roads.
Veronica arvensis L. In grassy places along stream banks.
Veronica scutellata L. In marshes in lower forests.

Orobanchaceae

Orobanche uniflora (L.) Britt. Dry ledges in lower meadows.

Plantaginaceae

Plantago lanceolata L. A weed along roads and trails.

Rubiaceae

Galium Aparine L. In lower forests.
Galium Claytoni Michx. Moist lower forests.
Galium bifolium Wats. Among boulders in the higher meadows.

Caprifoliaceae

Lonicera ciliosa Pursh. Lower forests.
Lonicera utahensis Wats. Rocky ledges in upper forest, to timber line.
Symphoricarpus albus (L.) Blake. Open places on lower slopes.

Compositae

Adenocaulon bicolor Hook. Common in lower forests.
Antennaria Howellii Greene. Alpine meadows.
Antennaria lanata (Hook.) Greene. On stony ridges above timber line.
Antennaria tomentella A. Nels. Alpine meadows.
Anthemis arvensis L. A weed in open places about Baker Lake.
Arctium minus Bernh. A roadside weed.
Arnica longifolia D. C. Eaton. On wet banks along Grouse Creek.
Chrysanthemum Leucanthemum L. var. pinnatifidum Lec. and Lam. A weed about Glacier.
Crepis capillaris (L.) Wallr. In grassy places in the Baker Lake region.
Erigeron acris L. var. debilis A. Gray. Skyline Ridge, *J. W. Thompson.*
Erigeron annuus (L.) Pers. Weed in grassy places between Glacier and Shuksan.

Erigeron canadensis L. Weed in grassy places between Glacier and Shuksan.
Erigeron philadelphicus L. Weed in grassy places between Glacier and Shuksan.
Eriophyllum lanatum (Pursh) Forbes. On dry ledges in the lower meadows.
Gnaphalium purpureum Nutt. In gravelly soils, Baker Lake region.
Gnaphalium uliginosum L. Along lower trails and stream banks.
Hypochaeris radicata L. A weed in grassy places about Glacier.
Lactuca scariola L. var. integrata Gren. and Godr. A weed of disturbed places.
Lactuca spicata (Lam.) Hitchc. Moist ground near Glacier, *J. W. Thompson.*
Madia glomerata Hook. A weed along lower trails and roads.
Matricaria suaveolens (Pursh) Buch. A weed about Glacier.
Senecio Elmeri Piper. Rocky ledges near perpetual ice above Heliotrope Ridge.
Senecio pauciflorus Pursh var. fallax Greenm. In open places in the lower forests.
Senecio vulgaris L. A weed along the lower roads.
Solidago lepida DC. var. fallax Fern. Open places between Glacier and Shuksan.
Sonchus oleraceus L. A weed about Glacier and Baker Lake.
Taraxacum officinale Weber. A weed in grassy places along lower roads and trails.

Cornell University,
Ithaca, New York, January, 1938.

Literature Cited

1. Muenscher, W. C. Flora of Whatcom County, Washington. Muhlenbergia 9: 101–132. 1914.
2. ————. Review: St. John, Harold, and Edith Hardin. Flora of Mount Baker. Torreya 31: 15. 1931.
3. St. John, Harold, and Edith Hardin. Flora of Mount Baker. Mazama 11: 52–102. 1929.
4. Thompson, J. Wm. 1930 Washington Fern Notes. Amer. Fern Journ. 21: 117–124. 1931.
5. ————. Notes on the Flora of the State of Washington, I. Rhodora 34: 236–239. 1932.
6. ————. Notes on the Flora of the State of Washington, III. Rhodora 37: 417–425. 1935.

NOTES ON STACHYS RIGIDA NUTT.

Carl Epling

While botanizing in Del Norte County, California, in 1935, the author found at two stations near Gasquet an unfamiliar form of *Stachys,* apparently referable to *S. rigida* Nutt. This has since been collected in two other places and since it appears to be a reasonably stable geographic race it is here described as new. The specimens cited are deposited in the Herbarium of the University of California at Los Angeles.

Stachys rigida subsp. **lanata** subsp. nov. Herba substricta altitudine 25–30 cm. superne frequenter ramosa caulibus pilis mollibus subretrorsis *dense hirsutulis;* foliorum laminis oblongis 5–7 cm. longis 12–24 mm. latis *utrimque praesertim subtus lanatis* mediorum petiolis *3–10 mm.* longis elatis; spicis subcongestis lanatis 5–10 cm. longis.

California. Del Norte County: Bear Basin near Gasquet, August, 1935, *C. & R. Epling*, type; Patrick's Creek, altitude 1000 feet, July 21, 1937, *Parks & Tracy 11405;* from Smith River Canyon up to rocky hills at 2000 feet altitude, Smith River and Patrick's Creek, July, 1937, *H. E. & S. T. Parks 24024;* French Hill, near Gasquet, August, 1935, *C. & R. Epling.*

Following is a key which will serve approximately to segregate the subspecies of *Stachys rigida* Nutt:

Petioles of lower leaves usually 2.5–4 cm. long.

  Montane plants of the North Coast and Cascade ranges (reappearing in San Diego and Riverside counties); commonly 60 to 100 cm. tall, leaf-blades tending to oblong or deltoid-oblong .... *S. rigida* subsp. *typica*

  Plants chiefly of the coast ranges south of San Francisco Bay and of southern California, but growing as far north as Dyerville, Humboldt County, and as far inland as Willow Creek, Humboldt County; commonly less than 60 cm. tall, leaf-blades tending to ovate or cordate. *S. rigida* subsp. *quercetorum*

Petioles of the lower leaves usually less than 2.5 cm. long; leaf-blades usually narrowly oblong or oblong-ovate; plants chiefly of the Sierra Nevada and Del Norte County.

  Both leaf surfaces softly lanate, silvery. *S. rigida* subsp. *lanata*

  Both leaf surfaces glabrate and green, or at most thinly hirsute .... *S. rigida* subsp. *rivularis*

Stachys rigida subsp. *typica* is found frequently in the Shasta plateau and extends northward to the Columbia River in the Cascade Mountains. It occurs in fairly typical form as far south as Plumas and Butte counties, but merges in this region with subsp. *rivularis* which is characteristic of the Sierra Nevada. The specimens from the Warner Mountains of Modoc County which I have referred to the latter subspecies are very close to *S. pilosa* Nutt., the Rocky Mountain homolog of *S. palustris* L. Subspecies *rivularis* is also found in Napa and Lake counties.

Stachys rigida subsp. *quercetorum* is found from Lower California to southern Oregon, usually at lower elevations, and as the name implies, is often associated with the oak woodland. It is readily recognized south of San Francisco Bay, and may be distinguished from *S. bullata* Benth. by the oblique and prominent annulus. North of San Francisco Bay, however, it seemingly passes into three other forms: *S. Emersoni, S. rigida* subsp. *typica* and subsp. *lanata.* In this region it is generally a coarser plant of larger parts than farther south and is much more tolerant of shade, occurring in almost complete shade in the redwood groves of Humboldt County, for example, in the Bull Creek Grove. In Del Norte County, it is apparently replaced in the redwoods by a shade form of *Stachys Emersoni.* However, plants are found frequently in Humboldt and Mendocino counties which are difficult to assign certainly to either of these species. In Humboldt County subsp. *quercetorum* is transitional to subsp. *typica* and in Mendocino and Sonoma counties forms occur which in turn suggest the silvery dense pubescence of subsp. *lanata,* but have the habit of subsp. *quercetorum.*

Stachys Emersoni is by no means a homogeneous species, and indeed, appears to partake of characteristics both of *S. bullata* and *S. ciliata.* The flowers are characteristically quite dark rose purple. As the author has indicated elsewhere there is reason to believe that *S. Riederi* of Chamisso described from "Kamtschatka" is conspecific with this species. The type of *S. Riederi* has not been located. Recent examination of the Labiatae of the Mociño and Sessé herbarium has further shown that *S. mexicana* of Bentham, a "lost" species, is certainly conspecific with *S. Emersoni.* The specimen of Mociño and Sessé is very similar to that collected by Abrams (no. 11246) at Ilwaco, Washington.

University of California
at Los Angeles, April, 1938.

EREMOCARPUS BENTHAM: PREOCCUPIED?

Louis C. Wheeler

The name *Eremocarpus* was proposed by Bentham (Bot. Voy. Sulphur 53, pl. 26, 1844) for a monotypic genus of Euphorbiaceae. The validity of the generic name was questioned by Coville (Contr. U. S. Nat. Herb. 4: 194. 1893) on the ground that "*Eremocarpus* was first used by Reichenbach, in 1837, as a designation for a genus of Hypericaceae." Piper, apparently accepting Coville's statement on faith (Contr. U. S. Nat. Herb. 11: 382. 1906), renamed *Eremocarpus* Bentham as *Piscaria.* The alleged *Eremocarpus* of Reichenbach which first appeared in his synopsis of the Hypericaceae (Handbuch Nat. Pflanzensystems 307. 1837) is there credited to Spach. The context makes it evident that Reichenbach merely suffered a *lapsus memoriae* regarding *Eremosporus* Spach (Hist. Nat. Veg. 5: 342. 1836, *nomen nudum;* Ann. Sci. Nat. Bot. ser. 2, 5: 355, 1836, Conspectus Monogr. Hypericacearum 349–369). Reichenbach published *Eremocarpus* as follows:

"α) Drosautheae: [*sic,* error for Drosantheae] capsula tricocca, coccis 1–3-spermis, demum cum placenta deciduis. Eremocarpus *Spach.* Drosanthe *Spach.*"

It is quite evident from the similarity of the names and descriptions and from the mention of Spach's monograph (Handbuch Nat. Pflanzensystems 308) that Reichenbach based his characterization of *Drosantheae* on the diagnosis of "*Sectio I.* Drosanthineae" Spach (Ann. Sci. Nat. Bot. ser. 2, 5: 354) under which Spach included only *Eremosporus* and *Drosanthe*. Without description and without indication of any intent to rename, Reichenbach in a later publication again mentions "*Eremocarpus* Spach" (Rep. Herb. Nomenclator 210. 1841). Thus it seems clear that Reichenbach was following Spach's work and merely changed *Eremosporus* Spach accidentally. The reasonable course to follow in this case is to consider "*Eremocarpus* Spach" as an unintentional change without any power to preoccupy. The International Rules of Botanical Nomenclature do not provide for such dubious cases. If anyone wishes to claim that this was an intentional renaming and, though illegitimate, capable of preoccupying the name, it is only necessary to enforce strictly the requirement for valid publication in Article 42: "(2) by the citation of a previously and effectively published description of the genus under another name"; this will automatically exclude "*Eremocarpus* Spach." In no case did Reichenbach give any page reference which is certainly an essential part of a citation. Reichenbach's vague mention on a succeeding page (*vide supra*) of Spach's monograph is not a citation.

There is an exactly parallel case which is apropos here. "Eremocarpus Bunge" appears in a bare list of genera (Lindley, Veg. Kingdom ed. 2: 778. 1847). The authors of Index Kewensis are probably quite right in interpreting this as *Eremodaucus* Bunge, from which it must have arisen by a *lapsus*.

Conclusion: *Eremocarpus* Bentham is not preoccupied.

Gray Herbarium, Harvard University,
Cambridge, Massachusetts,
April 5, 1938.

YNES MEXIA

Ynes Mexia, the daughter of General Enrique A. and Sarah R. (Wilmer) Mexia, was born May 24, 1870, in Georgetown, Washington, D. C. Her father, the son of José Antonio Mexia (a Mexican general under President Santa Anna) was at that time resident in Washington as a representative of the Mexican government. Her mother, Sarah R. Wilmer of Maryland, was of the family of Samuel Eccleston, Fifth Archbishop of Baltimore. A large part of her childhood was spent in Texas where the family owned an eleven league grant upon which the town of Mexia, Limestone County, is now located. Her early education was obtained mainly in private schools in Philadelphia and Ontario, Canada. Later, she attended St. Joseph's College, Emmetsburg, Maryland, and the University of California, Berkeley. She was married in Mexico to Agustin A. de Reygadas but later resumed the use of her maiden name. For considerable periods during the earlier part of her life she lived in Mexico but for the past thirty years has been a resident of San Francisco.

Mrs. Mexia's interest in botanical collecting began in 1922 when she joined an expedition led by Mr. E. L. Furlong, then Curator of Paleontology, University of California, Berkeley; on this occasion, however, she made only a few permanent collections. Her first important collecting was done on a second expedition to Mexico in 1925 in company with Mrs. Roxana S. Ferris, of Dudley Herbarium, Stanford University. During the thirteen years following she made three additional expeditions to Mexico, one to Alaska, and two to South America, collecting a total of about 8800 numbers, approximating 145,000 specimens. She was collecting in the mountains of the State of Oaxaca, Mexico, in 1938 when she became ill and was obliged to return home. Her health did not improve and death followed on July 12, 1938.

Fig. 1. Ynes Mexia.

Mrs. Mexia's collections were always carefully prepared and her field notes unusually detailed. Many of the regions she visited had been but little explored botanically and although studies upon her collections are not yet completed they have yielded a large number of species new to science. At present there have been described two new genera, *Mexianthus mexicanus* Robinson (Compositae) and *Spumula quadrifida* Mains (Pucciniaceae) and about 500 new species (mostly spermatophytes) of which more than 50 have been named in her honor. A brief résumé of her collecting expeditions with approximate numbers of specimens obtained is given at the end of this article.

Published accounts of Mrs. Mexia's expeditions and special reports upon her collections have appeared as follows: Ynes Mexia, Botanical Trails in Old Mexico—the Lure of the Unknown (Madroño 1: 227–238. 1929); Three Thousand Miles up the Amazon (Sierra Club Bulletin, 1933); Camping near the Equator (Sierra Club Bulletin, 1937); Edwin B. Bartram, Mosses of Western Mexico Collected by Mrs. Ynes Mexia (Jour. Wash. Acad. Sci. 18: 577–582. 1928); E. B. Copeland, Brazilian Ferns Collected by Ynes Mexia (Univ. Calif. Publ. Bot. 17: 23–50, pls. 1–8. 1932); Mrs. H. P. Bracelin, Itinerary of Ynes Mexia in South America (Madroño 3: 174–176. 1935).

In the San Francisco Bay region Mrs. Mexia was well known as a lecturer, having appeared before many scientific organizations. Her accounts of botanical explorations were vivid and entertaining, and because of her skill in photography, were unusually well illustrated with views of the general topography and plant associations of the regions visited.

Mrs. Mexia has been a member of the California Botanical Society since 1915. She was a member also of the Sierra Club, the Audubon Association of the Pacific, the Sociedad Geographica de Lima, Peru, a life member of the California Academy of Sciences, and an honorary member of Departamento Forestal y de Caza y Pesco of Mexico.—MRS. H. P. BRACELIN, Berkeley, California.

Botanical Expeditions of Ynes Mexia

Mexico

Western Mexico: September 15 to November 19, 1925; Sinaloa; expedition with Roxana S. Ferris, Dudley Herbarium, Stanford University; 500 numbers, 3500 specimens.

Western Mexico: September, 1926 to April, 1927; states of Sinaloa, Nayarit, Jalisco to 6000 feet elevation in Sierra Madre; 1600 numbers, 33,000 specimens.

Northern and central Mexico: May to July inclusive, 1929; Chihuahua, Mexico, Puebla, Hidalgo; expedition led by Mr. E. L. Furlong, Department of Paleontology, California Institute of Technology, Pasadena; 315 numbers, 5000 specimens.

Southwestern Mexico: October 31, 1937 to May 20, 1938; states of Oaxaca and Guerrero; 700 numbers, 13,000 specimens.

Alaska

Mt. McKinley National Park: June to September, 1938; first general collection of the Park flora; 365 numbers, 6100 specimens.

South America

Brazil and Peru: November, 1929 to March, 1932, inclusive; Brazil, Rio de Janeiro, Viçosa and Diamantina, state of Minas Geraes; Amazon and other river courses in states of Pará and Amazonas; Transandean Peru, upper Amazon and Santiago river valleys, Departamento de Loreto; accompanied for a short time by Agnes M. Chase, Division of Agrostology, United States Department of Agriculture; 3200 numbers, 65,000 specimens.

Ecuador: September, 1934 to September, 1935; coastal plains and eastern Amazonian slope of Andes, northern highlands and Columbian border; expedition for the Bureau of Plant Introduction and Exploration, United States Department of Agriculture to search for palms, cinchonas and soil-binding plants and to make a general collection; 900 numbers, 5000 specimens.

Peru, Bolivia, north central Argentina and Chile: October, 1935 to January, 1936, inclusive; Andean highlands; expedition of the University of California Botanical Garden led by Dr. T. H. Goodspeed; 300 numbers, 1900 specimens.

Peru, Chile, Argentina and Ecuador: January, 1936 to January, 1937, inclusive; southern Chile, Straits of Magellan, Tierra del Fuego; Peru, Cuzco, Machu Pichu, Cerro del Pasco; Ecuador, Esmeraldas; 1000 numbers, 13,000 specimens.

VIAE FELICITATIS: THE BEGINNING YEARS OF THE CALIFORNIA BOTANICAL SOCIETY[1]

Willis Linn Jepson

Mr. Toastmaster and old-time friend: Doctor Foxworthy, Past President of the Society, I salute you: Mr. President of the Society: Members and Guests.

At this silver jubilee happiness for good reason pervades this large gathering. It is a sign of continued vitality that the California Botanical Society this year elected as its president, Professor Howard E. McMinn of Mills College. It is also a source of gratification to me personally to find him occupying the president's chair. Naturally my mind, tonight, goes back to the very beginnings of the Society in 1913, and various happy reflections arise in memory. The backbone of the Society, the most eligible and vital part of the membership, in the earliest years, consisted in the main of those who were not professional botanists in the strictest sense, but men in other fields, most often in fields of applied botany such as agriculture, horticulture, agronomy, silviculture or forestry; but also including men in medicine, dentistry and pharmacy and various business occupations. There was reason for this. It was partly because there were extremely few professional botanists in California at that time, but there was another reason to which I shall advert later. Practically all of these persons who gave the Society its most solid support, and many others equally valuable as members, had a college bachelor's degree in botany, or a master's degree, or a doctor's degree. It will be interesting to recall a few that come to mind. Professor William T. Horne, now of the Citrus Experiment Station, a plant pathologist with the soundest kind of training; Professor W. W. Mackie, of the College of Agriculture, an able agronomist and world traveler; Dr. H. J. Webber, of the College of Agriculture, horticulturist and geneticist, a man with a distinguished scientific record who was the discoverer of motile spermatozoids in

[1] Response at the Annual Dinner of the Society held in Berkeley on April 23, 1938. The Toastmaster was Dr. W. W. Robbins, College of Agriculture at Davis. Past President F. W. Foxworthy, long a forest officer in the Federated Malay States, is now a resident of Berkeley. The President of the Society, Professor H. E. McMinn, introduced the Toastmaster. Those botanists from a distance included Dr. C. B. Wolf, Botanist at the Rancho Santa Ana Botanic Garden, Anaheim; Mr. Elmer I. Applegate, Palo Alto; Dr. Carl Epling, Associate Professor of Botany in the University of California at Los Angeles; Mr. M. Van Rensselaer, Director of the Blaksley Botanic Garden at Santa Barbara; Dr. H. F. Copeland, Professor of Botany in the Sacramento Junior College; Dr. L. H. Knoche of San Jose; Professor D. H. Campbell, Professor Geo. J. Peirce, Professor L. R. Abrams, Professor Ira L. Wiggins and Professor L. R. Blinks of Stanford University; Dr. E. B. Copeland of Chico; Mr. H. A. Dutton of Los Altos; and Dr. D. D. Keck of the Carnegie Institution at Stanford. The major portion of the members present at the dinner came from San Francisco, Burlingame, Oakland and Berkeley. Professor Peirce, a Past President of the Society, read the congratulatory messages from absent members.

Zamia, a genus of cycads; Dr. Herbert M. Evans, of the School of Medicine of the University of California, who never forsook his early love for botany; Elizabeth Smith, plant pathologist in the College of Agriculture, one-time officer of the Society; Professor P. B. Kennedy, a skillful agronomist, who had his doctor's degree in botany from Cornell University, and who was for a time president of the Society; Albert Walker, a pharmacist, who always increased the value of field trips by his knowledge of applied botany as did Dr. A. W. Card, a dentist; F. W. Koch, who was then in charge of the department of biology in the Galileo High School at San Francisco, added his store of field knowledge to the Society's interests; in his youth he had been attached in a minor capacity to the Death Valley Expedition of the United States Biological Survey and never forgot his field experiences with C. Hart Merriam and F. V. Coville; Frederic T. Bioletti, viticulturist in the College of Agriculture, who always remembered vividly the botanical collecting trips of his early days and thrilling discoveries of new species. One of the most valuable and loyal members was Dr. W. C. Blasdale. Although his profession was that of a professor of chemistry in the University of California, botany was with him a capital hobby; he had done much field work and his published papers on botanical subjects are critical contributions to their field. Many, many others could be mentioned if there were time to list them.

The first secretary of the Society was Mrs. D. W. de Veer. If wisdom be the art of so using knowledge or facts as to produce the most satisfactory results, Mrs. de Veer had much wisdom and handled our affairs to advantage. The numerous field trips scheduled by the Society in that early day necessitated a great deal of clerical work. On account of our extremely limited funds it was a rigid rule that all this clerical work must be done by members. Sometimes volunteers were ready, at other times perhaps not so ready. Sometimes I would make appeal in the name of the great Swedish botanist, Linnaeus, or of Theophrastus the Greek, without finding my office door blockaded by helpers.

The first person in these United States to put the unemployed to work was Tom Sawyer. The original Tom Sawyer of the California Botanical Society was our second secretary, Miss Anna Ehlers, who had been a student under that great teacher of botany, Professor Charles E. Bessey of the University of Nebraska. She had not the slightest difficulty in putting members to work. Indeed, it was a byword of that time that she made them work like Trojans. During my long tenure as president of the Society, the secretary of the Society in her capacity as secretary would often look at me reproachfully on account of my numerous shortcomings and perhaps I had reason, therefore, to be thankful that Miss Ehler's disposition was entirely amiable. The next secretary was Professor H. E. McMinn of Mills College, but inasmuch as he lived some distance away from our headquarters it was Mrs.

Adeline Frederick, Assistant Secretary of the Society, who did most of the secretarial work. She brought to the task a remarkable sense of perception and a sagacity and soundness of judgment that furthered the Society's progress in stabilizing ways that are observable to this day. Succeeding Mrs. Frederick as secretary was Mrs. Linda Dodd. It was her function, on account of the years in which she served, to pour oil on troubled waters. She successfully smoothed out many a rough spot and saved us many an inconvenience.

Another early member, for a time an officer of the Society, was Dr. C. B. Bradley, Professor of Rhetoric. We spoke of him as a good man gone wrong. In his early years he had a few happy weeks in the herbarium of Asa Gray and missed becoming a botanist by only a narrow margin. Never, though choosing the field of English, did he lose his early interest in botanical science. His published papers on botanical subjects are soundly, carefully and conscientiously done, and are true scientific contributions. In questions of taste and language he was our undisputed arbiter, especially in problems of transliteration of Greek roots into Latin or directly into English. If there were doubt about a Greek diphthong, as to whether transliteration should be literal or otherwise, we accepted his judgment as infallible. There is an anecdote concerning him, involving a curious case of transliteration, which I would tell if ladies were not present. Oh, well, I'll tell it anyway. Women should not become members of the California Botanical Society unless they are willing to take the risks of the Society. One summer Professor Bradley was in the Sierra Nevada with a small party of young men, naturalists all. One day, being unwell, he elected to stay in camp and write a letter. The cook of the party was a foreigner of the lower class whose English vocabulary was extremely limited but who thought he understood what was said to him. When the cook reported to Professor Bradley for orders, in that careful and precise speech for which he was famous, Professor Bradley said to him: "A cup of tea is all I wish; that will fully meet my requirements. As for the young gentlemen they must speak for themselves. I could not order for them." The cook was a little bewildered by this, but thought he understood fully. When the ravenously hungry field crew came into camp and found no food ready, the cook was taken to task but he defended himself. "But," said one, "didn't Professor Bradley tell you to get up our grub?" "No," said the cook. "But he told you something; what did he say?" Said the cook: "He said, 'By Jinx, I'm all right, but them blankety blankety guys can go blankety blank.' " When Professor Bradley was told of this case of transliteration, he enjoyed it as hugely as anyone else, for he had a deal within him of the liveliest fun and humor.

In the year 1901 there called upon me at my laboratory in Berkeley a research botanist who had come to the Pacific Coast to investigate botanically the sources of the drug cascara sagrada, which is derived from the tree, *Rhamnus Purshiana*. He had been sent by the Wellcombe Research Laboratories of the great London drug and chemical firm, Burroughs and Wellcombe. This botanist's name was P. E. F. Perrédès. In his surveys up and down the Pacific Coast he accumulated a store of highly interesting facts regarding our species of *Rhamnus,* the amount of variation in *Rhamnus Purshiana* as it ranged south into California, the places where it interbred with *Rhamnus californica,* and the extent to which the bark supply was adulterated by *Rhamnus californica* bark, which had quite the same cathartic properties but different therapeutic values. I extended to Perrédès every hospitality and aid, and he was most generous in sharing his knowledge; but it struck me that in such a case as this the hospitality of any one individual was inadequate and that there should be a botanical society in order to fully honor him. Perrédès was a jolly soul and vastly interested in the social habits and ways of my countrymen. One day he came into my laboratory and exclaimed very genially: "You Americans are a very curious people!" I replied, "Certainly we are. Go ahead." "You are a very strange people," he went on. "I observe that you sweep your parlors with a lawn-mower; you take up the collect in church with a fry-pan; you brush your clothes with a broom; and bless my soul, you call a pram a baby-carriage." There were before and after this many other foreign botanists, some of them highly distinguished men, who visited California in those years, botanists from Europe, Australia, New Zealand, Japan and South Africa. In my very early years at Berkeley one of these visitors was Dr. Paul Knuth from Kiel, Germany, the author at a later time of a monumental "Handbook of Flowers and Pollination." Of him I still have a lively picture in my memory, as dressed in a tropical suit he ran hither and thither in the Garden of Native Plants capturing insects with his net. Such travelers continued to appear in California and it was constantly borne in upon me that there should be a botanical society to greet them, honor them and benefit by their presence.

As planned it was determined in my mind that such a botanical society must needs envision four things: 1. It must be a statewide botanical society. 2. Its field of research must be the whole of western America. 3. It must have a printed journal in order to keep touch with its scattered membership. 4. It must have world relations and a world point of view and keep abreast of the progress of botanical science in every land by honoring in its public meetings botanical travelers from all parts of the earth who would interpret for us the research results of their country. These were the four primary objectives.

By means that were highly fortunate the Society to some degree realized these objectives within a few years. While the strength of the membership was in the cities of the San Francisco

Bay region, almost immediately botanists in various and often distant parts of California joined the Society and kept up their membership for decades, even though unable to attend a single meeting of the Society. If these members in remote or lonely places botanically could have a durable trace of light connecting them with the Society by receiving the Society's meeting notices they were happy to lend their continued support to a botanical organization and cooperate in its work. Mrs. Clara A. Hunt of Saint Helena kept up her membership faithfully for years, though never attending a Society meeting. But the inspiration derived from membership caused her to stir up Napa Valley botanically each year with an exhibition of native plants in the beautiful grounds of her Saint Helena home. Mr. Milo N. Wood, pomologist of the United States Department of Agriculture, who was stationed at Sacramento, an expert on *Juglans regia,* maintained his connection with the Society indefinitely; and Mrs. Harriet P. Kelley, at Selma in Fresno County, started a branch of the Society at that place which flourished as long as she was resident there.

For its journal the name Madroño was chosen, because Madroño is euphonious, because it makes a brief and handy title, because it is a name associated with the region, because, most of all, it is the name of the native arbute tree which has great biological and forestal significance. The native vegetation of California is not merely rich and varied to a remarkable degree; it has also an extraordinary geographic significance and an almost ponderous relation to geological history. In such a land a botanical journal must in every way be original and filled with original articles. It is unthinkable that with such a physical background, with such a geographic region as our field, that the Society should in any way copy the journals or adopt the *mores* of older lands; it is unthinkable that it should so lack in originality as to call its journal, for example, a bulletin, which word used a thousand times means perhaps nothing, perhaps anything. There is a great deal in a name if it be original. The name Madroño for our journal was an original thought happily seized by the imagination. It means so vastly more than bulletin that it at once puts the journal on a different plane. In addition to the original articles a portrait of a distinguished botanist or botanical explorer having to do with botany in California was planned as a frontispiece for each volume, thus placing upon each volume a fitting and distinctive seal. Volume one carries as frontispiece the portrait of Archibald Menzies, the botanist of the Vancouver Expedition, the first botanist to collect in any marked degree in California and whose name is inseparably associated with many of our most characteristic plants as discoverer, and especially with *Arbutus Menziesii,* the madroño. The second volume uses as frontispiece the portrait of the distinguished botanist, Thomas Nuttall, who came to California in 1836. It was believed that if the journal fortunately continued and attained to a dozen or twenty volumes or more, this one feature alone would give it an original interest to all botanists in every land.

The fourth condition that the society establish world relations was auspiciously begun when five months after its first meeting it entertained at dinner the members of the International Phytogeographic Excursion, which included amongst them some of the more distinguished botanists of the earth. The party included Dr. Adolf Engler of Berlin; Professor C. von Tubeuf of Munich; Dr. Edward Rübel, Dr. H. Brockmann-Jerosch and Professor Carl Schröter of Zürich; Professor A. G. Tansley of Cambridge, England; Dr. T. J. Stomps of Amsterdam; Dr. Ove Paulsen of Copenhagen; Dr. Carl Skottsberg then of Uppsala; Professor H. C. Cowles of Chicago; Dr. A. Dachnowski of Columbus; Professor and Mrs. F. E. Clements of Minneapolis; Mr. Geo. D. Fuller of Chicago; and Dr. Geo. E. Nichols of New Haven. Over one hundred members of the Society and their friends joined in a demonstration of hospitality to these guests. The arrangements and service were all that could be wished, the dinner being held in a quite noble private dining room of the Hotel Oakland.

The main festival of the Society in its year of activity is the annual dinner, which has been held regularly each year since the first one in 1913. At this dinner it has often been possible to have as chief speaker a visiting European or eastern botanist or botanical traveler from some part of the earth. Greetings are read from absent members and usually some five or six members talk a few minutes before the main speaker comes on.

The importance of this function, extending hospitality to botanists from other lands, cannot well be overestimated. The flora of western America nor that of California is not a vegetation apart, but is involved in its history with all other vegetation areas of the earth. Political boundaries, of course, have no significance. The same thought applies to botanists themselves. When one is reading Schimpfer's "Pflanzen-geographie," Linnaeus' "Fundamenta Botanica" or the "Enquiry into Plants" by Theophrastus, one never thinks of these botanists as belonging to any particular race or state but only as belonging to the company of scientists who have in every age carried forward the light of rationalism. Scientists in the world are a very small group, but they are the only men in any land who have with each other a common understanding, who are able to arrive at common judgments, because they are the only men whose decisions are arrived at purely on the basis of scientific facts, whose decisions are purely objective. In their mental processes, motives of race, country, creed, political orders or social emotion are wholly lacking. It is, therefore, fitting that in our land of California there should be a botanical group which does its share to tend the flame of pure rationalism as a signal and a sign to similar groups in other lands about the earth.

Since the idea of a Society was definitely conceived in the year 1902, some one may note the lapse between that date and the year 1913 when the Society was founded. The answer is not easy to express. Of professional botanists in California at that early day there were but few outside two small groups, one at Stanford University and the other at the University of California. There was no intercourse between the men of these two groups. The men at Berkeley had never called on the men at Stanford, the men at Stanford had never come to Berkeley. The only exception to this rule was myself. I had been down to the Stanford Department of Botany a few times. Eventually I decided to go ahead with the formation of a society, believing that when the botanists of the state generally were members these two groups would follow. It was certainly not to be expected that the professors at Stanford would travel the long distance to Berkeley to join a local society, a society having to do merely with Berkeley. It was obvious the Society must first establish proper claims to support. That judgment as to the Stanford group proved correct. As soon as it was possible I went down to Stanford more frequently. It was not difficult to win to membership so good-natured and genial a man as Dr. LeRoy Abrams and in time he was elected a vice-president of the Society. In 1918 the dean of the summer session at the University of California was Walter Morris Hart, a distinguished scholar and gentleman. I was given an opportunity to nominate the professor of botany in the summer session and I nominated Professor George James Peirce of Stanford University. Professor Peirce was called. He came to Berkeley for the summer, brought Mrs. Peirce and his three charming daughters, and all the family enjoyed themselves hugely. He came again the next year and possibly a third year, though I have forgotten. In any event it led to relations which were to prove of great importance to the California Botanical Society later on. A few years later Professor Douglas Houghton Campbell became a member. This accession led to certain associations which might otherwise have been missed.

Only yesterday I had a letter stamped by the military censor from my niece who is in Spain. In the city where she lives the alarm sounded, warning of the approach of a bombing plane with its bombs dealing a terrible death to people and ghastly destruction to buildings. Immediately, with her servants she fled to the bomb-proof shelter where she was joined by the members of a neighboring family. The mother of this family, however, on getting half way to the shelter remembered that a rug sent home from the cleaners had been left rolled up on the floor. She could not bear the thought that some one might come and find the room untidy, and so went back, unrolled the rug properly and then joined her family in the shelter. This is what might be called devotion to, enthusiasm for an ideal.

The enthusiasm of the early members of the Society for the welfare of the Society was like that. From the very beginning there was this deep enthusiasm. Those who joined in the Society's work took the greatest possible interest in it; they felt honored to be a part of it. I recall, almost at random, the loyalty of Inez Ray Smith of Hillsborough, the wife of Mr. James Bernard Smith. She made the flora of San Mateo County her specialty and usually led the field trips scheduled for that region. She took pains to go over the ground in advance so that the excursion might be in every way most profitable to the members and nothing missed. I observed that in addition to her scientific interest she had an appreciation of the beauties of nature in its manifold forms. It is probable that this esthetic appreciation was an inherited characteristic, since she was a cousin of the distinguished American artist, Charles Dana Gibson. Both Mr. and Mrs. Smith enjoyed greatly their connection with the Society which led directly to their financial aid to the Department of Botany at Mills College and their support of the research work of various California botanists.

As time passed the Society gradually drew into its fold botanists far and near about the state and took pride in its accessioned members, of whom I can only mention a few. Dr. L. H. Knoche, who had his undergraduate training under Professor W. R. Dudley, went to the University of Montpellier in France to study plant geography under Professor Charles Flahault. While in France he became interested in the problems of the Mediterranean flora and produced his classical four-volume work, "Flora Balearica," a phytogeographical study of the Balearic Islands. Later he returned to the United States, settled once more in his boyhood home of San Jose, built an herbarium building for his herbarium of over 100,000 specimens and a botanical library of approximately 12,000 volumes and 35,000 pamphlets. Milo S. Baker, another member, in his early years a well-known explorer of northeastern California, later resided in Sonoma County, and as professor of botany in the Santa Rosa Junior College, brought together an admirable local herbarium and specialized on the genus *Viola*. Carlotta Case Hall, whose interests centered on Pteridophyta and especially the ferns of California, was another delightful member of early days. Others of note were Dr. E. P. Meinecke, pathologist in the United States Forest Service, and Dr. Charles Piper Smith, of the San Jose High School, who left the eastern United States and settled in California for the field advantage of his critical studies on the genus *Lupinus*.

The field trips, some twenty to forty a year, were always a very important part of the Society's programmes in early years and were well attended. For at least a decade, a "camping trip," covering two or three days in the field, was arranged for the end of May. One such excursion in 1921 was made to the Mayacamas Range in Mendocino County where, on a high mountain side, are situated the native plant gardens of Carl Purdy. Some one hundred members formed the party, including a number of zoologists. The camp spot was situated in a most delightful vale where the natural conditions had never been disturbed.

Such field trips were of great profit to nurserymen, horticulturists and foresters and to teachers in the schools, especially to those who had recently come to California from the eastern United States and thus found an unfamiliar flora. The values of field experience were various and are not easy to summarize in a few words. It sometimes happened that members who had no particular bent for the critical side of either plant ecology or plant taxonomy yet developed certain natural history interests of importance. An illustrative example is that of Mrs. Ynes Mexia whose inspirations were derived from the Society. She made successful collecting trips to Mexico, and later, from 1929 to 1932, went to South America. On one of her expeditions she proceeded from the eastern coast of Brazil to the headwaters of the Amazon River and thence over the Andes, most of the way with only Indian canoemen, to Peru. The plant materials which she gathered on this trip are of real importance to botanists and will permanently associate her name with certain phases of South American botany. In addition, botanists from foreign countries appreciated the Society's field excursions. One recalls Dr. Alice Scouvart, a student of Professor Jean Massart of the University of Brussels, who, coming to live in California for a few years, taught some of our members the values lying in the scientific names of plants.

The field trips were unquestionably a great tonic and it were unfortunate if they lapsed entirely. One field trip a year, planned with elaborate care, to some remarkable area in California, would attract attendance from the eastern United States and give us the advantage of more frequent association with distant botanists. There is no botanist or botanical traveler or layman interested in the native plants but would wish to see first of all six notable plant associations in California, namely, the Torrey pines association on Santa Rosa Island; the Joshua tree or yucca association on the Coolgardie Yucca Mesa in the east central Mohave Desert north of the Calico Mountains; the big tree association in the Giant Forest at Round Meadow above Kaweah; the serpentine association in eastern Lake County; the redwood association of Prairie Creek in Humboldt County; and the Bishop pine-beach pine association on the Mendocino Coastal Plain. It were impossible to say which of these associations is the more remarkable, since they are all so utterly different and are, indeed, not comparable; but none of them is as yet botanically well known. All await intensive study.

On the Mendocino coastal plain are almost incredible sights: bishop pine and beach pine growing to their full stature 50 to 75 feet high in loam soil; a few yards away the same species dwarfed down to mere canes but coming into reproductive maturity and bearing cones when only 1 to 2 or 3 feet high. A short time ago I discovered on broken and difficult terrain a cluster of the Mendocino cypress, a small colony of about twenty-five trees, that probably represent the largest individuals of true cypress in the New World. Standing before these trees one feels as if he were in the presence of *Sequoia gigantea.* The trunks go on up and up and up without sensible diminution in size to a small rounded crown of short branches. One-eighth mile away on the gypsum soil this same species occurs as tiny dwarfs which produce cones when only 1 to 2 feet high.

Nor, in the planning of any major excursions, should the great San Joaquin, where much of the primitive vegetation still remains, be forgotten. Of all the areas surrounding the Great Valley of California the ranges on the west side of the San Joaquin Valley, far south, are in summer the most desolate—as if no living thing could ever flourish in that hopeless dryness. But then comes the providence of winter rains in a good year and one stands on the plain in front of the San Carlos foothills and beholds waterfalls of flowers down their steep faces and diadems of yellow on the summits which run out into filagrees of gold on the slopes and ridges. For fifteen miles north along the range, in brilliant sunshine, one surveys that color, for fifteen miles south the eye follows that broad band of pageantry—thirty miles of glory. In such a year uncommon species become common and help outline more definitely the plant associations. In such a year, too, one may get glimpses of the relation of the plant formations to the geological fault blocks. One traces a narrow endemic to a fault line where it stops. In one case a species was found in abundance, which had not been seen before in forty years. It was a so-called "lost species." The year that I was born in California was not so far from the year in which was published the "Origin of Species" and, as I grew up, everything was most naturally and easily explained by various interpretations of Darwin's beautiful theory. Some of the new species discovered and published at an early day in California had never been found again and it was explained to us that in the plentitude of evolutionary differentiation of new species more species were produced than could survive. Hence the "lost species" in California. We have quite different ideas now. We imagine we know more about behavior in the soil of seeds of certain native species—dormant five, twenty, fifty or more years, until a year comes when there is a favorable run of low temperatures in connection with appropriate moisture conditions and other as yet unappreciated or not fully understood factors.

Of the early years of the Society I tend to have only happy memories. Nevertheless, it was not always one bright and charming holiday without untoward incident. There were days and even years when discouragements nearly mastered the situation and I was again and again almost ready to give up. But these things were in the end offset by progress and success and especially by the moral support of one's friends, by friends who knew nothing of one's difficulties, but whose faith was unshakeable. Such friends were Anson and Anita Blake, Cornelius Beach Bradley, Samuel B. Parish, Eliza B. Parish, Cornelia C. Pringle, Frederick Hein, Emanuel Fritz and others, too many for all to be listed now.

On one of the Society's excursions a woman member chanced delightedly upon a California black oak seedling in the forest and claimed it for her garden. But she could not lift it out of the soil, nor could two men members who came to her aid, though it was only four inches high. They did not know that the little oak was eight or ten years old and had been insuring its life by giving nearly all to its root system. The California Botanical Society was like that in its first eighteen years. It had put its all in foundational roots. When late in 1929 the nominating committee brought to me the list of nominees of officers for the next year I took the list and drew a pencil through the name of Willis Linn Jepson for president and wrote in the name of George James Peirce of Stanford. I was now certain that the Society could not readily be uprooted. It was ready to flourish above ground and Professor Peirce was the one best fitted to guide it as president during a period of expansion and further development.

The future of the Society lies fair and bright before it. There is every hope that it will extend its usefulness to all parts of California and that its days will be days of inspiring growth and days of true felicity. Its friends will be multiplied and it will in this, our California, live long in the land.

NOTES ON THE GENUS RIBES IN CALIFORNIA

Clarence R. Quick

In the course of field work in the control of white-pine blister rust (*Cronartium ribicola* Fischer) in California, field supervisors have made interesting observations on the distribution and morphology of native species of *Ribes* (wild currants and gooseberries). The following notes include the more important of these observations which have not hitherto been recorded in botanical literature.

Acknowledgement is made of the facilities and technical assistance furnished by the College of Agriculture, the Depart-

ment of Botany and the Botanical Garden of the University of California at Berkeley. The Botanical Garden has materially assisted in accumulating and maintaining a large collection of *Ribes* species, both native and exotic.

Ribes amarum McClatchie, Erythea 2: 79. 1894. The northern limit in the Sierra Nevada of the distribution of *Ribes amarum,* a species principally of southern California, is given by Jepson (Fl. Calif. 2: 153. 1936) as Mariposa County. Early in the spring of 1936, however, Douglas R. Miller and Horace D. Jones collected specimens of *Ribes* in a canyon northeast of Georgetown, Eldorado County, which were identified by Stephen N. Wyckoff as this species. Additional specimens were obtained by the writer from the same locality on July 16, 1936. The collections were made at an elevation of about 3000 feet in a ravine along that small branch of Canyon Creek which is crossed by the Georgetown-Wentworth Springs road (section 5, T. 12 N., R. 11 E., Mt. Diablo B. & M.). During the past two years workers on blister rust control have reported a fair abundance of the species in this vicinity.

The elevational range of *Ribes amarum* is usually given as 1000 to 4000 feet. In September, 1936, Russell L. Keene showed the writer plants of this species on Chowchilla Mountain in Mariposa County. These plants grew on a small, steep branch of Devil's Gulch, at an elevation of about 6500 feet (sections 11 and 12, T. 5 S., R. 20 E., Mt. Diablo B. & M.). Specimens for the herbarium and a few seeds were collected.

Ribes cereum Dougl. Trans. Hort. Soc. 7: 512. 1830. This species is both widespread and abundant in the higher elevations of the Sierra Nevada. Fruiting bushes have been observed by the writer on the South Fork of the Stanislaus River, as low as 4800 feet, and the species has been noted by Jepson (Fl. Calif. 2: 146. 1936) at 12,000 feet elevation on Mt. Whitney. The size of the plants varies widely with elevation: at 6500 to 8500 feet, in the Stanislaus region, whole hillsides are sometimes covered by the species; at an elevation of about 7000 feet, the bushes may be as tall as eight feet; while at higher elevations in the same region where *Pinus albicaulis* Engelm. is slightly more than knee-high, plants of *R. cereum* are but a few inches high. Several three-inch bushes are shown in figure 1 (pl. XXXVIII), photographed at 11,000 feet elevation on a spur of Mount Leavitt near the summit of Sonora Pass highway (Mono-Tuolumne county line). Figure 2 (pl. XXXVIII), taken near Strawberry Lake, Tuolumne County, at 7200 feet elevation (section 13, T. 4 N., R. 18 E., Mt. Diablo B. & M.) depicts one of the branches of fruit from this region, which characteristically reach a greater length in a single season than do the entire plants illustrated in figure 1.

Ribes Menziesii Pursh var. **ixoderme** var. nov. Frutex viscido-glandulosissimus usque ad 18 dm. altus, internodis crebre aculeatis hirsutisque, herba partium juniorium ac foliis utrinque flavido-viridibus dense glanduloso-pubescentibus hirsutulis viscidis aromaticissimus, pedunculis petiolos plerumque excedentibus, floribus amplis (14–20 mm. longis) rubiginosis, ovario pilis albidis ac glandulis rubro-stipitatis obtecto, fructu diametro usque ad 2 cm. aliquantulum ovoideo stramineo vel dilute sanguineo, fructus crusta dura viscida crebre breviterque aculeata aromaticissima.

Deciduous shrub with densely glandular-hairy, viscid, pubescent, yellowish-green, and strongly aromatic herbage; nodal spines 3, unequal, about 1 cm. long; internodes densely prickly, very glandular and somewhat pubescent; peduncles 2–3 cm. long, 1–3-flowered, usually much longer than the petioles; flowers large (14–20 mm. long), and showy; hypanthium 3–4 mm. long, about as broad as long; sepals 2.5–5 mm. wide, 6–9 mm. long, 1.25–2.5 times length of hypanthium; rich mahogany red on inside surfaces; petals white, about half as long as filaments; anthers usually 3 mm. or longer; ovary densely covered with red-stalked glands, and a few white hairs; fruits subglobose or slightly elongate, up to 2 or 2.5 cm. in diameter, yellowish, or tan-colored, often tinged reddish, very densely glandular-bristly, viscid and strong-smelling, the thick skins superficially nauseous because of the oily glands.

Type: abundant in tall mixed chaparral, at 3000 feet altitude, just below the lower limit of yellow pine along the Sand Creek road to General Grant National Park in the foothills of the Sierra Nevada, Fresno County (section 19, T. 14 S., R. 27 E., Mt. Diablo B. & M.), April 17, 1934, *C. R. Quick 1254* (Herb. Univ. Calif. no. 575,099; isotypes, Stanford Univ., U. S. Nat. Herb., Calif. Acad. Sci.). It was also found growing abundantly at approximately the same elevation in Tulare County along the Orosi-Badger road (T. 15 S., R. 27 E., Mt. Diablo B. & M.). Transplants and seedlings have been established at Berkeley in the University of California Botanical Garden.

The very numerous glands on the herbage and fruits suggested the varietal designation. Of the varieties of the *Ribes Menziesii* aggregate, var. *ixoderme* most closely resembles var. *leptosmum* (Cov.) Jepson. It differs from typical *R. Menziesii* by having (1) much greater density of hairs and stalked glands on the herbage, (2) larger, less spiny, but much more glandular fruit, (3) longer petioles and especially peduncles, (4) larger flowers, (5) a much heavier and more penetrating odor. In addition, var. *ixoderme* grows at a higher elevation than *R. Menziesii*, and was found in a location distinctly different floristically from that previously described for *R. Menziesii*. The variety differs from *R. Menziesii* var. *leptosmum* by having (1) young twigs consistently hairy, and very bristly and glandular; (2) both surfaces of leaves densely glandular-hairy, (3) peduncles longer, (4) flowers heavier, (5) mature fruits much lighter colored, (6) a

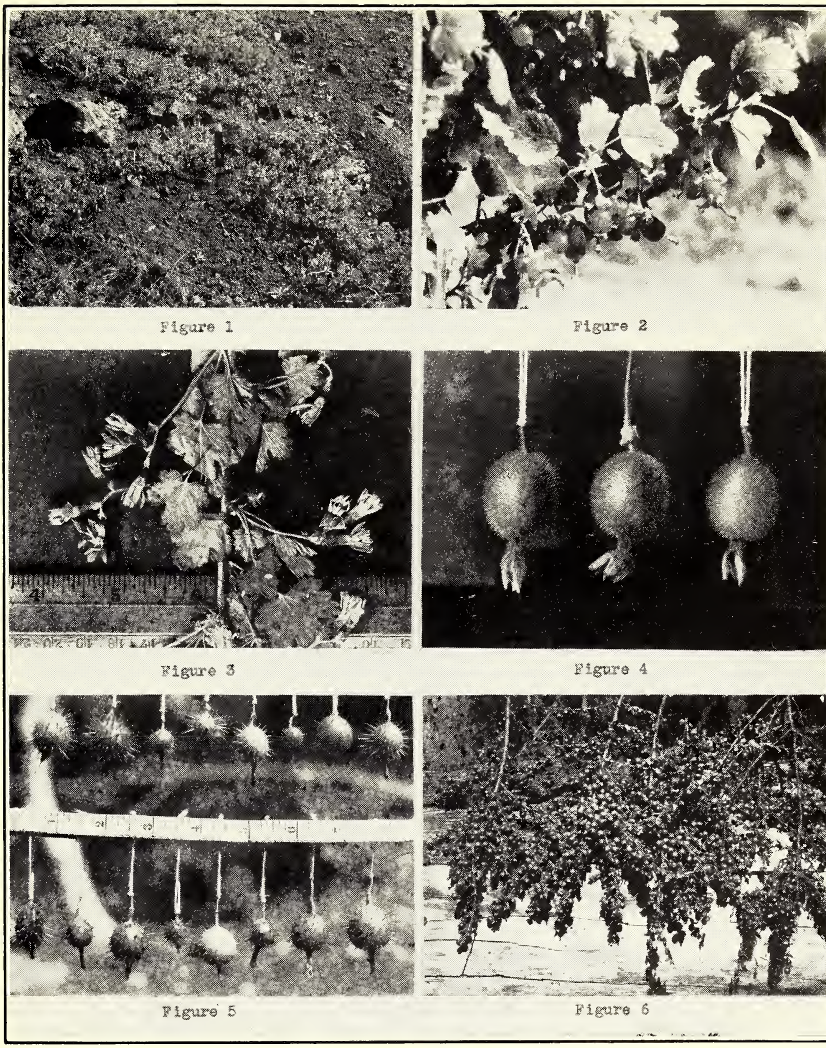


PLATE XXXVIII. STUDIES IN RIBES. Fig. 1. Mature bushes of *Ribes cereum* at 11,000 feet elevation (note pocket knife for comparison of size). Fig. 2. Fruiting branch of *Ribes cereum* at 7200 feet elevation. Fig. 3. Part of type specimen of *Ribes Menziesii* var. *ixoderme*. Fig. 4. Fruits of *Ribes Menziesii* var. *ixoderme*. Fig. 5. Ripe fruits of *Ribes Roezlii*. Fig. 6. Fruiting branches of *Ribes Roezlii* (Photograph by F. A. Patty).

distinctive and penetrating odor. Furthermore, the two varieties occupy distinct geographical ranges.

The geographic and taxonomic variations of the linneon *Ribes Menziesii* are outlined at some length by Jepson (*op. cit.*, p. 155–156). The recently discovered plant treated as a variety fits very well, it is believed, into Jepson's understanding of the *R. Menziesii* group. As far as can be determined, no representative of this aggregate has been reported previously from the Sierra Nevada.

Ribes petiolare Dougl. Trans. Hort. Soc. London 7: 514. 1830. Until recently this montane species, abundant along streams in the Pacific Northwest, had not been reported from California. On September 18, 1936, however, George A. Root and Hollis Day (California Ranger 89: 4. 1937), while inspecting *Ribes* and white pines for white-pine blister rust in the Goose Nest (Little Shasta) district of the Shasta National Forest, found bushes of *Ribes petiolare* scattered for about two miles along Shovel Creek, Siskiyou County) (section 25, T. 47 N., R. 3 W., Mt. Diablo B. & M.), in the ravine at 3200 feet. This site is about nine miles south of the California-Oregon state line. Specimens for the herbarium and a few seeds were collected.

In 1934 George A. Root and Robert Roney observed a few bushes of this species at 5000 feet on Kelley Creek in the Warner Mountains, Lake County, Oregon, only one and one-half miles north of the California-Oregon state line (sections 17 and 18, T. 41 S., R. 21 E., Willamette B. & M.). A few days previously the species was observed in abundance by the writer in Lake County, Oregon, on Crane Creek (sections 7 and 8, T., 40 S., R. 21 E.). Similar westerly flowing creeks in the Warner Mountains just south of California-Oregon state line were carefully inspected but the species was not found.

Ribes Roezlii Regel, Gartenfl. 28: 226. 1879. The Sierra gooseberry is the most widespread and abundant species of *Ribes* in the commercial sugar pine stands of California. It ranges in elevation from 3500 to 8500 feet in the central Sierra Nevada, occurring locally in extraordinary abundance at 4500 to 7500 feet.

The fruits are highly variable as to size, color, shape and spininess, those of some bushes being exceedingly spiny, while those of others may be practically spineless. Their usual color when ripe is dark red, but mature berries of many bushes in the Stanislaus National Forest are bright yellow. Figure 5 (pl. XXXVIII) shows a number of ripe fruits collected at 7200 feet elevation in a small area near Gooseberry Camp, southeast of Strawberry Lake, Tuolumne County (section 13, T. 4 N., R. 18 E., Mt. Dialbo B. & M.). The fourth berry from the right in each line of fruits is fully mature, and bright yellow.

In favorable years vigorous bushes of *Ribes Roezlii* fruit prolifically. The plants illustrated in figure 6 (pl. XXXVIII) were photographed at about 6300 feet elevation on Cow Creek, a tributary of the middle fork of the Stanislaus River, Tuolumne County (section 34, T. 5 N., R. 18 E., Mt. Diablo B. & M.).

Bureau of Entomology and Plant Quarantine,
United States Department of Agriculture,
Berkeley, California, November 9, 1937

A HYBRID ERIOGONUM

HERBERT L. MASON

× **Eriogonum Blissianum** hybr. nov. (*E. giganteum* Wats. × *E. arborescens* Greene). Frutex compactus, hemisphericus, 9–12 dm. altus; forma et cymis *E. arborescenti,* bracteis *E. giganteo* similis; folia 2–10 cm. longa, oblongo-elliptica, forma inter parentes intermedia, paullo revoluta, in petiolis brevibus, crassis attenuata, supra puberula vel glabra, subtus dense tomentosa; cymae paniculatae; pedunculi 6–20 cm. longi; structura floralis ut in parentibus; perianthii segmenta albida, apicibus saepe rubescentibus.

Compact rounded shrub, 9–12 dm. high; resembling *E. arborescens* Greene in compact growth form and inflorescence, and *E. giganteum* Wats. in shape and size of bracts; leaves 2–10 cm. long, oblong-elliptic, intermediate in shape between those of the two parent species, somewhat revolute, attenuate to a short stout petiole; upper surface puberulent to glabrate, lower surface with dense felt-like tomentum; cyme paniculate; peduncules 6–20 cm. (averaging 10 cm.) long; floral structure as in both parents; perianth segments whitish, often with pink tinge at tips.

Type: collected in Blaksley Botanic Garden, Santa Barbara, California, July 12, 1938, *M. Van Rensselaer 557* (University of California Herbarium no. 589831).

The specimen selected as the type appeared as a volunteer in the *Eriogonum* bed of the Blaksley Botanic Garden at Santa Barbara, California, and similar specimens have been grown from seed taken from *E. giganteum* in that garden. Thus it would appear that *E. giganteum* is the female parent. As a result of several years' observation it can be stated that the hybrids are probably sterile.

The widespread popularity of this *Eriogonum* hybrid as a garden ornamental makes a name desirable. As an ornamental it surpasses either parent and is highly recommended for California gardens. I take pleasure in naming it in honor of the late Anna Dorinda Blaksley Bliss, founder of the Blaksley Botanic Garden, and her daughter Mrs. Robert Woods Bliss.

University of California,
Berkeley, August 1, 1938.

Plate XXXIX. Eriogonum Blissianum Mason.

INDEX TO VOLUME IV

New scientific names, and page numbers of principal entries of species and varieties, are printed in bold-face type.

ERRATA

Page 52, line 19: for *tuberculosa* read *tuberosa.*

Page 78, line 10: for *D. multiflora* read *Dondia multiflora.*

Page 80, line 9: for *leptocephala* read *leptosepala;* line 13, for *Hallii* read *Halei;* line 20, for *confertifolia* read *confertiflora.*

Page 94, lines 9 and 10: for *Amelopsis* read *Ampelopsis;* line 34, for *verticillaria* read *verticillata.*

Page 111, line 41: for *Hypis* read *Hyptis.*

Page 126, line 2: for Professor *read* Associate Professor.

Cover, April 1938, line 3 of Contents: for *Caytonia* read *Claytonia.*

Volume 3, page 325, line 44: *for* 6000 *read* 3400.

[illegible]